



University of Belgrade
Technical Faculty in Bor
28th International Conference Ecological Truth
& Environmental Research



EcoTER'20

PROCEEDINGS



EDITOR

Prof. Dr Snežana Šerbula

16 - 19 June 2020, Hotel Aquastar Danube, Kladovo, Serbia



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ECOLOGICAL TRUTH AND ENVIRONMENTAL RESEARCH – EcoTER'20

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PREFACE

The world today is faced with the rapid changes in technology. The excessive unsustainable consumption of fossil fuels and primary raw materials require a multidisciplinary approach in finding adequate sustainable solutions. That is why environmental research and ecological truth are at the focus of the 28th International Conference Ecological Truth & Environmental Research 2020 (EcoTER'20), which will be held at Kladovo, Serbia, 16-19 June 2020. On behalf of the Organizing Committee, it is a great honor and pleasure to wish all the participants a warm welcome to the Conference.

We hope to convey the message of the conference, which is that a transformation of attitudes and behavior would bring the necessary changes. This is also an opportunity for the participants who are experts in this field to exchange their experiences, expertise and ideas, and also to consider the possibilities for their collaborative research.

The 28th International Conference Ecological Truth & Environmental Research 2020 is organized by the University of Belgrade, Technical faculty in Bor, and co-organized by the University of Banja Luka, Faculty of Technology, University of Montenegro, Faculty of Metallurgy and Technology – Podgorica, University of Zagreb, Faculty of Metallurgy – Sisak, University of Pristina, Faculty of Technical Sciences – Kosovska Mitrovica and the Association of Young Researchers, Bor.

These proceedings include 51 papers from the authors coming from the universities, research institutes and industries in 7 countries: Russia, Lithuania, Nigeria, Croatia, Bosnia and Herzegovina, Montenegro and Serbia.

As a part of this year's conference, the third student section is being held. We appreciate the research of the students and their mentors who have made a contribution to the conference. Abstracts of the students' papers have been included into the EcoTER'20 proceedings.

Financial assistance provided by the Ministry of Education, Science and Technological Development of the Republic of Serbia is gratefully acknowledged.

We appreciate the effort of all the authors who have contributed to these proceedings. We would also like to express our gratitude to the members of the scientific and organizing committees, reviewers, speakers, chairpersons and all the Conference participants for their support to EcoTER'20. Sincere thanks go to all the people who have contributed to the successful organization of EcoTER'20.

*On behalf of the 28th EcoTER Organizing Committee,
Snežana Šerbula, Professor*



TABLE OF CONTENTS

Plenary Lecture

<i>Velizar Stanković</i>	
AMDs FROM COPPER MINES – A DRAMATIC THREAT TO LOCAL WATER FLOWS OR A VALUABLE SOURCE FOR COPPER PRODUCTION	3

Conference Papers

<i>Slavica Stevanović, J. Krstić, B. Stojanović, D. Paunović, D. Dimitrijević, J. Veličković</i>	
THE EFFECT OF EFFLUENT ON THE WATER QUALITY IN THE NIŠAVA	5
<i>Ana Čučulović, J. Stanojković, R. Čučulović, S. Nestorović, N. Radaković, D. Veselinović</i>	
THE DISTRIBUTION OF THE MASS CONCENTRATIONS OF POTASSIUM, THORIUM AND RADIUM IN THE SOILS OF THE TEKIJA REGION, THE NP ĐERDAP	11
<i>Suzana Lutovac, M. Gligorić, J. Majstorović, L. Crnogorac</i>	
EXPERIMENTAL DETERMINATION THE PARAMETERS OF ROCK MASS OSCILLATION EQUATION AT COPPER ORE USING SIMPSONS'S RULE	17
<i>Tatjana Anđelković, D. Bogdanović, I. Kostić, G. Kocić</i>	
COMPARISON OF THE INFLUENCE OF TEMPERATURE AND ULTRASOUND ON DEHP MIGRATION FROM PLASTIC PACKAGING INTO FOOD RECIPIENTS	24
<i>Tatjana Anđelković, D. Bogdanović, I. Kostić, G. Nikolić, B. Kostić, T. Cvetković, G. Kocić</i>	
DETERMINATION OF PHTHALATES IN PVC MEDICAL DEVICES BY FOURIER TRANSFORM INFRARED SPECTROSCOPY	30
<i>Milanka Negovanović, L. Kričak</i>	
REDUCTION OF DRILLING DUST USING DRY DUST COLLECTION SYSTEMS IN SURFACE BLASTING OPERATIONS	36
<i>Marija Petrović Mihajlović, Ž. Tasić, A. Simonović, M. Radovanović, M. Antonijević</i>	
DETERMINATION OF PARACETAMOL USING CARBON BASED SENSOR ELECTRODES	42
<i>Jovica Sokolović, D. Marilović, S. Vasković</i>	
THE ROLE OF SUSTAINABLE DEVELOPMENT IN THE CEMENT INDUSTRY IN SERBIA	48

Jelena Kalinović, S. Šerbula, T. Kalinović, J. Milosavljević, A. Radojević, M. Nujkić	ANALYSIS OF Al, Cr AND Mn IN THE ROOT ZONE SOIL AND PLANT PARTS OF WILD ROSE (<i>Rosa</i> spp.) IN THE BOR AREA	54
Tanja Kalinović, S. Šerbula, J. Kalinović, J. Milosavljević, A. Radojević	THE DISTRIBUTION OF Al, Fe, Cu, Zn, Pb, Ni, As AND Cd WITHIN THE PINE TREES FROM THE CHEMICALLY IMBALANCED ENVIRONMENT	60
Jelena Milosavljević, S. Šerbula, T. Kalinović, J. Kalinović, A. Radojević, B. Spalović	THE RELATIONS BETWEEN SOIL PHYSICO-CHEMICAL PROPERTIES AND SOIL ENZYME ACTIVITIES IN LONG-TERM CONTAMINATED AREA	66
Igor Kodranov, M. Pergal, D. Manojlović	TOXICITY SCREENING AFTER DEGRADATION OF ORGANOPHOSPHORUS PESTICIDES WITH CHLORINE DIOXIDE	72
Darko Anđelković, M. Branković, B. Zlatković, M. Radović-Vučić, G. Kocić	<i>Pistia stratiotes</i> HEAVY METAL UPTAKE POTENTIAL: A STUDY OF MULTIPLY LEVEL CADMIUM POLLUTED WATER	77
Miljan Bigović, S. Krivokapić, D. Đurović, N. Cupara, I. Nikolić	AGRICULTURAL SOIL POLLUTION BY HEAVY METALS IN THE MUNICIPALITY OF PLJEVLJA, MONTENEGRO	82
Miljan Vilimonović, V. Cvetković, M. Košanin, G. Grkajac, V. Bogojević	THE INFLUENCE OF THE PROCESS OF WASHING ORE OF BORN MINERALS FROM THE "POBRDJE" DEPOSIT ON THE ENVIRONMENT	88
Nevena Čule, A. Lučić, Z. Miletić, M. Veselinović, S. Mitrović	REMOVAL OF PHOSPHORUS AND NITROGEN IN MODIFIED FLOATING TREATMENT WETLAND	94
Jakov Baleta, L. Lazić, D. Pavlović, D. Cerinski	NUMERICAL ANALYSIS OF THE INDUSTRIAL POLLUTANTS DISPERSION IN URBAN AREA	100
Maja Nujkić, S. Milić, A. Papludis, S. Stanković, A. Radojević, S. Alagić, B. Spalović	WALNUT SHELL AS A BIOSORBENT FOR REMOVAL OF HEAVY METAL IONS FROM DIFFERENT SAMPLE SOLUTIONS	106
Aleksandra Papludis, S. Alagić, S. Milić	DETECTION OF PAHs AS MICRO-POLLUTANTS IN ENVIRONMENTAL SOIL AND PLANT SAMPLES	111
Sonja Stanković, M. Antonijević, S. Milić	SOURCES AND AVAILABILITY OF INORGANIC PHOSPHOROUS IN THE SOIL	116
Mihajlo Stanković	CONTRIBUTION TO THE KNOWLEDGE OF THE DISTRIBUTION OF <i>Gias titanus</i> SIMON, 1879 (OPILIONES, PHALANGIIDAE) IN THE TERRITORY OF BOSNIA AND HERZEGOVINA	122
Mihajlo Stanković	23 YEARS OF THE NATURAL COLLECTION OF ZASAVICA RESERVES	128
Darko Anđelković, M. Branković, G. Kocić	SUITABILITY OF PROCEDURAL CALIBRATION STANDARDS AFTER LONG-TERM STORAGE FOR PESTICIDE ANALYSIS IN APPLE PEEL	136

Darko Anđelković, M. Branković, G. Kocić	LABORATORY SCALED EVALUATION OF SORPTION BEHAVIOR FOR FIVE PESTICIDES IN APPLE PEEL: EFFECT OF CONTACT TIME	143
Tatjana Anđelković, D. Bogdanović, I. Kostić, D. Anđelković, G. Kocić	THE MIGRATION OF DEHP FROM PLASTIC PACKAGING INTO DAIRY PRODUCTS WITH DIFFERENT FAT CONTENT	148
Nena Velinov, M. Petrović, M. Radović Vučić, M. Kostić, J. Mitrović, D. Bojić, A. Bojić	OPTIMIZATION AND APPLICATION OF LIGNOCELLULOSIC- Al_2O_3 BIOSORBENT FOR COPPER IONS REMOVAL FROM WATER	154
Miljana Radović Vučić, N. Velinov, M. Petrović, S. Najdanović, J. Mitrović, D. Bojić, A. Bojić	REACTIVE DYE CONTAMINATED WATER TREATED BY PHOTO DRIVEN ADVANCED OXIDATION PROCESSES	160
Milica Petrović, N. Velinov, M. Radović Vučić, S. Najdanović, M. Kostić, J. Mitrović, A. Bojić	A NOVEL STAINLESS STEEL/ Bi_2O_3 ELECTRODE FOR ELECTROCHEMICAL DEGRADATION OF TEXTILE DYE	165
Đuro Čokeša, M. Marković, M. Gajić-Kvašček, B. Kaluđerović, S. Radmanović, S. Šerbula	ISOTHERMAL TITRATION CALORIMETRY STUDY OF As(III) BINDING TO HUMIC ACIDS	171
Miljan Bigović, S. Krivokapić, I. Milašević, N. Cupara, D. Đurović	DETERMINATION OF POLYCYCLIC AROMATIC HYDROCARBONS (PAHs) CONTENT IN FOOD AND HEY IN PLJEVLJA MUNICIPALITY, MONTENEGRO	178
Adeleke Victor Adedayo	CORROSION BEHAVIOUR OF ZA27 AND ZA27/EGGSHELL COMPOSITE IN SCOTCH BONNET PEPPER FLUID	184
Adeleke Victor Adedayo	CORROSION BEHAVIOUR OF ZA27 AND ZA27/EGGSHELL COMPOSITE IN SIMULATED SEA WATER	189
Milena Tadić, I. Nikolić, D. Laković, D. Đurović, N. Cupara	MODIFIED FLY ASH AS A NEW ADSORBENT FOR Cu^{2+} REMOVAL FROM AQUATIC SOLUTIONS	193
Branka Kaluđerović, Đ. Čokeša, M. Marković, V. Rajković, M. Srečković	HYDROTHERMAL CARBONIZATION–GREEN PROCESS FOR CARBON MATERIAL PREPARATION	198
Žaklina Tasić, A. Simonović, M. Petrović Mihajlović, M. Radovanović, M. Antonijević	THE APPLICATION OF PENCIL GRAPHITE ELECTRODE IN ELECTROANALYSIS	203
Ivan Đorđević, S. Milić, D. Medić, M. Nujkić, A. Papludis	RECOVERY OF METALS FROM SPENT LITHIUM ION BATTERIES	209
Marina Pešić, S. Milić, M. Nujkić, D. Medić, S. Stanković	APPLICATION OF SIMULATION METHODS AND ANALYSIS OF THE INFLUENCE OF PRECIPITATION REGIME ON TURBIDITY OF KARST AQUIFER: A CASE STUDY OF KARST ZLOT'S SPRING (BOR, SERBIA)	215
Nataša Đorđević, S. Mihajlović, A. Patarić	DISPOSAL OF FLYING ASH FROM THERMAL POWER PLANTS	221

Marija Nešić, D. Obratov-Petković, I. Bjedov, D. Skočajić	EFFECTS OF ALLELOPATHY ON THE SPREAD OF INVASIVE SPECIES <i>Aster Lanceolatus</i> WILLD. COMPLEX	225
Ivana Bjedov, D. Obratov-Petković, M. Nešić, S. Belanović-Simić, J. Beloica	CHANGES IN THE DISTRIBUTION OF <i>Vaccinium</i> L. GENUS IN RELATION TO THE SOIL ACIDIFICATION SCENARIO	231
Veselin Bežanović, M. Novaković, M. Živančev, D. Milovanović, D. Adamović	ADSORPTION OF METHYLENE BLUE FROM AQUEOUS SOLUTION USING ACTIVATED CARBON PREPARED FROM HAZELNUT SHELL	237
Miodrag Živančev, D. Milovanović, V. Bežanović, M. Novaković, M. Petrović, D. Ubavin	CONTRIBUTION OF WASTE MANAGEMENT SECTOR IN NOVI SAD TO CLIMATE CHANGE	243
Ljiljana Stosic, D. Stojanovic, K. Lazarevic	OPINIONS AND ATTITUDES OF THE CITIZENS OF NIS ON COMMUNITY NOISE	249
Zoranka Malešević, R. Krgović, M. Jovović	PHYSICAL-CHEMICAL CHARACTERISTICS OF SM "VELIKI CRLJENI" COAL AND ITS EFFECT ON THE ENVIRONMENT	255
Daniela Urošević, Z. Sovrlić, I. Svrkota, M. Mikić, R. Kovačević, M. Šteharik	IMPLEMENTATION OF QUALITY CONTROL ON SAMPLED SOIL WITH TRIP AND FIELD BLANK	261
Miomir Mikić, D. Urošević, N. Stanić, M. Jovanović, S. Petrović	ENERGY, RENEWABLE ENERGY SOURCES, POTENTIALS AND APPLICATIONS	269
Jovana Bošnjaković, I. Jelić, V. Komadinić	APPLICATION AND PROPERTIES OF NATURAL FIBER-BASED BIOCOMPOSITE MATERIALS – A REVIEW	275
Maja Radić, S. Čemer, M. Avdagić	PLANET PRESERVATION THROUGH CLIMATE ACTIONS AND CREATING QUALITY JOBS ONLY	281
Senad Čeragić, H. Husić	PREVENTION OF CONTAMINATION OPEN WATERCOURSES FROM EVACUATION MINE WATER FROM SURFACE MINE TURIJA	286
Ligita Baležentienė	CROP' CONTRIBUTION TO SEASONAL CARBON EXCHANGE IN TEMPERATE CLIMATE OF CENTRAL LITHUANIA	292

Student section

Student: Damnjan Trifunović		
Mentor: Maja Nujkić	HONEY BEES AS BIOINDICATOR OF ENVIRONMENTAL POLLUTION	299
Student: Nemanja Milošević		
Mentor: Snežana Milić	THERMOSTABLE PLASTIC POLYMERS	301
Author Index		304



DISPOSAL OF FLYING ASH FROM THERMAL POWER PLANTS

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Abstract

The problem of fly ash as a by-product of thermal power plants is an actual issue. This ash is extremely hazardous to the environment. It contains particles of extremely small diameter that are easily carried by the wind, and have many toxic elements and heavy metals. The scattered particles reach the water and soil, thus causing environmental contamination. Multiple solutions have been offered to remedy this serious problem, which relates not only to the environment (land, air and water) but also significantly affects the health of people living close to the thermal power plants. Remediation of ultra-fine particles spread by aeolian erosion reduces the potential for water and soil contamination as well as crops used by the population for nutrition, and thus for acute and chronic diseases found to be caused by fly ash pollution. The use of elemental sulfur, which is a secondary product of the oil refining process, in order to bind fly ash, manages waste, thus solving two environmental problems.

Keywords: environment, fly ash, heavy metals, solid waste, risk, pollutants, contamination, waste management, protection.

INTRODUCTION

Now days, it is virtually impossible to imagine a life without electricity. The primary energy sources used in power generation are coal, oil, natural gas and fossil fuels. When low-calorie coal types are used in the production of electricity, many environmental pollutants are produced as a result of their combustion. Their combustion produces solid waste as well as harmful gases that lead to significant pollution of water, land and air. One of the biggest problems facing both employees in thermal power plants and, even more importantly, people living near the thermal power plant is fly ash [1].

In most existing thermal power plant installations, ash that has not reacted in the coal combustion process is carried to special landfills where it is deposited. At the exit of the thermal power plant, ash is soaking with water. At the landfill, the water level should be constantly above the ash level to prevent ash spreading [2]. To make an ash watering system more effective, it must be constant, adapted to the weather conditions. Water has to be applied over a larger area than the surface of the ejected ash. This requires a large amount of water, which significantly complicates the ash moistening process without being a permanent solution [3]. In practice, adequate wetting is practically impossible to achieve because the quantities of ash that emerge from the thermal power plant daily are extremely high. Data show that about 35 million tons of coal, mainly lignite, is used in power plants in Serbia

annually [4,5]. This type of coal has a lower heat output of 6000-8000 kJ/kg, average moisture content of 45-53% and ash of 10-23%. Daily consumption of coal is from 17000 to 19000 tons per unit of power plant ("Nikola Tesla" thermal power plant, Obrenovac), whereby a significant amount of ash remains by burning coal in thermal power plants, producing every kilowatt of electricity. The landfills where ash is deposited have a total area of approximately 1639 hectares. Between 1974 and today, between 250 and 300 million tons of ash and slag have been disposed. Ash is one of the most common pollutants in the workplace and the environment, polluting land, water and air.

MATERIALS AND METHODS

In this study, the possibility of using elemental sulfur to bond fly ash was investigated. To be used for this purpose, it is necessary to modify the elemental sulfur, which is a secondary product of the oil refining process, with dicyclopentadiene to a chain crystal structure. The process of homogenization and binding of ultrafine ash particles with sulfur would be carried out in the reactor at temperatures of 150°C to 170°C by injecting sulfur in an amount of 15% to 22% with intensive mixing of the components. As the ash leaving the thermal power plant is already at the high temperature required for the sulfur agro-metering process, no additional heating of the system is necessary. The ash is fed to the corresponding reactor with a rotary mixer at the exit point from the existing plant. At these temperatures, elemental sulfur enters the molten state boundary, and plays the role of filler and binder. The ash particles get coated, and increase the dimensions and weight. Analyzes show that the particle content of less than 63 µm decreases from 17.5% to 7% (with 15% sulfur added) and 1% (with 22% sulfur added). During the cooling process of the obtained product (after homogenization and agglomeration), a product is obtained that can be deposited much more easily into the landfill without additional use of the wetting system used so far to prevent the fly ash from scattering. The resulting ash-sulfur agglomerate cannot be dispersed by the wind due to the size and weight of the particles. Sulfur that coats the ash prevents heavy metals from leaching from the ash and thus reduces water and soil pollution. This procedure is a permanent solution to the problem of the deposition of ash from thermal power plants, and the problem of environmental pollution also.

RESULTS AND DISCUSSION

The bonding of ultra-fine ash particles with elemental sulfur solves three current problems. This implies a drastic reduction in the amount of fly ash spread by aerosol erosion over the wider area of the thermal power plant. This has a direct impact on reducing the respiratory diseases of the surrounding population, as well as reducing pollution of water and land on which food crops are cultivated. Reducing the intake of heavy metals into the body would significantly reduce the number of patients with malignant diseases. Statistics show that over 50% of the population has respiratory problems, and that almost 2/3 of school and preschool children have similar problems, which can be directly linked to the impact of ash dump. In addition to the complex effects of air pollution factors, other food and drinking factors are also important, as the areas around power plants are mostly populated by agrarian

populations, and many households use both drinking water and the food they produce at these locations. Considering the statistical data on the number of patients with respiratory diseases in these regions, environmental pollution in the ash dumps reaches the level of ecological catastrophe. Chemical analysis of ash reveals the presence of heavy metals (Zn, Cr, Cd, Sr, Pb, Co, and Ni) that through the diet indirectly enter the human body and increase the number of cancerous diseases. Remediation of fly ash has therefore become a burning problem from an environmental point of view.

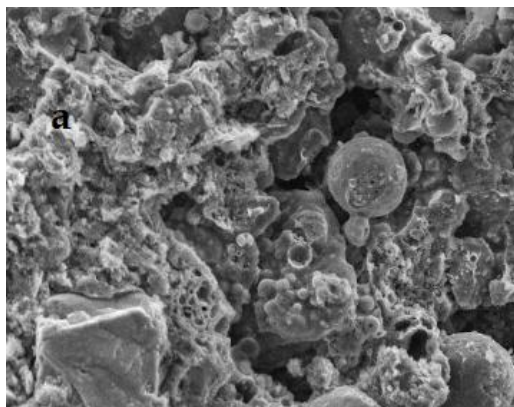


Figure 1 SEM micrographs original fly ash

Using sulfur, which is a co-product in the oil refining process, reduces the sulfur landfill, which without that threatens to become a serious environmental problem. Elemental sulfur is a product of oil refining process and a result of desulphurisation of the resulting petroleum products. It is a ballast material and also threatens to become a serious environmental problem. In the future, the amount of sulfur obtained and deposited in this way will be increasing with us, with the tightening of domestic regulations on the sulfur content of petroleum products and the approximation of those regulations to EU norms. In recent years, the world has been intensively working on finding effective ways to rationally consume rapidly increasing amounts of elemental secondary sulfur. This technological solution enables the use of elemental sulfur, which is a by-product of the petroleum refining process, as a binder of fly ash particles of less than 63 μm and reduces the amount of these ultrafine particles from 17.5% to 1%. This would allow its permanent binding to soil and thus suppressing aeolian erosion of deposited ash. Implementing suitable technical solutions shown in this article, it could effectively solve both environmental problems in one place.

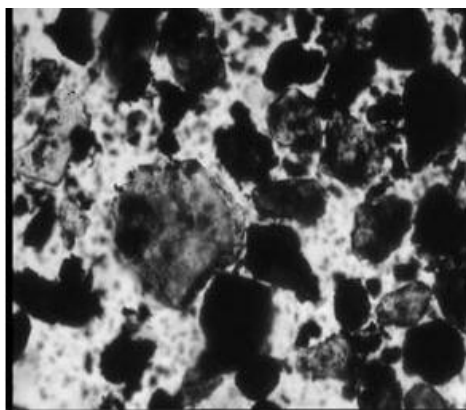


Figure 2 SEM of a sample of fly ash bound with sulfur

CONCLUSION

Repairing fly ash problems by bonding to elemental sulfur, it is not necessary to make drastic changes to the existing equipment within the thermal power plant. As the ash temperature at the outlet of the reactor is at the appropriate level required for the sulfur bonding process, it is sufficient to associate the outlet system with a mixer in which to agglomerate. Some solutions even require sintering of the material, which requires the investment of large material assets and new facilities. After sulfur-coated agglomeration, the resulting product is transported to already existing by-products landfills. It is not necessary to use water used in large quantities for the purpose of wetting fine ash particles, which thus far prevents the ash from spreading around the environment and affects the pollution of surrounding soil and water due to the presence of heavy metals in the ash. By wetting system, it would be necessary to ensure that the water level is always above the ash level, which is difficult to achieve under current conditions. Ash binding to sulfur completely replaces the use of water, which significantly reduces material investment, as a problem of summer high temperatures. Elemental sulfur that would be used as a binder for ash agglomeration is available without investment because it is a secondary product in the oil refining industry, and as such is a disposal problem, so this technological solution would practically solve the problem of its disposal as well. Ash after agglomeration can still be used in the construction industry and in the road construction process.

REFERENCES

- [1] V. Vidojković, N. Đorđević, T. Boljanac, *et al.*, Hem. Ind; 60 (5–6) (2006) 144–147.
- [2] L. Gray, K. J. Champagne, Y. Soong, *et al.*, International Ash Utilization Symposium, Center for Applied Energy Research, University of Kentucky, (1999) Paper #6.
- [3] C. Song, H.H. Schobert, Fuel; 75 (1996) 724–736.
- [4] T.C. Eisele, S.K. Kawatra, D.D. Banerjee, SME Annual Meeting, Preprint (1996).
- [5] B.G. Kutchko, A.G. Kim, Fuel; 85 (17–18) (2006) 2537–2544.