MINING AND METALLURGY INSTITUTE BOR

and

TEHNICAL FACULTY BOR, UNIVERSITY OF BELGRADE

IOC 2018

International October Conference

50th International October Conference on Mining and Metallurgy

PROCEEDINGS

Editors:

Ana Kostov

Milenko Ljubojev

30th September – 3rd October 2018

Hotel "Jezero" Bor Lake, Serbia

MINING AND METALLURGY INSTITUTE BOR

and

TEHNICAL FACULTY BOR, UNIVERSITY OF BELGRADE

50th International October Conference on Mining and Metallurgy

PROCEEDINGS

Editors:

Ana Kostov
Milenko Ljubojev

30th September – 3rd October 2018

Hotel "Jezero" Bor Lake, Serbia

50[th] International October Conference on Mining and Metallurgy

Editors: Ana Kostov, Milenko Ljubojev

Publisher: Mining and Metallurgy Institute Bor

Printed in: "GRAFOMED-TRADE" Bor

Text printing preparation: Vesna Simić

Disclaimer: Authors are responsible for the content, translation and accuracy.

Circulation: 200 copies

CIP- Каталогизација у публикацији
Народна библиотека Србије, Београд

622(082)
669(082)

INTERNATIONAL October Conference on Mining and Metallurgy (50 ; 2018 ; Borsko jezero)
Proceedings / 50th International October Conference on Mining and Metallurgy - IOC 2018, 30th September - 3rd October 2018 Bor Lake, Serbia ; [organized by] Mining and Metallurgy Institute Bor and Technical Faculty Bor, University of Belgrade ; editors Ana Kostov, Milenko Ljubojev. - Bor : Mining and Metallurgy Institute, 2018 (Bor : Grafomed-trade). - XXV, 519 str. : ilustr. ; 25 cm

Tiraž 200. - Bibliografija uz svaki rad. - Registar.

ISBN 978-86-7827-050-5

1. Institut za rudarstvo i metalurgiju (Bor) 2. Tehnički fakultet (Bor)

a) Рударство - Зборници
b) Металургија - Зборници

COBISS.SR-ID 267792140

Bor, October 2018

SCIENTIFIC COMMITTEE

50th International October Conference on Mining and Metallurgy

Dr Mile Bugarin (Serbia) - *president*
Dr Ana Kostov (Serbia) - *vice president*
Dr Milenko Ljubojev (Serbia) - *vice president*

Dr. Walter Valery (Australia)
Prof. Dr. Boyan Boyanov (Bulgaria)
Prof. Dr. Stoyan Groudev (Bulgaria)
Prof. Dr. Vencislav Iwanov (Bulgaria)
Dr. Anto Gajić (B&H)
Dr. Boško Vuković (B&H)
Dr. Eldar Pirić (B&H)
Prof. Dr. Jelena Penavin Škundrić (B&H)
Dr. Kemal Gutić (B&H)
Prof. Dr. Lazar Stojanović (B&H)
Prof. Dr. Mevludin Avdić (B&H)
Prof. Dr. Mirsada Oruč (B&H)
Prof. Dr. Sulejman Muhamedagić (B&H)
Dr. Dragan Komljenović (Canada)
Prof. Dr. Fathi Habashi (Canada)
Prof. Dr. Vladimir Krstić (Canada)
Prof. Dr. Kaikun Wang (China)
Prof. Dr. Yong Du (China)
Prof. Dr. Mirko Gojić (Croatia)
Prof. Dr. Tamara Holjevac Grgurić (Croatia)
Prof. Dr. Heikki Jalkanen (Finland)
Prof. Dr. Aleksandar Dimitrov (FYR Macedonia)
Prof. Dr. Carl Heinz Spitzer (Germany)
Dr. Srećko Stopić (Germany)
Prof. Dr. Costas Matis (Greece)
Prof. Dr. Dimitris Panias (Greece)
Prof. Dr. György Kaptay (Hungary)
Prof. Dr. Iwao Katayama (Japan)
Prof. Dr. Nobuyuki Masuda (Japan)
Prof. Dr. Essen Suleimenov (Kazakhstan)
Prof. Dr. Kemal Delijić (Montenegro)
Prof. Dr. Žarko Radović (Montenegro)
Prof. Dr. Krzystof Fitzner (Poland)
Prof. Dr. Luis Filipe Malheiros (Portugal)
Prof. Dr. Andrei Rotaru (Romania)
Prof. Dr. Dimitriu Sorin (Romania)
Prof. Dr. Sanda Krausz (Romania)
Prof. Dr. Alexander Udovsky (Russia)
Prof. Dr. Petr M. Solozhenkin (Russia)
Prof. Dr. Sergey Krasikov (Russia)
Dr. Slavomir Hredzak (Slovakia)
Prof. Dr. Tomaš Havlik (Slovakia)
Prof. Dr. Boštjan Markoli (Slovenia)
Prof. Dr. Jakob Lamut (Slovenia)
Prof. Dr. Jožef Medved (Slovenia)
Prof. Dr. Milivoj Vulić (Slovenia)
Dr. Mirjam Jan-Blažić (Slovenia)
Dr. Magnus Ericsson (Sweden)
Prof. Dr. Seshadri Seetharaman (Sweden)
Prof. Dr. Guven Onal (Turkey)
Prof. Dr. OnuralpYucel (Turkey)
Prof. Dr. Batrić Pešić (USA)
Prof. Dr. Velimir Radmilović (USA)
Prof. Dr. Vladislav Kecojević (USA)
Prof. Dr. Aco Janićijević (Serbia)
Dr. Aleksandra Ivanović (Serbia)
Dr. Aleksandra Milosavljević (Serbia)
Prof. Dr. Andjelka Mihajlov (Serbia)
Dr. Biserka Trumić (Serbia)
Prof. Dr. Branislav Nikolić (Serbia)
Prof. Dr. Branka Jordović (Serbia)
Dr. Daniel Kržanović (Serbia)
Dr. Daniela Urošević (Serbia)
Dr. Dragan Milanović (Serbia)
Prof. Dr. Dragan Milovanović (Serbia)
Dr. Dragana Božić (Serbia)
Dr. Dragoslav Rakić (Serbia)
Prof. Dr. Dejan Ivezić (Serbia)
Prof. Dr. Dejan Tanikić (Serbia)
Prof. Dr. Desimir Marković (Serbia)
Prof. Dr. Dragan Manasijević (Serbia)
Prof. Dr. Dragoslav Gusković (Serbia)
Prof. Dr. Duško Minić (Serbia)
Prof. Dr. Endre Romhanji (Serbia)
Prof. Dr. Grozdanka Bogdanović (Serbia)
Dr. Ivana Jovanović (Serbia)
Dr. Jasmina Stevanović (Serbia)
Prof. Dr. Karlo Raić (Serbia)
Dr. Lidija Gomidželović (Serbia)
Prof. Dr. Ljubiša Kuzović (Serbia)
Prof. Dr. Milan Antonijević (Serbia)
Prof. Dr. Milan Trumić (Serbia)
Prof. Dr. Mile Dimitrijević (Serbia)
Prof. Dr. Mirjana Rajčić Vujasinović (Serbia)
Dr. Miroslav Sokić (Serbia)
Prof. Dr. Nada Štrbac (Serbia)
Dr. Nadežda Talijan (Serbia)
Prof. Dr. Nedeljko Magdalinović (Serbia)
Prof. Dr. Nenad Radović (Serbia)
Prof. Dr. Nenad Vušović (Serbia)
Prof. Dr. Rade Jelenković (Serbia)
Dr. Radmila Marković (Serbia)
Prof. Dr. Radoje Pantović (Serbia)
Prof. Dr. Rodoljub Stanojlović (Serbia)
Dr. Renata Kovačević (Serbia)
Dr. Silvana Dimitrijević (Serbia)
Prof. Dr. Slobodan Trajković (Serbia)
Prof. Dr. Snežana Šerbula (Serbia)
Prof. Dr. Svetlana Ivanov (Serbia)
Prof. Dr. Tatjana Volkov-Husović (Serbia)
Prof. Dr. Velizar Stanković (Serbia)
Dr. Vesna Conić (Serbia)
Dr. Vesna Krstić (Serbia)
Prof. Dr. Vitomir Milić (Serbia)
Dr. Viša Tasić (Serbia)
Dr. Vladan Ćosović (Serbia)
Prof. Dr. Vlastimir Trujić (Serbia)
Dr. Zdenka Stanojević Šimšić (Serbia)
Dr. Zoran Stevanović (Serbia)
Dr. Zvonko Gulišija (Serbia)
Prof. Dr. Željko Kamberović (Serbia)
Prof. Dr. Živan Živković (Serbia)

ORGANIZING COMMITTEE

50th International October Conference on Mining and Metallurgy

Dr. Ana Kostov, *president*

Dr. Milenko Ljubojev, *vice-president*
Prof. Dr. Dejan Tanikić, *vice-president*

Suzana Cvetković, *secretary*

Members:
Dr. Aleksandra Milosavljević
Dr. Silvana Dimitrijević
Dr. Zdenka Stanojević Šimšić
Dr. Dragana Božić
Borivoje Stojadinović
Lidija Đurđevac Ignjatović
Dragan Ignjatović
Nevenka Vukašinović
Vesna Simić
Danilo Spalović
Saša Stojanov

TABLE OF CONTENTS

PLENARY LECTURES

GEOLOGY, MINING AND MINERAL PROCESSING

METALLURGY AND MATERIALS SCIENCE

TECHNOLOGY AND CHEMISTRY

ENVIRONMENTAL PROTECTION

RELATED FIELDS:
MECHANICAL ENGINEERING,
CIVIL ENGINEERING, ARCHITECTURE, ELECTRONICS,
INFORMATION, MANAGEMENT, ETC.

CORN SILK AS A BIOSORBENT FOR THE METAL IONS REMOVAL FROM THE MINING, SMELTING AND ELECTROPLATING WASTEWATER

Marija Petrović, Tatjana Šoštarić, Jelena Petrović, Jelena Milojković, Marija Koprivica, Mirjana Stojanović

Institute for Technology of Nuclear and Other Mineral Raw Materials, Franchet d'Esperey 86, 11000 Belgrade, Serbia, E-mail: m.petrovic@itnms.ac.rs

Abstract

Heavy metals are widely used in different industries and large volumes of wastewater are discharged in the environment. The agricultural waste materials are efficient for removal the heavy metals ions from thewater solutions. In this work, corn silk was used as a biosorbent for the Pb^{2+}, Cu^{2+} and Zn^{2+} ions removal from the wastewater originated from the Trepča Mines, Mining and Smelting Basin Bor and electroplating. Corn silk was characterized by a SEM-EDX. The experimental results show that the corn silk can be used as an efficient biosorbent for removal th eheavy metals removal from water as well as wastewater solutions.

Keywords: *biosorption, corn silk, heavy metals, wastewater*

1 INTRODUCTION

Industrial effluents from different production processes such as tanneries, battery manufacturing, metal plating, mining and smelting are the major source of heavy metal pollution. High concentration of heavy metals is harmful to the living organisms. They can cause a serious diseases (brain damage, vomiting, anorexia) in humans or animal and plant death [1,2]. Due to, it is important to remove the toxic metals from wastewater. Water pollution is one of the most important environment tasks.

There are some conventional techniques that can be used for the metal removal from the industrial wastewater such as ion exchange, membrane filtration, electrolysis, adsorption, precipitation and flocculation [3]. The main disadvantages of listed techniques are a high operation costs, production of toxic sludge, low efficiency and selectivity [4]. Due to, the cost-effective and environmental friendly technique for heavy metals removal are desired. Biosorption is an adsorption process using the low cost, locally available and ecofriendly agro-waste materials for metal uptake and its removal from the wastewater. Pehlivan et al., showed that the waste biomass of hazel nut and almond shell is a suitable sorbent for lead removal from the aqueous solutions [5]. Olive stone and pine bark can be used as an effective sorbent for effective coper removal, and a grape stalks waste is suitable for copper and nickel ions removal from aqueous solutions [6,7].

Corn (maize) is the most cultivated crop in the world. After the harvest, the corn silk (CS) is left as a waste material. The psycho-chemical structure of CS makes this agro waste material appropriate adsorbent for the heavy metals removal from wastewater. On the other hand, the previous investigations showed that the CS have a high affinity for interaction with lead, zinc and coper ions from water solutions [8,9].

The purpose of this study was to investigate a possibility of CS for heavy metals removal from three different industrial effluents-wastewater from the Trepča Mines, Mining and Smelting Basin Bor and electroplating. The biosorption experiments were carried out in batch system and physicochemical properties of the CS were determined by the Scanning Electron Microscopy and Energy-dispersive X-ray (SEM-EDX) analysis.

2 EXPERIMENTAL

2.1 Biosorbent and Wastewater Preparation

The CS was collected on the local corn field near Belgrade (Serbia). Collected biomaterial was washed several times by the deionized water, dried at 60°C, grounded and sieved. A prepared biomaterial was used for the biosorption experiments.

The wastewater samples from Trepča Mines (S1), Mining and Smelting Basin Bor (S2) and electroplating (S3) were collected by the proposed procedure according to the "Official Gazette RS", 33/2016.

2.2 Biosorbent Characterization

The CS morphology was characterized by the SEM – EDX analysis using a JEOL JSM-6610 LV SEM model after coating of CS powder with a thin layer of gold.

2.3 Biosorption Study

The biosorption experiments were carried out in a batch system. A mass of 1g/L of CS was added in each wastewater sample and shacked in a mechanical shaker during 120 min at the room temperature (250 rpm). Afterward, the mixtures were filtered and metal ions concentration measured by the Atomic Absorption Spectrophotometry (AAS) using a Perkin Elmer Analyst 300 Spectrophotometer.

The biosorption efficiency was determined using the equation (1):

$$R\,(\%) = \frac{C_i - C_{eq}}{C_i} x100 \qquad (1)$$

where C_i and C_{eq} (mg/L) are the initial and final concentration of the metal ions in the wastewater sample, respectively.

3 RESULTS AND DISCUSSION

3.1 Biosorbent Characterization

The SEM micrographs (500 times magnification) and EDX spectra of CS are shown in Figure 1.

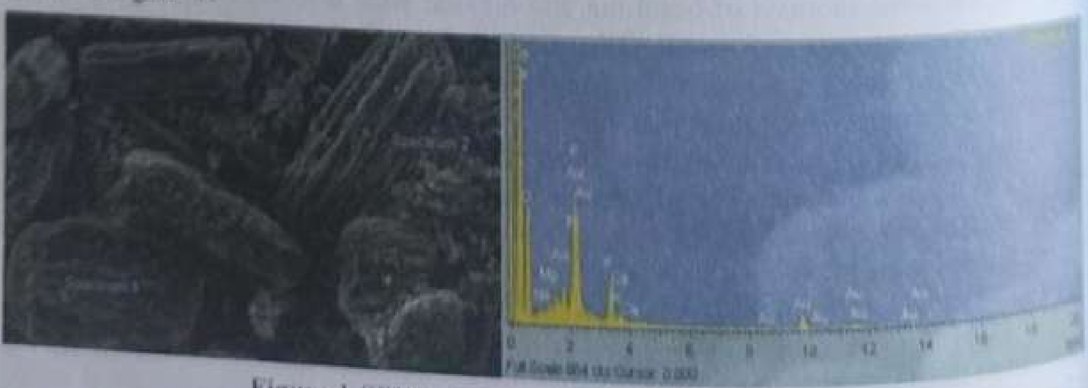

Figure 1 *SEM micrographs and EDX spectra of CS*

As it can be seen from Figure 1, the CS is a porous material with a large number of channels and rough surface area. This morphology is suitable for interaction with metal ions from water solution and their adsorption on CS surface.

3.2 Removal of Heavy Metal Ions from Wastewater

The efficiency of CS for removal of Pb(II), Cu(II) and Zn(II) ions from different wastewater solutions was investigated. Heavy metal contents in the wastewater samples from the Mining Basin Trepča, Mining And Smelting Basin Bor and Electroplating before and after the CS biosorption (S1, S2, S3 and S1-CS, S2-CS, S3-CS, respectively) are given in Table 1.

Table 1 *Lead, copper and zinc concentrations in the waste water samples before and after the CS biosorption*

Ion	S1	S1-CS	S2	S2-CS	S3	S3-CS
	concentration (mg/L)					
Pb(II)	0.332	0.004	0.206	< 0.005	<0.005	< 0.005
Cu(II)	0.191	0.01	205.0	135.0	0.251	0.02
Zn(II)	2.51	1.11	27.60	17.40	9.00	0.77

*S1 – wastewater from mining basin Trepča
*S2 – wastewater from mining and smelting basin Bor
*S3 – wastewater from electroplating

The biosorption efficiency of the CS is graphically presented in Figure 2.

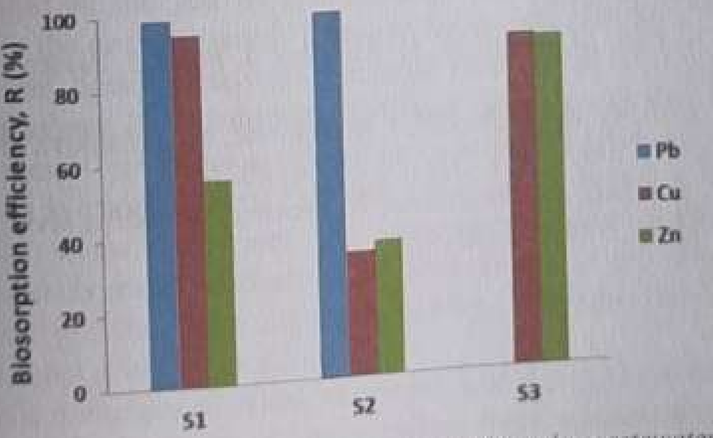

Figure 2 *Efficiency of lead, copper and zinc removal from the wastewater samples by the CS*

As it can be seen from Figure 2, the CS has high affinity for heavy metals removal from the S1, S2 and S3 samples. Lead concentration decreased 98.9 and 100 % in S1 and S2, respectively after CS adsorption (in S3 lead were notr detected). Copper concentration decreased 94.8, 34.1 and 92 % in S1, S2 and S3, respectively and zinc concentration decreased 55.8, 36.9 and 91.4 % in S1, S2 and S3, respectively, after the CS biosorption.

4 CONCLUSION

From the results of SEM-EDX study, it can be concluded that the CS morphology is suitable for interaction with the metal ions. According to the experimental results from this investigation, a high biosorption efficiency for lead, copper and zinc removal from the three different waste water revealed that the CS can be used as an ecofriendly and low-cost adsorbent.

ACKNOWLEDGEMENTS

This study is a part of the Project TR 31003, "Development of Technologies and Products Based on the Mineral Raw Materials and Waste Biomass for Protection the Natural Resources for Safe Food Production", supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia.

REFERENCES

[1] M. Iqubal, A. Saed, N. Akhtar., Bioresour. Technol., 81 (2002) 153–155.
[2] G.M. Naja, B. Volesky., In Handbook on Heavy Metals in the Environment, Taylor & Francis and CRC Press, Boca Raton (2009) 13–61.
[3] X.S. Li, S.L. Liu, Z.Y. Na, D.N. Lu, Z. Liu., Ecol. Eng. 60 (2013) 160-166.
[4] M.N. Zafar, I. Aslam, R. Nadeem, S. Munir, U.A. Rana, S.D. Khan., J. Taiwan Inst. Chem. Eng., 46 (2015) 82-88.
[5] E. Pehlivan, T. Altun, S. Cetin, B.M. Iqbal., J. Hazard. Mater., 167 (2009) 1203–1208.
[6] N. Fiol, I. Villaescusa, M. Martínez, N. Miralles, J. Poch, J. Serarols., Sep. Purif. Technol., 50 (2006) 132–140.
[7] I. Villaescusa, N. Fiol, M. Martínez, N. Miralles, J. Poch, J. Serarols.,Water Res., 38 (2004) 992–1002.
[8] M. Petrović, T. Šoštarić, M. Stojanović, J. Milojković, M. Mihajlović, M. Stanojević, S. Stanković., J. Taiwan Inst. Chem. Eng., 58 (2016) 407–416.
[9] M. Petrović, T. Šoštarić, M. Stojanović, J. Petrović, M. Mihajlović, A. Ćosović, S. Stanković., Ecol. Eng., 99 (2017) 83-97.