



University of Belgrade  
Technical Faculty in Bor

EcoTEK

31<sup>st</sup> International conference

# Ecological Truth & Environmental Research

Editor

Prof. Dr Snežana Šerbula

## PROCEEDINGS

Hotel Sunce, Sokobanja, Serbia  
18–21 June 2024

## PROCEEDINGS

### 31<sup>st</sup> INTERNATIONAL CONFERENCE

### ECOLOGICAL TRUTH & ENVIRONMENTAL RESEARCH – EcoTER'24

**Editor:**

Prof. Dr Snežana Šerbula, University of Belgrade, Technical Faculty in Bor

**Technical editors of the Proceedings:**

Dr Tanja Kalinović, University of Belgrade, Technical Faculty in Bor

Dr Jelena Kalinović, University of Belgrade, Technical Faculty in Bor

Prof. Dr Ana Radojević, University of Belgrade, Technical Faculty in Bor

Dr Jelena Jordanović, University of Belgrade, Technical Faculty in Bor

Sonja Stanković, MSc, University of Belgrade, Technical Faculty in Bor

**Editor of the 6<sup>th</sup> Student Section:**

Prof. Dr Maja Nujkić, University of Belgrade, Technical Faculty in Bor

**Technical editor of the 6<sup>th</sup> Student Section:**

Vladan Nedelkovski, MSc, University of Belgrade, Technical Faculty in Bor

**Cover design:**

Aleksandar Cvetković, BSc, University of Belgrade, Technical Faculty in Bor

**Publisher:** University of Belgrade, Technical Faculty in Bor

**For the publisher:** Prof. Dr Dejan Tanikić, Dean

**Printed:** University of Belgrade, Technical Faculty in Bor, 100 copies, electronic edition

**Year of publication:** 2024



This work is available under the Creative Commons Attribution-Non-commercial-NoDerivs licence (CC BY-NC-ND)

CIP - Katalogizacija u publikaciji  
Narodna biblioteka Srbije, Beograd

502/504(082)(0.034.2)

574(082)(0.034.2)

**INTERNATIONAL Conference Ecological Truth & Environmental Research (31 ; 2024 ; Sokobanja)**

Proceedings [Elektronski izvor] / 31st International conference Ecological Truth & Environmental Research - EcoTER'24, Sokobanja, Serbia, 18-21 June 2024 ; [organized by] University of Belgrade, Technical faculty in Bor (Serbia) ; [co-organizers University of Banja Luka, Faculty of Technology – Banja Luka (B&H) ... [et al.]] ; [editor Snežana Šerbula]. - Bor : University of Belgrade, Technical faculty, 2024 (Bor : University of Belgrade, Technical faculty). - 1 elektronski optički disk (CD-ROM) ; 12 cm

Sistemski zahtevi: Nisu navedeni. - Nasl. sa naslovne strane dokumenta. - Preface / Snežana Šerbula. - Tiraž 100. - Bibliografija uz svaki rad.

ISBN 978-86-6305-152-2

a) Животна средина -- Зборници б) Екологија – Зборници

COBISS.SR-ID 147002889



**The 31<sup>st</sup> International Conference  
Ecological Truth & Environmental Research – EcoTER'24**

*is organized by:*

UNIVERSITY OF BELGRADE  
TECHNICAL FACULTY IN BOR (SERBIA)

*Co-organizers of the conference:*

University of Banja Luka, Faculty of Technology,  
Banja Luka (B&H)

University of Montenegro, Faculty of Metallurgy and Technology, Podgorica  
(Montenegro)

University of Zagreb, Faculty of Metallurgy, Sisak (Croatia)

University of Pristina, Faculty of Technical Sciences, Kosovska Mitrovica  
(Serbia)

Society of Young Researchers – Bor (Serbia)

## SCIENTIFIC COMMITTEE

### **Prof. Dr Snežana Šerbula, *President***

Prof. Dr Alok Mittal (India)	Prof. Dr Milutin Milosavljević (Serbia)
Prof. Dr Jan Bogaert (Belgium)	Prof. Dr Nenad Stavretović (Serbia)
Prof. Dr A. Nadgórska-Socha (Poland)	Prof. Dr Ivan Mihajlović (Serbia)
Prof. Dr Luis A. Cisternas (Chile)	Prof. Dr Milovan Vuković (Serbia)
Prof. Dr Wenhong Fan (China)	Prof. Dr Nada Blagojević (Montenegro)
Prof. Dr Martin Brtnický (Czech Republic)	Prof. Dr Darko Vuksanović (Montenegro)
Prof. Dr I.M. De Oliveira Abrantes (Portugal)	Prof. Dr Irena Nikolić (Montenegro)
Prof. Dr Shengguo Xue (China)	Prof. Dr Šefket Goletić (B&H)
Prof. Dr Tomáš Lošák (Czech Republic)	Prof. Dr Džafer Dautbegović (B&H)
Prof. Dr Maurice Millet (France)	Prof. Dr Borislav Malinović (B&H)
Prof. Dr Murray T. Brown (New Zealand)	Prof. Dr Slavica Sladojević (B&H)
Prof. Dr Xiaosan Luo (China)	Prof. Dr Nada Šumatić (B&H)
Prof. Dr Daniel J. Bain (USA)	Prof. Dr Snežana Milić (Serbia)
Prof. Dr Che Fauziah Binti Ishak (Malaysia)	Prof. Dr Dejan Tanikić (Serbia)
Prof. Dr Richard Thornton Baker (UK)	Prof. Dr Milan Trumić (Serbia)
Prof. Dr Mohamed Damak (Tunisia)	Dr Jasmina Stevanović (Serbia)
Prof. Dr Jyoti Mittal (India)	Dr Dragana Randelović (Serbia)
Prof. Dr Miriam Balaban (USA)	Dr Viša Tasić (Serbia)
Prof. Dr Fernando Carrillo-Navarrete (Spain)	Dr Ljiljana Avramović (Serbia)
Prof. Dr Pablo L. Higuera (Spain)	Dr Stefan Đorđievski (Serbia)
Prof. Dr Mustafa Cetin (Turkey)	Prof. Dr Branimir Jovančičević (Serbia)
Prof. Dr Mauro Masiol (Italy)	Dr Mirjana Marković (Serbia)
Prof. Dr George Z. Kyzas (Greece)	Dr Lidija Mančić (Serbia)
Prof. Dr Mustafa Imamoğlu (Turkey)	Dr Tanja Brdarić (Serbia)
Prof. Dr Petr Solzhenkin (Russia)	Prof. Dr Tatjana Anđelković (Serbia)
Prof. Dr Yeomin Yoon (USA)	Prof. Dr Milan D. Antonijević (UK)
Prof. Dr Chang-min Park (South Korea)	Prof. Dr Jelena Mitrović (Serbia)
Prof. Dr Faramarz Doulati Ardejani (Iran)	Prof. Dr Polonca Trebše (Slovenia)
Prof. Dr Natalija Dolić (Croatia)	Prof. Dr Popescu Francisc (Romania)
Prof. Dr Adrian Eugen Cioablă (Romania)	

## HONORARY COMMITTEE

**Dr. Petar Paunović**

(Zaječar, Serbia)

**Prof. Dr Zvonimir Stanković**

(Bor, Serbia)

**Prof. Dr Velizar Stanković**

(Bor, Serbia)

**Prof. Dr Milan M. Antonijević**

(Bor, Serbia)

**Prof. Dr Ladislav Lazić**

(Sisak, Croatia)

**Dragan Randelović, Society of Young Researchers – Bor**

(Bor, Serbia)

**Toplica Marjanović, Society of Young Researchers – Bor**

(Bor, Serbia)

**Mihajlo Stanković, Special Nature Reserve of Zasavica**

(Sremska Mitrovica, Serbia)

## ORGANIZING COMMITTEE

**Prof. Dr Snežana Šerbula, *President***

**Prof. Dr Snežana Milić, *Vice President***

**Prof. Dr Đorđe Nikolić, *Vice President***

**Prof. Dr Ana Radojević, *Vice President***

**Dr Tanja Kalinović, *Vice President***

Prof. Dr Marija Petrović Mihajlović

Prof. Dr Milan Radovanović

Prof. Dr Milica Veličković

Prof. Dr Danijela Voza

Prof. Dr Maja Nujkić

Prof. Dr Ana Simonović

Dr Jelena Kalinović

Dr Jelena Jordanović

Dr Dragana Medić

Sonja Stanković, MSc

Vladan Nedelkovski, MSc

Aleksandar Cvetković, BSc

Dragan Milenković, IT service

## **PREFACE**

*The 31<sup>st</sup> international conference Ecological Truth & Environmental Research – EcoTER'24 focuses on showing the latest research findings and innovations in the field of ecology, environmental protection and sustainable development. The conference will be held in Sokobanja (Serbia) in hotel Sunce in the period of 18–21 June 2024.*

*The aim of the conference is to connect the experts in various fields in order to transform attitudes and behaviors in everyday practices, as well as in the industry and economy sector which is essential for achieving the desired changes that our society must undergo.*

*The 31<sup>st</sup> international conference Ecological Truth & Environmental Research – EcoTER'24 is organized by the University of Belgrade, Technical Faculty in Bor, and co-organized by the University of Banja Luka, Faculty of Technology; the University of Montenegro, Faculty of Metallurgy and Technology – Podgorica; the University of Zagreb, Faculty of Metallurgy – Sisak; the University of Pristina, Faculty of Technical Sciences – Kosovska Mitrovica and the Society of Young Researchers – Bor.*

*These Proceedings encompass 119 papers from the authors coming from the universities, research institutes and industries in 15 countries: Brazil, Norway, USA, Spain, Austria, Libya, Italy, Israel, Slovenia, Croatia, Romania, Bulgaria, Montenegro, Bosnia and Herzegovina, North Macedonia, and Serbia. It is a great honor and pleasure to cordially wish a warm welcome to all the participants of the conference.*

*As a part of this year's conference, the 6<sup>th</sup> Student Section – EcoTERS'24 will be held. We appreciate the contribution of the students and their mentors who have also participated in the conference and hope that students will continue to explore and to be curious, since education is a never-ending process, and knowledge is continuously growing.*

*The organization of the EcoTER'24 conference has been financially supported by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia.*

*The support of the Donors and their willingness and ability to cooperate has been of great importance for the success of the EcoTER'24 conference. The organizing committee would like to extend their appreciation and gratitude to the Platinum donors of the conference – Serbia ZiJin Copper doo Bor and HBIS SERBIA, to the Gold donor of the conference – Elixir Group, as well as to the Silver donor of the conference – Serbian Chamber of Engineers.*

*We would like to express our sincere appreciation to all the authors who have contributed to the Proceedings. We would also like to express our gratitude to the members of the scientific, organizing and honorary committees, reviewers, speakers, chairpersons and all the conference participants for their support of the EcoTER'24. Sincere thanks go to all the people who have contributed to the successful organization of the EcoTER'24.*

*Prof. Snežana Šerbula,*

*President of the scientific and organizing committee*



## TABLE OF CONTENTS

### Plenary Lectures

**Branko Bugarski**

ELECTROSTATIC DISPERSION OF POLYMER SOLUTIONS IN THE PRODUCTION OF MICROGEL BEADS CONTAINING BIOCATALYST 1

**Anupama Ghosh, M. R. Del Grande, L. T. Teixeira, S. Letichevsky, C. A. Senna, M. D. Carbajal Ccoyllo, J. F. Chaves e Silva, V. C. Gois de Oliveira, R. N. Correia de Siqueira**

HEAT TREATMENT OF IRON-ADSORBED FUNCTIONALIZED NANOCELLULOSE FIBERS IN ORDER TO SYNTHESIZE HYBRID INORGANIC-CARBON MATERIAL 8

**Alena Bartonova**

ENVIRONMENTAL PROTECTION: WHY IS EUROPE'S AIR (MOSTLY) SO CLEAN? 14

### Invited Lectures

**Nevenka Rajić, J. Pavlović**

APPLICATION OF NATURAL ZEOLITE – CLINOPTILOLITE IN WATER TREATMENT BY ADSORPTION AND PHOTOCATALYSIS 17

**Dušan Nikolić, A. Tasić**

THE EUROPEAN PERCH (*Perca fluviatilis*) AS AN INDICATOR OF OCPs POLLUTION IN DIFFERENT TYPES OF RESERVOIRS IN SERBIA 24

**Jelena Korać Jačić, M. R. Milenković, D. Bartolić**

DEGRADATION OF TETRACYCLINE ANTIBIOTICS IN AQUATIC ENVIRONMENT BY UV IRRADIATION AND FERRIC ION PHOTOLYSIS 30

### Conference Papers

#### Environmental monitoring and impact assessment

**Aleksandra Papludis, S. Alagić, S. Milić, J. Nikolić, I. Zlatanović, S. Jevtović, V. Stankov Jovanović**

NAPHTALENE SCREENING IN BOR'S MUNICIPALITY BASED ON ITS CONCENTRATIONS IN LEAVES AND STEMS OF *Hedera helix* L. 38

**Darko Anđelković, M. Branković**

APPLE PEEL AS A BARRIER TO PESTICIDES MIGRATION INTO DEEPER FRUIT PARTS 43

<b>Darko Anđelković, M. Branković</b>	PERFORMANCES OF QuEChERS BASED GC-MS AND LC-MS/MS METHODS FOR PESTICIDES ANALYSIS IN APPLES	49
<b>Darko Anđelković, M. Branković</b>	COMPARISON OF PESTICIDES STABILITY STORED IN TWO SOLVENTS OF DIFFERENT VISCOSITY	55
<b>Milena Tadić, I. Nikolić, D. Đurović, N. Cupara, J. Vuković</b>	TRihalOMETHANES CONTENT IN HOTEL'S SWIMING POOLS WATER IN A SOUTH OF MONTENEGRO	61
<b>Jelena Vranković, K. Jovičić, V. Đikanović</b>	FIRST LINE DEFENCE ANTIOXIDANT ENZYMES IN <i>Blicca bjoerkna</i> (LINNAEUS, 1758) FROM THE BELGRADE SECTION OF THE DANUBE RIVER	66
<b>Miomir Mikić, R. Marković, V. Marjanović, R. Rajković, M. Jovanović</b>	REcULTIVATION OF RTH FLOTATION TAILINGS IN BOR, SERBIA	71
<b>Miomir Mikić, V. Marjanović, R. Marković, M. Jovanović, R. Rajković</b>	MINING AND THE ENVIRONMENT, ENVIRONMENTAL IMPACT MONITORING PROGRAM FOR FLOTATION TAILING RTH-BOR, SERBIA	77
<b>Vesna Obradović, M. Perović, T. Vučković</b>	EVALUATING CORROSION AND BIOFOULING POTENTIAL BASED ON GROUNDWATER MICROBIOLOGICAL COMPOSITION	83
<b>Vesna Obradović, M. Perović, J. Lekić</b>	EVALUATION OF CORROSION POTENTIAL USING PHYSICOCHEMICAL WATER QUALITY ASSESSMENT	89
<b>Jelena Čanak Atlagić, A. Marić, K. Jovičić, J. Stanković, V. Đikanović, T. Mitić, M. Raković</b>	QUESTIONING THE RESILIENCE OF THE DANUBE FISH FAUNA UNDER THE PRESSURE OF BELGRADE WASTEWATERS	95
<b>Vladan Marinković, M. Maksimović, M. Jovanović, S. Trujić</b>	MONITORING OF THE STATE OF THE ENVIRONMENT IN THE BOR DISTRICT, GIVEN THROUGH THE EXAMPLE OF THE DISTRIBUTION OF Pb IN THE SOIL LOCATED IN THE IMMEDIATE VICINITY OF THE BOR RIVER	101
<b>Mirjana Ocokoljić, Dj. Petrov, N. Galečić, D. Skočajić, D. Vujičić, J. Čukanović, I. Simović</b>	EFFECTIVENESS OF <i>Photinia × Fraseri</i> 'RED ROBIN' IN THE URBAN LANDSCAPE: TOWARDS OF CLIMATE CHANGE	106
<b>Mirjana Ocokoljić, Dj. Petrov, N. Galečić, D. Skočajić, D. Vujičić, J. Čukanović, I. Simović</b>	<i>Chaenomeles japonica</i> (Thunb.) Lindl. ex Spach IN THE DESIGN OF URBAN PARKS: LEARNING FROM NATURE	113

<b>Mirjana Ocokoljić, J. Čukanović, Dj. Petrov, N. Galečić, D. Skočajić, D. Vujičić, I. Simović</b> <i>Parthenocissus quinquefolia</i> L.: PHENOMONITORING IN BLUE-GREEN INFRASTRUCTURE OF BELGRADE AND NOVI SAD	119
<b>Bojana Tubić, J. Đuknić, K. Zorić, N. Popović, N. Marinković, M. Paunović, M. Raković</b> EFFECTS OF THE IRON GATE DAMS ON THE BENTHIC MACROINVERTEBRATE COMMUNITY	126
<b>Danica Bogdanović, T. Anđelković, I. Kostić Kokić, M. Milovanović</b> GC-MS QUANTITATIVE DETERMINATION OF PHTHALATES IN PVC ARTICLES INTENDED FOR CHILDREN'S USE	132
<b>Danica Bogdanović, T. Anđelković, I. Kostić Kokić, M. Milovanović</b> OPTIMIZATION OF LIQUID-LIQUID PHTHALATES EXTRACTION FROM ARTIFICIAL SALIVA	138
<b>Danica Bogdanović, T. Anđelković, I. Kostić Kokić, M. Milovanović</b> MIGRATION OF DI-2-ETHYLHEXYL PHTHALATE AND DI-N-OCTYL PHTHALATE FROM PVC ARTICLES TO ARTIFICIAL SALIVA	144
<b>Daliborka Stanković, D. Z. Rajković, M. Raković, S. Skorić</b> HAEMOSPORIDIAN PARASITES IN LONG-EARED OWLS WINTERING IN BANAT, SERBIA	150
<b>Nenad Zarić, I. Hotea, A. Lato, M. Zarić, F. Crista</b> UNVEILING PESTICIDE CONTAMINATION IN TRANSBOUNDARY WATERS: A CASE STUDY OF SERBIA AND ROMANIA	156
<b>Nenad Zarić, F. Crista, A. Berbecea, I. Hotea, L. Crista, M. Zarić</b> COMPARATIVE ANALYSIS OF PESTICIDE RESIDUES IN AGRICULTURAL SOILS OF SERBIA AND ROMANIA	160
<b>Milica Veličković, D. Voza</b> THE RELATIONSHIP BETWEEN PM <sub>10</sub> AND METEOROLOGICAL PARAMETERS CLOSE TO THE MINING AREA	164
<b>Biljana Budzakoska Gjoreska, S. Trajanovski</b> MACROZOOBENTHOS COMMUNITY AND ECOLOGICAL STATUS IN PRESPIA LAKE (OTESHEVO, STENJE AND EZERANI) IN SPRING 2022	169
<b>Suzana Patcheva, J. Leshoski, E. Veljanoska Sarafiloska</b> PHYTOPLANKTON COMMUNITY AS BIOINDICATOR OF WATER TROPHIC STATE IN LAKE PRESPIA	176
<b>Boris Novaković, M. Raković</b> EARLY, LATE AND OUT-BREEDING SEASON BIRD SINGING – EFFECTS OF CLIMATE CHANGE?	183
<b>Boris Novaković, M. Raković</b> THE USE OF HOA (HEMIPTERA-ORTHOPTERA-AVES) INDICATORS TO FORMULATE THE SERBIAN CLIMATE CHANGE INDEX (S <sub>CCI</sub> )	189

<i>Ana Marić, V. Nikolić, D. Škraba Jurlina, V. Sokolović, D. Miličić, T. Karan Žnidaršič, T. Kanjuh, P. Simonović</i>	ASSESSMENT OF NON-NATIVE SPECIES IMPACT ON FISH DIVERSITY IN THE ČELIJE RESERVOIR: IMPLICATIONS FOR CONSERVATION AND MANAGEMENT	194
<i>Ivana Jelić, A. Savić, T. Miljojčić, M. Rajković, M. Janković, N. Sarap, S. Dimović, M. Čurčić, V. Stanić, D. Antonijević, M. Šljivić-Ivanović</i>	THE IMPACTS OF WASTE MATERIALS UTILIZATION IN LIQUID RADIOACTIVE WASTE SOLIDIFICATION BY MORTAR MATRIX	200
<i>Stefan Đorđievski, M. Đukić, A. Petrović, D. Adamović, J. Petrović, Lj. Lekić</i>	INSIGHTS FROM THE DAILY MONITORING OF WATER QUALITY PARAMETERS IN CEROVO RIVER NEAR BOR CITY IN OCTOBER 2023	206
<i>Nataša Kojadinović, S. Đuretanović, A. Milošković, M. Radenković, M. Jakovljević, T. Veličković, M. Nikolić, V. Simić</i>	FISH DIVERSITY ASSESSMENT OF THE IBAR RIVER: A 20-YEAR PERSPECTIVE	212
<i>Milanka Negovanović, L. Kričak, S. Milanović, N. Simić, J. Majstorović</i>	APPLICATION OF EXPANSIVE MORTARS FOR THE FORMATION OF ARTIFICIAL SCREENS DURING BLASTING IN URBAN AREAS	216
<i>Snežana Šerbula, T. Kalinović, A. Radojević, J. Kalinović, J. Jordanović</i>	AIR POLLUTION IN THE BOR REGION FROM 1994 TO 2023	225
<i>Irena Blagajac, I. Samardžić</i>	CAUSES OF FLOODING AND MEASURES TO MITIGATE THE CONSEQUENCES – CASE STUDY OF RAKOVICA MUNICIPALITY (BELGRADE, SERBIA)	231
<b>Urban and industrial ecology</b>		
<i>Žarko Radović, N. Tadić</i>	SIMULATION OF THE EAF DUST RECYCLING	240
<i>Mirko Gojić, S. Kožuh, I. Ivanić, D. Dumenčić</i>	DEVELOPMENT OF METALLURGY AND ENVIRONMENTAL PROTECTION IN THE REPUBLIC OF CROATIA IN THE PERIOD FROM 1900 TO 2020	246
<b>Air, water and soil pollution, prevention and control</b>		
<i>Viša Tasić, T. Apostolovski-Trujić, V. Kamenović, B. Radović, I. Zlatković, N. Ristić, Z. Damnjanović</i>	APPLICATION OF LOW-COST NETWORK FOR URBAN MICROCLIMATE AND AIR QUALITY MONITORING	251

<i>Nebojša Tadić, Ž. Radović, A. Knežević</i>	ANALYSIS OF THE INFLUENCE OF NATURAL GAS COMPOSITION AND EXCESS AIR COEFFICIENT ON COMBUSTION PRODUCTS	258
<i>Aleksandar Jovanović, N. Knežević, M. Bugarčić, J. Petrović, M. Sokić, M. Stevanović, A. Marinković</i>	INVESTIGATION OF MULTI-CYCLE USAGE OF NANOPHOTOCATALYSTS IN DEGRADATION OF THIOPHANATE-METHYL	265
<i>Vesna Obradović, M. Perović, P. Pajić</i>	PHYSICO-CHEMICAL AND MICROBIAL ANALYSIS IN SELECTED GROUNDWATER IN SERBIA	270
<i>Silvia Dimova, K. Zaharieva, O. Dimitrov, P. D. Petrov, H. Penchev</i>	METHATHESIS SYNTHESIZED OLIGOMERIC POLYPHENYLACETYLENE AS STERIC STABILIZER OF CARBON NANOTUBES/PLANT EXTRACT SYNTHESIZED ZINC OXIDE HYBRIDS	276
<i>Miljan Marković, M. Gorgievski, N. Štrbac, V. Grekulović, M. Marković, K. Božinović, D. Jovanović</i>	EQUILIBRIUM ANALYSIS OF COPPER IONS BIOSORPTION ONTO HAZELNUT SHELLS	282
<i>Vesna M. Marjanović, R. Marković, D. Božić</i>	CALCULATION OF CALCIUM OXIDE CONSUMPTION IN THE MINE WASTEWATER TREATMENT FROM INACTIVE OPEN PITS OF THE COPPER MINE	287
<i>Marina Marković, M. Gorgievski, N. Štrbac, V. Grekulović, M. Marković, M. Zdravković, D. Jovanović</i>	THERMODYNAMIC ANALYSIS AND INFLUENCE OF THE pH VALUE ON THE BIOSORPTION OF COPPER IONS ONTO HAZELNUT SHELLS	294
<i>Jelena Korać Jačić, D. Bartolić, M.R. Milenković</i>	THE IMPACT OF FERROUS AND FERRIC IONS ON DEGRADATION OF ANTIHYPERTENSIVE DRUG DIHYDRALAZINE IN IRON-BASED FLOCCULATION AND COAGULATION METHODS FOR WASTE WATER TREATMENT	299
<i>Berina Sejdinović</i>	OILY WASTEWATER	305
<i>Vesela Radović, S. Krnjajić, S. Stanković, V. Tomić, G. Knežević</i>	ENVIRONMENTAL RISKS CAUSED BY THE POLLUTION FROM AGRICULTURAL PLASTICS – A BRIEF STATE OF ART	311
<i>Marija Koprivica, J. Dimitrijević, J. Petrović, M. Ercegović, M. Simić</i>	COMPARISON BETWEEN HYDROCHAR AND ITS ALKALI MODIFIED FORM IN THE REMOVAL OF Cd(II) IONS FROM AQUEOUS SOLUTION	317

<i>Milena Pijović Radovanović, M. Seović, I. Perović, N. Zdolšek, J. Georgijević, P. Laušević, S. Brković</i>	EFFICIENT REMOVAL OF RHODAMINE B FROM AQUEOUS SOLUTIONS USING CARBONIZED WASTE CAR TIRES: CHARACTERIZATION AND ADSORPTION STUDIES	323
<i>Svetlana Butulija, J. Maletaškić, B. Todorović, G. Branković, A. Krstić, R. Mihailović, B. Matović</i>	SYNTHESIS, CHARACTERIZATION AND ADSORPTION POTENTIAL OF CORN COB-DERIVED ACTIVATED CARBON	329
<i>Vladan Nedelkovski, S. Stanković, D. Medić, D. Buzdugan, I. Hulka, S. Milić, M. Radovanović</i>	PHOTOCATALYTIC PROPERTIES OF C-ZnO NANOPARTICLES SYNTHESIZED <i>via</i> MECHANOCHEMICAL METHOD	335
<i>Aleksandar Zdravković, M. Nikolić, D. Marković Nikolić, D. Stojadinović, G. Petković, T. Nikolić</i>	EQUILIBRIUM AND THERMODYNAMICS OF NITRATE SORPTION BY MODIFIED ZEOLITE FROM AQUEOUS SOLUTION	341
<i>Aleksandar Zdravković, M. Nikolić, D. Marković Nikolić, D. Stojadinović, I. Ristić, T. Nikolić</i>	POTENTIAL USAGE OF OAT STRAW FOR ANIONS REMOVAL FROM WATER: A KINETIC STUDY	348
<i>Aleksandar Zdravković, M. Nikolić, A. Pavlović, D. Marković Nikolić, G. Petković, T. Nikolić</i>	ULTRASOUND-ASSISTED EXTRACTION OF ACETAMIPRID FROM POLLUTED SOIL	354
<i>Katerina Zaharieva, B. Barbov</i>	PLANT-MEDIATED SYNTHESIS AND PHOTOCATALYTIC INVESTIGATIONS OF CeO <sub>2</sub> -ZnO COMPOSITES	358
<i>Milena Milošević, M. Abdualatif Abduarahman, M. M. Vuksanović, Z. Veličković, N. Knežević, B. Najdanović, A. Marinković</i>	CELLULOSE BASED MEMBRANE FOR CATIONIC POLLUTANTS REMOVAL FROM WATER	363
<i>Milena Milošević, A. Marinković, M. M. Vuksanović, Z. Veličković, I. Đuričković, B. Najdanović, N. Knežević</i>	HEMP MODIFIED WITH BETAINE AS A GREEN AND EFFICIENT ADSORBENT FOR REMOVAL OF ANIONIC DYES FROM WATER	369
<i>Nevena Surudžić, M. Spasojević, M. Crnoglavac Popović, M. Stanišić, R. Prodanović, O. Prodanović</i>	PHENOL REMOVAL FROM WASTEWATER WITH HORSERADISH PEROXIDASE IMMOBILIZED BY PERIODATE METHOD ONTO NOVEL MACROPOROUS POLY(GMA-CO-EGDMA) CARRIERS	375

<b>Miljana Radović Vučić, N. Velinov, J. Mitrović, S. Najdanović, M. Petrović, M. Kostić, A. Bojić</b>	MODIFIED ACTIVATED WOOD SAWDUST AS GREEN ENVIRONMENTAL-FRIENDLY CATALYST FOR TREATMENT OF PHARMACEUTICAL EFFLUENT	381
<b>Jelena Mitrović, M. Radović Vučić, N. Velinov, S. Najdanović, M. Kostić, M. Petrović, A. Bojić</b>	ADVANCE OXIDATION OF TEXTILE DYE BY ACTIVATED HYDROGEN PEROXIDE WITH UV-C LIGHT	387
<b>Protection and preservation of natural resources</b>		
<b>Gordana Šekularac, M. Aksić, T. Dimitrijević, M. Ratknić, N. Gudžić</b>	QUANTIFYING SOIL EROSION OF THE TOM'S BROOK CATCHMENT (WESTERN SERBIA)	393
<b>Gordana Šekularac, M. Aksić, T. Dimitrijević, S. Gudžić, N. Gudžić, D. Gračak, M. Grčak, M. Ratknić</b>	EFFECT OF IRRIGATION RATE ON THE ONSET INTENSITY OF GREY MOULD AND LATE BLIGHT IN GREEN HOUSE TOMATOES	399
<b>Tatjana Dimitrijević, M. Ratknić, G. Šekularac, M. Aksić</b>	INFLUENCE OF SOIL TYPE ON MEAN TREE HEIGHTS OF FIR TREES IN A 40-YEAR PROVENANCE TRIAL	406
<b>Dragana Božić, Lj. Avramović, V. Trifunović, R. Marković, Z. Stevanović, V. Marjanović, E. Požega</b>	AGITATION LEACHING OF FLOTATION TAILINGS AT THE PILOT PLANT	412
<b>Ivana Kerkez Janković, D. Vilić, M. Nonić, J. Devetaković, M. Šijačić-Nikolić</b>	FOREST FRUIT SPECIES OF URBAN FOREST "KOŠUTNJAK" (SERBIA) – GENEPOOL ASSESSMENT AND CONSERVATION	418
<b>Boris Novaković, N. Paskaš, M. Raković</b>	NEW DATA ON THE DISTRIBUTION OF AQUATIC BEETLES IN SERBIA	424
<b>Matej Fike, M. Pezdevšek, A. Roger</b>	COMPARING FROST PROTECTION STRATEGIES FOR SUSTAINABLE AGRICULTURE IN SLOVENIA	430
<b>Filip Maksimović, M. Nonić, D. Vilotić, I. Kerkez Janković, M. Šijačić-Nikolić</b>	GENE POOL OF FOREST FRUIT TREES IN THE PROTECTED AREA OF THE NATURAL MONUMENT "KOŠUTNJAK FOREST" – THEN AND NOW	435
<b>Dragana Medić, S. Milić, N. Milošević, M. Nujkić, M. Pešić, V. Nedelkovski, S. Stanković</b>	APPLICATION OF THE SHRINKING CORE MODEL IN THE LEACHING PROCESS OF $\text{LiNiMnCoO}_2$	441

## Ecotoxicology and environmental safety

<b>Branko Matovic, J. Maletaskic, S. Butulija, S. Petrovic, B. Todorovic</b> IMMOBILIZATION OF LEAD USING CERIA CRYSTAL STRUCTURE	448
<b>Dragana Medić, S. Milić, N. Milošević, M. Nujkić, S. Alagić, A. Cvetković, A. Papludis</b> CAUSES AND POSSIBLE CONSEQUENCES OF THERMAL RUNAWAY IN LITHIUM-ION BATTERIES	454
<b>Nena Velinov, M. Radović Vučić, J. Mitrović, M. Petrović, S. Najdanović, D. Bojić, A. Bojić</b> KINETIC AND EQUILIBRIUM STUDIES OF CHROMIUM SORPTION USING ULTRASONICALLY MODIFIED WOOD SAWDUST BY ALUMINA	460
<b>Hazardous materials and green technologies</b>	
<b>Uroš Stamenković, I. Marković, V. Čosović, B. Markoli</b> THE INFLUENCE OF AGEING PARAMETERS ON MICROHARDNESS, ELECTRICAL CONDUCTIVITY AND MICROSTRUCTURE OF SOME Al-Mg-Si ALLOYS	466
<b>Marija Simić, D. Aćimović, B. Savić Rosić, M. Ječmenica Dučić, K. Stojanović, D. Maksin, T. Brdarić</b> KINETIC STUDY OF DEGRADATION BISPHENOL A BY FENTON PROCESS	472
<b>Danka Aćimović, K. Stojanović, M. Simić, B. Savić Rosić, Z. Vranješ, M. Ječmenica Dučić, T. Brdarić</b> DETECTION OF BISPHENOL A INTERMEDIATES DURING FENTON PROCESS AND PREDICTION OF REACTION PATHWAYS	476
<b>Tanja Brdarić, D. Aćimović, B. Savić Rosić, K. Stojanović, M. Simić, Z. Vranješ, M. Ječmenica Dučić</b> ADVANCED OXIDATION PROCESSES (AOPs) FOR WASTEWATER TREATMENT: BIBLIOMETRIC STUDY	480
<b>Vanja Trifunović, S. Milić, Lj. Avramović</b> POSSIBILITY OF ZINC AND CADMIUM RECOVERY FROM HAZARDOUS INDUSTRIAL WASTE – EAF DUST	486
<b>Sandra Bulatović, N. Nedić, T. Tadić, B. Marković, A. Nastasović</b> MAGNETIC BIOSORBENT BASED ON THE <i>Ambrosia arthemisiifolia</i> FOR ADSORPTION OF MALACHITE GREEN FROM WATER	491
<b>Milan Nedeljković, S. Mladenović, J. Petrović, M. Mitrović</b> STUDIES OF THE INFLUENCE OF GRAPHENE NANOSHEETS ON THE WETTABILITY OF ECO-FRIENDLY SOLDER ALLOYS	497

<i>Ana Simonović, M. Petrović Mihajlović, M. Radovanović, Ž. Tasić, M. Antonijević</i> ELECTROCHEMICAL SENSORS FOR DETERMINATION OF ANTIBIOTICS	502
<i>Sonja Stanković, V. Nedelkovski, D. Buzdugan, I. Hulka, M. Gorgievski, S. Milić, M. Radovanović</i> INFLUENCE OF CALCINATION TEMPERATURE ON THE MORPHOLOGY, CHEMICAL COMPOSITION, AND STRUCTURE OF ZnO NANOPARTICLES	508
<b>Human and ecological risk assessment</b>	
<i>Milena Tadić, I. Nikolić, D. Đurović, J. Vuković, N. Cupara</i> CHILDREN HEALTH RISK ASSESSMENT OF TRIHALOMETHANES CONTENT IN HOTEL'S SWIMMING POOL WATER IN MONTENEGRO	515
<i>Miljan Bigović, D. Đurović, Lj. Ivanović, M. Blagojević, A. Orahovac</i> HEALTH RISK ASSESSMENT OF ACRYLAMIDE IN POTATO CHIPS FROM MONTENEGRIN MARKET	520
<i>Vesna Djikanović, K. Jovičić, J. S. Vranković, M. Dimitrijević, S. Kovačević, N. Pankov, B. Miljanović</i> ACCUMULATION OF HEAVY METALS AND HUMAN HEALTH RISK ASSESSMENT <i>via</i> THE CONSUMPTION OF FRESHWATER FISH <i>Esox lucius</i>	524
<b>Agriculture: nutrition, organic food and health impacts</b>	
<i>Vitaly Erukhimovitch, M. Huleihel</i> OPTIMIZATION OF PREPARATION PROCEDURES FOR FUNGAL INFECTED PLANTS BY FTIR ANALYSES	531
<i>Mahmoud Huleihel, V. Erukhimovitch</i> POSSIBLE USE OF FOURIER–TRANSFORM INFRARED (FTIR) MICROSCOPY FOR IDENTIFICATION OF FUNGAL PHYTO–PATHOGENS	536
<i>Ana Čučulović, J. Stanojković, R. Čučulović</i> RADIOACTIVITY IN SAMPLES OF IMPORTED MINERAL FERTILIZER ANALYZED IN THE PERIOD 2020–2022	541
<i>Nenad Zarić, M. Zarić</i> METAL CONTENTS IN VEGETABLES ORIGINATING FROM COAL FIRED THERMAL POWER PLANTS REGION	547
<b>Alternative energy: efficiency and environmental policy</b>	
<i>Snežana Brković, N. Zdolšek, I. Perović, M. Seović, P. Laušević, J. Georgijević, M. Čebela</i> ENHANCING OXYGEN EVOLUTION: THE ELECTROCATALYTIC POWER OF Ag-DOPED BISMUTH FERRITE	552

<i>Nebojša Potkonjak, Đ. Čokeša, M. Marković</i>	NONLINERA PHENOMENA DURING VOLTAMMETRIC MEASUREMENT OF COPPER CORROSION	558
<i>Mirjana Marković, Đ. Čokeša, N. Potkonjak</i>	EVALUATION OF THE HYDROGEN DIFFUSION COEFFICIENT IN METAL HYDRIDE BATTERIES	562
<b>Greenhouse effect and global climate change</b>		
<i>Slobodan Milutinović, T. Radenović, S. Živković</i>	FORESTS UNDER THREAT: IMPLICATIONS OF CLIMATE CHANGE ON SERBIAN WOODLANDS	566
<i>Danijela Nikolić, S. Jovanović, Z. Đorđević, D. Končalović, V. Vukašinić</i>	GLOBAL WARMING – TREND ANALYSIS IN THE REPUBLIC OF SERBIA	574
<b>Sustainable development and green economy</b>		
<i>Dragana Randelović, A. Jovanović, B. Marković, M. Sokić</i>	CONTRIBUTION OF THE INSTITUTE FOR TECHNOLOGY OF NUCLEAR AND OTHER MINERAL RAW MATERIALS TO THE SDGs – TOWARDS INTERNATIONAL DECADE OF SCIENCE FOR SUSTAINABLE DEVELOPMENT	580
<i>Veljko V. Savić, J. D. Nikolić, V. Topalović, M. S. Djošić, M. Marković, S. Matijašević, S. Grujić</i>	CHEMICAL DURABILITY EVALUATION OF SINTERED FLY ASH BASED GLASS	586
<i>Stefan Mitrović, S. Brković, M. Seović, N. Zdolšek, P. Laušević, J. Georgijević, I. Perović</i>	RECYCLING ELECTRONIC WASTE CPUs FOR ENHANCED HYDROGEN AND OXYGEN EVOLUTION: AN ECO-FRIENDLY LEACHING APPROACH	593
<i>Adrijana Jevtić, D. Riznić, M. Vuković</i>	BRAND MANAGEMENT AND SOCIO-ECONOMIC ASPECTS OF ADAPTATION TO CLIMATE CHANGES	598
<i>Ana Radojević, J. Jordanović, T. Kalinović, J. Kalinović, S. Šerbula</i>	PROSPECTS OF SUSTAINABLE UTILIZATION OF FOOD WASTE	606
<i>Maja Bogdanović, I. Blagajac</i>	DECENTRALIZATION OF THE URBAN TOURIST ZONE OF ZLATIBOR	613

## Environmental biology

- Sladana Popović, N. Nikolić, Ž. Savković, M. Stupar, D. Predojević, A. Anđelković, O. Jakovljević**  
ISOLATION AND CULTIVATION OF CHROOCOCCUS (CYANOBACTERIA) FROM AEROPHYTIC BIOFILM IN STOPIĆ CAVE 621
- Tamara Mitić, J. Čanak Atlagić, J. Tomović, J. Stanković, D. Mrdak, D. Škraba Jurlina, A. Marić**  
MORPHOMETRIC STUDY OF EUROPEAN BULLHEAD *Cottus gobio* FROM DIFFERENT DRAINAGE POPULATIONS 626
- Jelena Đuknić, N. Popović, B. Vasiljević, B. Tubić, S. Andjus, M. Ilić, M. Paunović**  
ECOLOGICAL POTENTIAL OF THE DANUBE RIVER THROUGH SERBIA BASED ON BIOLOGICAL QUALITY ELEMENTS 632
- Sladana Popović, G. Subakov Simić, S. Stanković, D. Lazić**  
*Chlorella vulgaris* GROWTH IN SMALL OPEN CULTIVATION SYSTEMS 638
- Olga Jakovljević, S. Popović, D. Predojević**  
EPIPHYTIC DIATOMS AS TOOL IN BIOINDICATION OF LAKE PALIĆ 643
- Mihailo Jovanović, J. Paunković**  
IMPROVING PALEOENVIRONMENTAL RECONSTRUCTIONS BASED ON SMALL VERTEBRATES IN THE BALKANS 648
- Jovana Damjanović, M. Milković, A. Mišćević, M. Šćiban, V. Lakušić, M. Stanković**  
SUPPLEMENT TO THE LIST OF ENTOMOFAUNA FROM THE RESEARCH ACTIONS AND CAMPS OF SRSBE “JOSIF PANČIĆ” AT SRN ZASAVICA 654
- Mihajlo Stanković**  
“LIVING FOSSILS” IN THE CRASH FAUNA OF THE ZASAVICA SPECIAL NATURE RESERVE 662

## Environmental and material flow management

- Nataša Knežević, A. Jovanović, M. Vuksanović, M. Savić, M. Milošević, A. Marinković**  
DEGRADATION OF DYE CRYSTAL VIOLET RELEASED FROM THE TEXTILE INDUSTRY 669
- Milenko Jovanović, D. Kržanović, E. Požega, V. Marinković, M. Mikić**  
APPLICATION AND ENVIRONMENTAL SUITABILITY OF HYBRID GEOGRIDS 674
- Miroslav Drljača**  
MODERN APPROACH TO SUPPLY CHAIN BASED ON CIRCULAR ECONOMY PRINCIPLES 681

<i>Isidora Berežni, T. Marinković, N. Stanisavljević, M. Muhadinović, B. Batinić</i> ASSESSMENT OF THE MUNICIPAL SOLID WASTE MANAGEMENT – CASE STUDY: NOVI SAD (SERBIA)	687
---	-----

<i>Ljubiša Balanović, D. Manasijević, I. Marković, U. Stamenković, K. Božinović</i> CALCULATION OF THERMODYNAMIC PROPERTIES Al-Ga-Sn TERNARY ALLOY USING GENERAL SOLUTION MODEL	693
---	-----

### Life-Cycle-Analysis (LCA)

<i>Danijela Nikolić, S. Jovanović, D. Mikić, Z. Đorđević</i> LIFE CYCLE ASSESMENT OF THE HAIR DRYER WITH ECO-it SOFTWARE	701
--	-----

## Student Section – EcoTERS'24

<i>Students: Sofija Kostić, Aleksa Marjanović (Serbia)</i> <i>Mentor: Maja Nujkić (Serbia)</i> SOME ASPECTS OF THE APPLICATION OF METAL-ORGANIC FRAMEWORKS	709
---	-----

<i>Student: Jelena Janković (Serbia)</i> <i>Mentor: Maja Nujkić (Serbia)</i> MECHANISMS OF CADMIUM UPTAKE INTO THE PLANT	711
--	-----

<i>Student: Jovana Kumbrijanović (Serbia)</i> <i>Mentors: Maja Nujkić, Sonja Stanković (Serbia)</i> COAGULATION PROCESS AND APPLICATION OF NEW ECOLOGICAL COAGULANTS	713
---	-----

<i>Student: Lazar Cvetković (Serbia)</i> <i>Mentors: Maja Nujkić, Tanja Kalinović, Jelena Kalinović (Serbia)</i> SOME APPLICATION ASPECTS OF THE MATERIALS BASED ON THE GREEN MAGNESIUM OXIDE ECOLOGICAL COAGULANTS	715
--	-----

<i>Students: Milena Radivojević, Kristina Konstadinović (Serbia)</i> <i>Mentors: Maja Nujkić, Dragana Medić (Serbia)</i> RECYCLING OF USED LITHIUM-ION BATTERIES	717
--	-----

<i>Student: Milica Denić (Serbia)</i> <i>Mentor: Ana Radojević (Serbia)</i> MEDICAL WASTE ISSUES RELATED TO COVID-19 PANDEMIC	719
---	-----

<i>Student: Sara M. Pantović (Serbia)</i> <i>Mentor: Enisa S. Selimović (Serbia)</i> PRESENCE OF TOXIC AND POTENTIALLY TOXIC ELEMENTS IN SOME DOMESTIC FRUIT FROM THE PEŠTER PLATEAU, SJENICA, SERBIA	721
---	-----

<i>Student: Milena Stanković (Serbia)</i> <i>Mentor: Ljiljana Stanojević (Serbia)</i>	CHEMICAL COMPOSITION OF ESSENTIAL OIL ISOLATED FROM FRESH AND DRY LEAVES OF <i>Geranium robertianum</i> L.	723
<i>Student: Nikola Petrović (Serbia)</i> <i>Mentor: Ana Simonović (Serbia)</i>	TOXIC EFFECTS OF PETROLEUM DERIVATIVES ON LIVING ORGANISMS FROM CONTAMINATED SOILS	725
<i>Students: Anja Antanasković, Nevena Ilić (Serbia)</i> <i>Mentors: Milan Milivojević, Suzana Dimitrijević-Branković, Zorica Lopičić, Nikola Vuković (Serbia)</i>	ENZYME IMMOBILIZATION ON MODIFIED BIOMASS: OPTIMIZATION AND CHARACTERIZATION	727
<i>Student: Milena Balabanović (Serbia)</i> <i>Mentor: Ana Radojević (Serbia)</i>	BIOLOGICAL TREATMENT OF THE BIODEGRADABLE WASTE	729
<i>Student: Natalija Stojanović (Serbia)</i> <i>Mentors: Maja Nujkić, Vladan Nedelkovski (Serbia)</i>	ADSORPTION MATERIALS BASED ON NANOPARTICLES FOR THE REMOVAL OF ARSENIC FROM WASTEWATER	731
<i>Student: Jelena Vesković (Serbia)</i> <i>Mentor: Antonije Onjia (Serbia)</i>	HEALTH RISK ASSESSMENT OF RARE EARTH ELEMENTS IN GROUNDWATER NEAR A THERMAL POWER PLANT	733
<i>Students: Vladimir Topalović, Anja Antanasković, Veljko Savić (Serbia)</i> <i>Mentors: Marija Djošić, Zorica Lopičić, Ana Vujošević, Jelena Nikolić (Serbia)</i>	EFFECT OF PHOSPHATE GLASS AND BIOCHAR ON ROSE GROWTH	735
<i>Student: Aleksandra Milenković (Serbia)</i> <i>Mentor: Ljiljana Stanojević (Serbia)</i>	THE REDUCING POWER OF BLACK PEPPER ( <i>Piper nigrum</i> L.) ESSENTIAL OIL HYDRODISTILLATION FRACTIONS	737
<i>Student: Marija Tasić (Serbia)</i> <i>Mentor: Dragan Cvetković (Serbia)</i>	ENVIRONMENTAL METHOD OF GOLD NANOPARTICLES SYNTHESIS AND THEIR CHARACTERIZATION	739
<i>Student: Marija Stanković (Serbia)</i> <i>Mentor: Jelena Kalinović (Serbia)</i>	PURIFICATION METHODS FOR POLLUTED AIR	741
<i>Student: Marija Stanković (Serbia)</i> <i>Mentor: Jelena Kalinović (Serbia)</i>	PURIFICATION OF INDUSTRIAL WASTEWATER	743

<i>Students: Željka Nikolić, Nebojša Radović (Serbia)</i> <i>Mentor: Olga Tešović (Serbia)</i>	
RISKS OF CHLORINE EXPOSURE IN HOUSEHOLD CLEANING: A CALL FOR AWARENESS AND PREVENTION	745
<i>Students: Željka Nikolić, Nebojša Radović (Serbia)</i> <i>Mentor: Olga Tešović (Serbia)</i>	
IS THERE A NEED TO INFORM CITIZENS MORE DIRECTLY ABOUT THE HANDLING OF HOUSEHOLD HAZARDOUS WASTE?	747
<i>Students: Nataša Simonović, Tamara Milosavljević (Serbia)</i> <i>Mentors: Jelena Stanojević, Ljiljana Stanojević, Jelena Zvezdanović, Dragan Cvetković (Serbia)</i>	
SOLID WASTE FROM HYDRODISTILLATION OF HERNIARIAE HERBA ( <i>Herniaria glabra</i> L.) AS A POTENTIAL SOURCE OF ANTIOXIDANTS	749
<i>Students: Aleksa Vizi, Nebojša Radović, Željka Nikolić, Stefan Lekić (Serbia)</i> <i>Mentors: Goran Roglić, Ksenija Stojanović, Vele Tešević (Serbia)</i>	
SUSTAINABLE SOLUTIONS IN ANALYTICAL CHEMISTRY: COMBINING OF INSTRUMENTAL TECHNIQUES AND ENVIRONMENTAL-FRIENDLY NATURAL INDICATORS FOR CLASSICAL VOLUMETRY	751
<i>Students: Aleksa Vizi, Nebojša Radović, Željka Nikolić (Serbia)</i> <i>Mentors: Ivan Kojić, Ksenija Stojanović (Serbia)</i>	
EFFICIENT DETERMINATION OF UNDECYLENIC ACID CONTENT IN PHARMACEUTICAL PRODUCTS: A NOVEL SIMPLE APPROACH	753
<i>Student: Andrijana Miletić (Serbia)</i> <i>Mentor: Antonije Onjia (Serbia)</i>	
HEALTH RISK ASSESSMENT OF POTENTIALLY TOXIC ELEMENTS IN AGRICULTURAL SOIL OF BRANIČEVO DISTRICT	755
<i>Student: Jelena Obradovic (Serbia)</i> <i>Mentor: Antonije Onjia (Serbia)</i>	
DISTRIBUTION OF PM <sub>2.5</sub> , CO <sub>2</sub> , HCHO, AND TVOC IN AIR IN A HIGH SCHOOL CLASSROOM	757
<i>Student: Gordan Mišić (Serbia)</i> <i>Mentors: Ana Radojević, Jelena Jordanović (Serbia)</i>	
TOXICOLOGICAL EFFECTS OF MICRO- AND NANO-PLASTICS ON HUMAN HEALTH	759
<i>Student: Anđela Bogdanović (Serbia)</i> <i>Mentor: Marija Petrović Mihajlović (Serbia)</i>	
MAGNESIUM AND ITS ALLOYS	761
<b>Author index</b>	<b>763</b>



## CALCULATION OF CALCIUM OXIDE CONSUMPTION IN THE MINE WASTEWATER TREATMENT FROM INACTIVE OPEN PITS OF THE COPPER MINE

Vesna M. Marjanović<sup>1\*</sup>, Radmila Marković<sup>1</sup>, Dragana Božić<sup>1</sup>

<sup>1</sup>Mining and Metallurgy Institute, A. Ajštajna 1, 19210 Bor, SERBIA

\*vesna.marjanovic@irmbor.co.rs

### Abstract

*This paper presents the calculation of required amount of calcium oxide (CaO) for neutralization the mine water, accumulated in the abandoned open pits of the copper mine. This water represents a resource that can be reused in the mining activities after treatment. Calculation of calcium hydroxide consumption on a daily basis for converting the metal ions (Fe, Cu and Zn), dissolved in mine water into an insoluble hydroxide form and increasing the pH value, is given in relation to their flow and mass of CaO needed to neutralize 1 m<sup>3</sup> of water.*

**Keywords:** mine wastewater, neutralization, calcium oxide.

### INTRODUCTION

There is accumulation of large amounts of water at the inactive open pits of the copper mine, which most often come from atmospheric precipitation, underground water, water from the surrounding catchment areas and water from rock cracks [1]. The chemical composition of this water depends on the mineralogical and chemical composition of the ore deposit. Due to the long-term effect of accumulated water on this material, this water is characterized by the specific physical and chemical properties such as a low pH value between 2–3, a high content of dissolved iron, sulfates and heavy metals [2,3].

Acid mine water treatment technologies include the precipitation methods of metal hydroxide precipitation with lime milk, the process of precipitation the metal sulfides present in water, the return sludge method (HDS) and biological oxidation methods.

Probably the most conventional and widely used method of wastewater treatment is neutralization. By increasing the pH value of waste water by addition of lime milk, metals will settle in the form of metal hydroxides and form sludge [4,5].

The choice of wastewater treatment process is the key to designing a wastewater treatment system. It is directly related to the requirement for water quality after treatment, requirement for stable and reliable plant operation, adequately trained personnel and level of investment and operating costs.

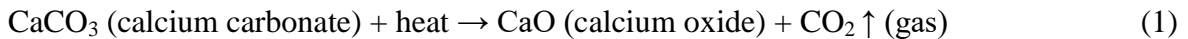
The wastewater treatment process should be carefully selected according to the wastewater quality, output water requirements, degree of treatment, local temperature, engineering geology, surrounding environment and other conditions, and at the same time the economic factors must be considered.

## MATERIALS AND METHODS

### Calculation of the CaO consumption for the mine water neutralization

For the process of chemical treatment the mine water, a process of neutralization with a 10% lime milk suspension is provided, which is prepared by mixing the calcium oxide (CaO, quicklime) and water in a certain ratio. In order to obtain the lime milk of a defined concentration, it is necessary to dissolve quicklime in water at a certain speed, defined by the procedure for preparation the lime milk and depends on the amount used for dissolution.

Quicklime consists primarily of calcium oxide and is produced from limestone in a process known as calcination:



During the preparation of lime milk, the following properties of CaO should be taken into account: type, purity, reactivity, particle size. The type of CaO affects the speed of its conversion into the form of Ca(OH)<sub>2</sub>. Purity represents the amount of quicklime that is chemically available as calcium oxide (CaO) and it affects the reactivity and determines the purity of hydrated lime product. The purity of commercially available quicklime that will be used for calculation is with a calcium oxide content of approx. 70%. Reactivity describes the relative capacity of quicklime to react chemically with water. Reactivity is a function of purity, particle size, and other factors such as particle porosity. The quenching reaction of CaO is considered complete when the temperature of a given sample reaches a maximum. As the reactivity increases, so does the quenching rate, ultimate temperature rise, and specific surface area of hydrated lime. The mass concentration of 10% lime milk is defined as the ratio of the mass of water to the mass of quicklime. This ratio does not include dilution water or process water, which may be added to lime milk after its preparation.

The starting data used for calculation are:

- Mine water flow  $Q = 5000 \text{ m}^3/\text{day}$ ,
- Mass of CaO for mine water neutralization of  $1 \text{ m}^3$ : 1.5 kg,
- Mass of CaO for daily flow of  $5000 \text{ m}^3/\text{day}$  is 7.5 t/day,
- Coefficient of increased consumption: 1,
- Specific density H<sub>2</sub>O,  $\rho$ :  $1000 \text{ kg/m}^3$

Calculation of the required volume of water to prepare 10% lime milk:

$$V_{\text{H}_2\text{O}} = \frac{M_{\text{CaO}} \cdot 100}{10} - M_{\text{CaO}} = \frac{7.5 \cdot 100}{10} - 7.5 = 67.5 \frac{\text{m}^3}{\text{day}} \quad (1)$$

Calculation of lime consumption is based on real data on the quality of waste water that will be treated in the waste water treatment plant given in Table 1 and requirements for the output water quality given in Table 2. The concentrations of elements that are present in the mine water and are lower of 1 mg/L were not taken into account during the calculation.

**Table 1** An example of chemical composition of accumulated mine water in an inactive open pit

Element	Zn	Cd	Cr	Cu	Ni	Fe	Pb	As	Hg
mg/l	12.82	0.12	0.06	29.56	0.62	149.28	0.16	<0.020	<0.0005

**Table 2** pH value of accumulated mine water before and after neutralization

Water	Parameter	Value
Mine water before neutralization	pH	2.0–3.0
Water after neutralization	pH	6.0–9.0

## RESULTS AND DISCUSSION

The lime consumption to adjust the pH value from 2 to 9

The calculation was made on the basis of the following initial data:

- Flow of mine waste water on a daily basis,  $Q = 5000 \text{ m}^3/\text{day}$
- $\text{pH}_{\text{start}} = 2$ ;  $\text{pH}_{\text{end}} = 9$ ,
- Molar mass  $\text{Ca}(\text{OH})_2$ , 74 g/mol,
- Molar mass  $\text{CaO}$ , 56 g/mol,
- Activity  $\text{CaO}$ , 70%,
- Molar mass  $\text{CaSO}_4$ , 136 g/mol,
- Molar mass  $\text{H}_2\text{SO}_4$ , 98 g/mol,
- Concentration of calcium hydroxide, 10%  $C_{\text{Ca}(\text{OH})_2}$ .

Based on the pH value, the concentration of  $\text{H}^+$  ions at  $\text{pH}=2$  and  $\text{pH}=9$  were calculated and the same is:

- $\text{H}^+$  concentration at  $\text{pH} 2 = 0.01 \text{ mol/l}$ ,
- $\text{H}^+$  concentration at  $\text{pH} 9 = 0.000000001 \text{ mol/l}$ ,
- Number of  $\text{H}^+$  ions,  $n_{\text{H}^+}: 2$

The required mass of  $\text{Ca}(\text{OH})_2$  to change the pH value from pH 2 to pH 9 is:

$$M_{\text{Ca}(\text{OH})_2} = \frac{Q \cdot (C_{\text{pH}2} - C_{\text{pH}9}) \cdot 74}{n_{\text{H}^+} \cdot 10^6} = \frac{5000000 \cdot (0.01 - 0.000000001) \cdot 74}{2 \cdot 10^6} = 1.85 \frac{\text{t}}{\text{day}} \quad (2)$$

Consumption 10% calcium hydroxide  $M_{10\% \text{Ca}(\text{OH})_2}$ :

$$M_{10\% \text{Ca}(\text{OH})_2} = \frac{M_{\text{Ca}(\text{OH})_2}}{10} \cdot 100 = \frac{1.85}{10} \cdot 100 = 18.5 \frac{\text{t}}{\text{day}} \quad (3)$$

Consumption 100%  $\text{CaO}$ :

$$M_{100\% \text{CaO}} = \frac{M_{\text{Ca}(\text{OH})_2} \cdot 56}{74} = \frac{1.85 \cdot 56}{74} = 1.4 \frac{\text{t}}{\text{day}} \quad (4)$$

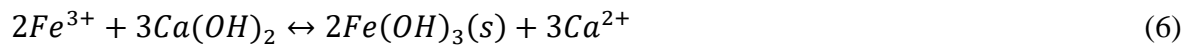
Consumption of  $\text{CaO}$  activity 70%:

$$M_{70\% CaO} = 1.4 / 0.7 = 2 \frac{t}{day} \quad (5)$$

After the lime is slaked, the slurry is added to the acid mine water, which leads to an increase in the pH value. Free (OH<sup>-</sup>) ions react with metal ions to form the metal hydroxides that precipitate at a certain pH value.

Calculation of lime consumption for precipitation of Fe<sup>3+</sup> ions at concentration of approx. 150 mg/l

Precipitation of Fe hydroxide is shown by the following reaction:



Calculation of CaO consumption was made on the basis of the following initial data:

- Concentration of Fe<sup>3+</sup> ion, cca 150 mg/l,
- Coefficient of increased consumption: 1,
- Atomic mass Fe, 56 g/mol,
- Molar mass Fe(OH)<sub>3</sub> 107 g/mol.

Consumption 10% Ca(OH)<sub>2</sub>:

$$M_{10\%Ca(OH)_2} = \frac{C_{Fe^{3+}} \cdot Q \cdot 74 \cdot 3}{56 \cdot 2 \cdot 10 \cdot 10^9} \cdot 100 = \frac{150 \cdot 5000000 \cdot 74 \cdot 3}{56 \cdot 2 \cdot 10 \cdot 10^9} \cdot 100 = 14.85 \frac{t}{day} \quad (7)$$

Consumption Ca(OH)<sub>2</sub>:  $M_{Ca(OH)_2} = 14.85 \cdot 0.1 = 1.485$  t/day.

Consumption 100% CaO:

$$M_{100\% CaO} = \frac{M_{Ca(OH)_2} \cdot 56}{74} = \frac{1.485 \cdot 56}{74} = 1.12 \frac{t}{day} \quad (8)$$

Consumption of CaO activity 70%:

$$M_{70\% CaO} = 1.12 / 0.7 = 1.6 \frac{t}{day} \quad (9)$$

Calculation of the water amount for chemical reaction with CaO, resulting in Ca(OH)<sub>2</sub>:

$$M_{H_2O} = \frac{18 \cdot M_{Ca(OH)_2}}{74} = \frac{18 \cdot 1.12}{74} = 0.27 \frac{t}{day} \quad (10)$$

Calculation of lime consumption for precipitation of  $\text{Cu}^{2+}$  ions at concentration of approx. 30 mg/l

Precipitation of Cu hydroxide is shown by the following reaction:



Calculation of lime consumption was made on the basis of the following initial data:

- Concentration of  $\text{Cu}^{2+}$  ions, cca 30 mg/l,
- Coefficient of increased consumption: 1.4,
- Atomic mass Cu, 64 g/mol,
- Molar mass  $\text{Cu}(\text{OH})_2$ , 98 g/mol.

Consumption 10%  $\text{Ca}(\text{OH})_2$ :

$$M_{10\% \text{Ca}(\text{OH})_2} = \frac{C_{\text{Cu}} \cdot Q \cdot 74}{A_{\text{rCu}} \cdot 0.1 \cdot 10^9} = \frac{30 \cdot 5000000 \cdot 74 \cdot 1.4}{64 \cdot 0.1 \cdot 10^9} = 2.40 \frac{\text{t}}{\text{day}} \quad (12)$$

Consumption of calcium hydroxide:  $M_{\text{Ca}(\text{OH})_2} = 2.40 \cdot 0.1 = 0.24 \text{ t/day}$ .

Consumption 100% CaO:

$$M_{100\% \text{CaO}} = \frac{M_{\text{Ca}(\text{OH})_2} \cdot 56}{74} = \frac{0.24 \cdot 56}{74} = 0.18 \frac{\text{t}}{\text{day}} \quad (13)$$

Consumption of CaO activity 70%:

$$M_{70\% \text{CaO}} = 0.18 / 0.7 = 0.26 \frac{\text{t}}{\text{day}} \quad (14)$$

Calculation of the required amount of water for chemical reaction of CaO and  $\text{H}_2\text{O}$  resulting in  $\text{Ca}(\text{OH})_2$  is:

$$M_{\text{H}_2\text{O}} = \frac{18 \cdot M_{\text{Ca}(\text{OH})_2}}{56} = \frac{18 \cdot 0.24}{56} = 0.08 \frac{\text{t}}{\text{day}} \quad (15)$$

Calculation of lime consumption for precipitation of  $\text{Zn}^{2+}$  ions at concentration of approx. 13 mg/l

Precipitation of Zn hydroxide is shown by the following reaction:



Calculation of lime consumption was made on the basis of the following initial data:

- Concentration of  $Zn^{2+}$  ions, cca 13 mg/l,
- Coefficient of increased consumption: 1
- Atomic mass of Zn, 65.5 g/mol,
- Molar mass of  $Zn(OH)_2$ , 99.5 g/mol.

Consumption 10%  $Ca(OH)_2$ :

$$M_{10\% Ca(OH)_2} = \frac{C_{Zn} \cdot Q \cdot 74}{A_{rZn} \cdot 0.1 \cdot 10^9} = \frac{13 \cdot 5000000 \cdot 74}{65.5 \cdot 0.1 \cdot 10^9} = 0.73 \frac{t}{day} \quad (17)$$

Consumption of calcium hydroxide:  $M_{Ca(OH)_2} = 0.73 \cdot 0.1 = 0.073$  t/day.

Consumption 100% CaO:

$$M_{100\% CaO} = \frac{M_{Ca(OH)_2} \cdot 56}{74} = \frac{0.073 \cdot 56}{74} = 0.055 \frac{t}{day} \quad (18)$$

Consumption of CaO activity 70%:

$$M_{70\% CaO} = 0.055 / 0.7 = 0.078 \frac{t}{day} \quad (19)$$

Calculation of the required amount of water for chemical reaction of CaO and  $H_2O$  resulting in  $Ca(OH)_2$  is:

$$M_{H_2O} = \frac{18 \cdot M_{Ca(OH)_2}}{56} = \frac{18 \cdot 0.073}{56} = 0.023 \frac{t}{day} \quad (20)$$

The total mass of CaO for treatment of 5000 m<sup>3</sup>/day of mine waste water obtained on the basis of previous calculations:

$$M_{70\% CaO} = 2 + 1.6 + 0.26 + 0.078 = 3.94 \frac{t}{day} \quad (21)$$

A 20% higher value is adopted (for other present elements):  $4.73 \frac{t}{day}$  CaO activity 70%.

## CONCLUSION

Large amounts of accumulated mine water in the abandoned open pits represent a resource that can be reused in the production processes after adequate treatment. Their treatment by the neutralization process of 10%  $Ca(OH)_2$ , during which the metal hydroxides are formed and pH value increases, is significant from the point of view of its reuse for the mining activities.

The calculation of calcium hydroxide consumption of known activity was made for elements that are present in water in a concentration higher than 1 mg/L. The calculated mass of CaO was increased by 20% due to the presence of other elements in accumulated water.

### **ACKNOWLEDGEMENT**

*The authors acknowledge the Ministry of Science, Technological Development and Innovation of the Republic of Serbia for the financial support of scientific research at the Mining and Metallurgy Institute Bor (contract no. 451-03-66/2024-03/200052).*

### **REFERENCES**

- [1] Stepanović S., Stanić N., Doderović A., *et al.*, Mining and Metallurgy Engineering Bor. (2) (2022) 51–58.
- [2] Dragišić V., Polomčić D., Hydrogeological Dictionary, University of Belgrade, Faculty of Mining and Geology, Belgrade (2009), p. 404. (In Serbian and English), ISBN 978-86-7352-189-3.
- [3] Stanković V., Božić D., Gorgievski M., *et al.*, J. Min. Metall. B. 57(1) (2021) 33–42.
- [4] Dimitrijević M. D. Copper. 37(1) (2012) 33–44. (In Serbian)
- [5] Dimitrijević M. D., Nujkić M. M., Milić S. M. Copper. 37(1) (2012) 45–55. (In Serbian)