ZEOLITE 2018

10th International Conference on the Occurrence,
Properties and Utilization of Natural Zeolites

Book of Abstracts

Edited by Wojciech Franus, Jarosław Madej

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Preface

It is a great honor to welcome you to the 10th International Conference on the Occurrence, Properties and Utilization of Natural zeolites – Zeolite 2018 that was organized under the auspices of the International Natural Zeolite Association – INZA and the following hosting institutions: Lublin University of Technology (Lublin, Poland), AGH University of Science and Technology (Kraków, Poland) and the Mineral and Energy Economy Research Institute, Polish Academy of Science (Kraków, Poland).

The primary focus of the INZA is to promote and encourage interest in natural zeolite materials throughout the scientific and technical community. INZA was officially organized in 2005 as a formal outgrowth from the International Committee on Natural Zeolites (ICNZ). Through the efforts of Dr. Frederick A. Mumpton, the ICNZ began as an *ad hoc* organization during the Zeolite '76 conference, the first International Conference on the Occurrence, Properties and Utilization of Natural Zeolites, held in Tucson, Arizona (USA) in 1976. The organization is open to any person interested in any aspect of natural zeolites.

In keeping with the primary purpose of the ICNZ and INZA, the organization encourages the advancement of natural zeolite science and technology, promotes research and scientific interest in natural zeolites and increases the diffusion of knowledge of natural zeolite science and technology.

Zeolite 2018 is the latest in a series of conferences organized under auspices of the ICNZ and INZA. Following the initial Zeolite '76 conference, subsequent conferences were held in Budapest, Hungary (Zeolite '85); Havana, Cuba (Zeolite '91); Boise, Idaho, USA (Zeolite '93); Ischia (Naples), Italy (Zeolite '97); Thessaloniki, Greece (Zeolite '02); Socorro, New Mexico, USA (Zeolite '06); Sofia, Bulgaria (Zeolite 2010) and Belgrade, Serbia (Zeolite 2014).

Every four years, researchers and students interested in natural zeolites present their results on all aspects of research on natural zeolites. It is a privilege to have participants from 40 countries around the world attending the Zeolite 2018 conference.

We wish you a pleasant stay in Krakow and hope that you will have a very successful and beneficial conference.

Aleksandra Daković, INZA President
Wojciech Franus
Magdalena Wdowin
Tomasz Bajda

Cracow, Poland
June 2018

The distribution and retardation coefficients as a tool in selection of low-cost sorbent as a material for permeable reactive barrier – SEM-EDS analysis

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Introduction

A permeable reactive barrier (PRB) is considered as an innovative, green engineering approach for remediation of contaminated groundwater, using a passive, *in situ* technology with high potential of treatment of contaminant plume at in a cost-effective manner. Recently, scientific investigations are focused on discovering of materials for PRB which are abundant in nature or are waste material from another process. In this study, distribution and retardation coefficient were used as a tool to select various natural materials such as natural zeolites, clays and apatite as a material for PRB for removal of heavy metals lead, cadmium, zinc and cooper from contaminated groundwater. In addition, scanning electron microscopy (SEM) analysis and semi-quantitative energy dispersive spectrometry (EDS) of selected sorbent were analysed before and after saturation with the best removing metals.

Experimental Methods

The following sorbents were investigated: natural zeolite, NZ (Zlatokop deposit,Vranjska Banja, Serbia), IMZ (prepared by modification of natural zeolite), bentonite (Šipovo deposit, Bosnia), apatite (ore deposit Lisina, Bosilegrad, Serbia), concentrate apatite (prepared from apatite), kaolin (plant for production of quartz sand, Rgotina Serbia) (Ugrina et al., 2017). All samples were analysed on sorbent density and sorbent porosity (results not given here). Batch sorption experiments are performed by mixing metal ion (Pb, Cu, Zn or Cd) solutions with each sorbent, at solid/liquid ratio of 10 g/l, during 48 hours at room temperature. The leaching experiment included evaluation of metal released from saturated sorbents in ultrapure water with adjusted pH values in range 6.07-6.47. SEM-EDS of selected sorbent were analysed on a JEOL JSM-6610 instrument.

Results and Discussion

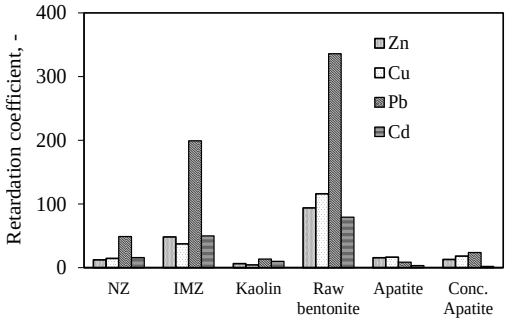


Figure 1. Retardation coefficient of heavy metals on selected sorbent.

Distribution coefficient K_d (l/g) and the retardation coefficient R_d (-), are calculated using the following equations:

$$K_d = \left(\frac{c_o - c_e}{c_e}\right) \cdot \frac{V}{m} \quad (1)$$

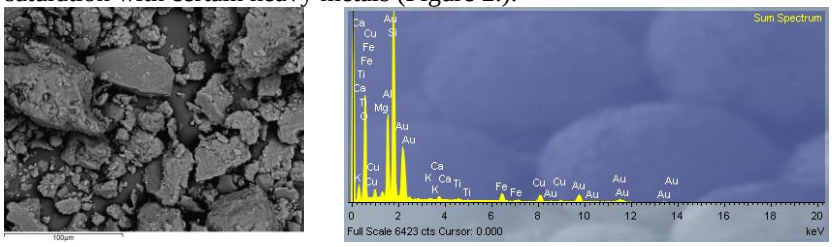
$$R_d = \left(1 + \frac{\rho}{\varepsilon} \cdot K_d \cdot 1000\right) \quad (2)$$

where c_o and c_e are the initial and equilibrium metal concentrations (mmol/l), V is the metal solution volume (l), m is the sorbent mass (g), ρ is the sorbent density (g/cm^3), ε is the sorbent porosity (-). Figure 1 represents the results of retardation coefficient.

Based on calculated distribution and retardation coefficients using equation (1) and (2), raw bentonite and IMZ showed the highest removal potential for zinc, cadmium and lead, while raw bentonite was the best option for cooper removal, as in system of Cu-IMZ, adjustment of pH was necessary in order to avoid precipitation. Beside the distribution and retardation coefficients, the leaching test in ultrapure water solution

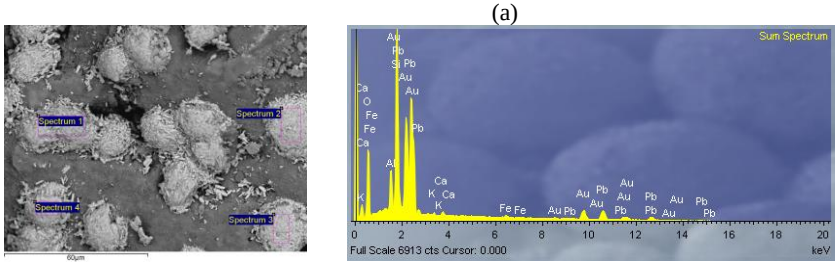
at pH=6.07-6.46 was performed and leaching of lead and cadmium from raw bentonite was noticed. This indicates that distribution and retardation coefficients are not sufficient for selection of material for PRB, as secondary pollution as a consequence of leaching cannot be predicted. Thus, based on retardation coefficients and performing leaching test, selected low-cost sorbents with the best removal properties for investigated heavy metals are: raw bentonite and IMZ for zinc ions, raw bentonite for cooper, and IMZ for lead and cadmium.

SEM-EDS analysis is giving insight into surface characterization of selected sorbents before and after saturation with certain heavy metals (Figure 2.).



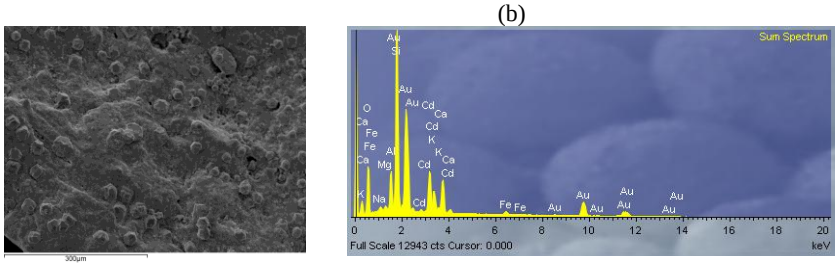
raw bentonite - Cu

(a)



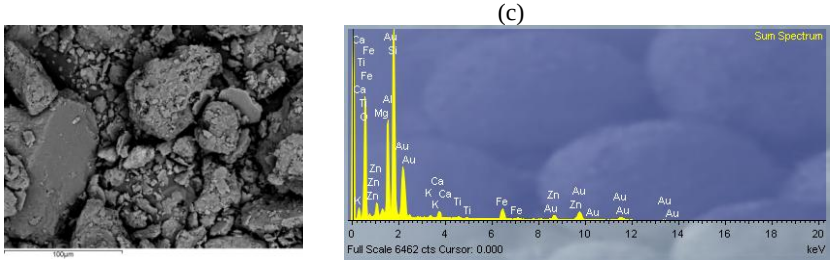
IMZ - Pb

(b)



IMZ - Cd

(c)



raw bentonite - Zn

(d)

Figure 2. SEM image and EDS analysis on a marked surface of: (a) raw bentonite saturated with cooper; (b) IMZ saturated with lead; (c) IMZ saturated with cadmium; (d) raw bentonite saturated with zinc.

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References

Ugrina, M., Petrić, M., Marković, M., Daković, A., Vukojević Medvidović, N., Trgo, M., Nuić, I., Mihajlović, M. (2017), Leaching behaviour of natural *low cost* sorbents saturated with zinc and copper, Pp. 59-62 in: Proceedings of the 7th Slovenian-Serbian-Croatian Symposium on Zeolites (Zabukovec Logar, N., Rajić, N., Bronić, J., editors), Croatian Zeolite Association, Zagreb.