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

49th International October Conference on Mining and Metallurgy

PROCEEDINGS

Editors:
Nada Štrbac
Ivana Marković
Ljubiša Balanović

Bor Lake, Serbia
October 18-21, 2017

PROCEEDINGS,
49th INTERNATIONAL OCTOBER CONFERNCE
on Mining and Metallurgy

Editors:
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Technical Editor:
M. Sc. Uroš Stamenković
University of Belgrade, Technical Faculty in Bor

Publisher: University of Belgrade, Technical Faculty in Bor
For the publisher: Dean Prof. dr Nada Štrbac
Circulation: 200 copies

Printed by "Happy trend DOO", Zaječar, 2017

ISBN 978-86-6305-066-2

CIP - Каталогизација у публикацији - Народна библиотека Србије, Београд

622(082)
669(082)

INTERNATIONAL October Conference on Mining and Metallurgy (49 ; 2017 ; Bor Lake)
Proceedings / 49th International October Conference on Mining and Metallurgy - IOC 2017,
Bor Lake, Serbia, October 18-21, 2017;
[organized by] University of Belgrade, Technical Faculty Bor and Mining and Metallurgy Institute Bor;
editors Nada Štrbac, Ivana Marković, Ljubiša Balanović. - Bor : University of Belgrade, Technical Faculty,
2017 (Zaječar : Happy trend). - XXIII, 664 str. : ilustr. ; 25 cm

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

ISBN 978-86-6305-066-2

a) Рударство - Зборници b) Металургија - Зборници

COBISS.SR-ID 246349324

Bor Lake, Serbia, October 18-21, 2017

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

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BIOSORPTION OF HEAVY METALS FROM MINING INFLUENCED WATER

Jelena Milojković, Marija Mihajlović, Zorica Lopičić, Tatjana Šoštarić, Jelena Petrović, Marija Kojić, Mirjana Stojanović

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Abstract

Heavy industries mining and metals processing require energy, water, chemicals, and land zone. Water coming from mine sites has low pH and high concentrations of toxic metals causing a significant impact on water pollution. That creates important priority in the tightening and enforcement of environmental regulations. The need for effective and low-cost methods for the removal of metals has emerged in the development of new separation technologies. Biosorption is currently recognized as a promising technique for heavy metals removal. The present work summarizes some results obtained in application biosorption process in mining influenced water.

***Keywords**: mining influencing water, biosorption, metals, organic filter materials*

1. INTRODUCTION

Biosorption provided the basis for a whole new technology aimed at the removal of pollutants from dilute solutions by biological material. Biosorption occurs onto biomasses of living or non-living organisms such as: macroalgae, freshwater macrophytes, microorganisms (bacteria, microalgae, fungi, actinomycetes) agricultural by-products and different biopolymers. Furthermore, biological materials can be applied for the recovery of valuable metals or for the removal of toxic metal pollutant present in wastewaters [1,2]. Since, vast volumes of metal containing waters are discharged from mineral processing industry, biosorption as low cost technology can provide the solution to pollution of this industry [3].

The biomass, properly prepared: dried, ground and screened, can be easily manipulated and being able to be applied in batch or continuous reactors as a simple sorbent. This material is cheap, competing with commercial ion exchange and activated carbon. It is important to know the effect on biosorption of the many compounds present in wastewaters that could obstruct the process of metal removal. Mostly in the case of mineral processing effluents, the water may contain other metal ions, surfactants, cyanide and other metal sequestering substances [4]. A large number of organic filter materials, for removal of heavy metals in mine drainage have been reviewed. Some examples of organic filter materials (from literature) are: bark, chitin, chitosan, dairy manure compost, rice husks, vegetal compost, and yeast [5-8].

2. PREPARATION OF BIOSORBENTS FOR INDUSTRIAL USE

There are different types of biosorbents, ranging from delicate microorganisms to highly stable particles. Although, the main purpose of applications of biosorbents is to remove metal ions, they should be rigid enough to withstand extreme operating conditions employed during the process. Other factors such as materials and treatment costs, availability and continuous supply play a major role in the selection of biosorbents. Suitable biosorbent for successful application to industrial scale should have required characteristics [6]:

- Act over wide range of pH, temperature and other physico-chemical parameters
- No release secondary pollutants
- Good stability under acidic/alkaline surroundings
- Good uptake capacity towards different ions
- Cost effective
- Sequential removal of metal ions
- Easy desorption and reuse ability
- Easy adaptability to different system schemes

Even though these characteristics are desirable, different classes of biosorbents are available and not all of them possess all the desired characteristics for real applications. In those cases, biosorbents can be technically tailored to suit the needs.

3. BIOSORPTION TREATMENT OF MINE DRAINAGE

It has been proposed that mine wastewaters could be divided in to three categories according to their acid/base properties [7]:

- acid mine drainage (AMD)-pH values at 6 or below. Occurs at sites where the rock is rich in sulphide minerals
- neutral mine drainage -pH values above 6. Rock is less abundant with sulphides
- saline mine drainage- pH values below 6 in combination with a salinity of 1,000 mgL−1 carbonates. Usually found at locations where saline minerals are in abundance

Increasing interest for filter materials, not only for acid mine drainage but also for other types of wastewater such as: domestic wastewater, landfill leakage and storm water. The filter technique is concerned as an adequate alternative technique to more technical solutions or other small-scale solutions. Based on literature, there are a lot of different filter organic materials that could be used for removal of heavy metals from acid mine drainage. This creates possibilities to use a local (low cost) available materials. Filter technique has a number of advantages such as: smaller degree of maintenance is needed, it is not necessary to use precipitation chemicals as additives to promote the metal removal, filter material can easy be replaced when metal saturation is achieved [5].

Comparison of different biosorbents that have been applied for the treatment of mining wastewaters is presented in Table 1.

Table 1 - Comparison of different biosorbents that have been applied for the treatment of mining wastewaters [5]

Organic material	Availability	Cost	Advantages	Disadvantages
Chitin	Abundant, especially China and India	Low cost 0.8–31 €/kg (1–40 $/kg)	–Efficient removal of metals –Neutralising agent –Sulfate removal	–Variable composition –Swelling
Chitosan	Quite abundant, especially China, India, and Thailand	12.2–230 €/kg (16–300 $/kg)	–Efficient removal of metals –Neutralising agent –Sulfate removal –Modification –Partial chemical regeneration	–Variable composition –Swelling –Soluble in dilute acids
Dairy manure compost	Abundant	Low cost	–Efficient removal of metals –Regeneration using acid	–Variable composition –Leaching of elements
Rice husk	Abundant	Low cost	–Efficient removal of metals –Regeneration using acid	–Variable composition
Yeasts	Abundant	Low cost	–Efficient removal of metals –Regeneration –Easy to modify	–Better in neutral conditions –Type of the wastewater has a significant effect

Majority presented filter materials have been investigated in laboratory studies, based on a number of experimental set-ups (batch and/or column tests) and different conditions [5].

4. CONCLUSION

The differences in experimental conditions that have overcame in the experiments contribute to difficulties in normalization of the obtained results. Nevertheless, the literature reveals that Fe, Pb, Zn, Hg and Al are removed to a large degree. Remediation strategies for mine wastewater must be designed to support high output while keeping costs to a minimum. Biosorption is an alternative to traditional physicochemical means for removing toxic metals from wastewater. Future application of biosorption is evident since it can quickly (rapid intrinsic kinetics) and effectively sequester dissolved metals out of dilute complex solutions with high efficiency. Because of that biosorption is an ideal candidate for the treatment of high volumes of low concentration complex mine wastewater. Though, formulating biosorption for application as a process requires a strong chemical engineering background, and an understanding of the sorption operation is a need. Pilot scale studies are crucial for ascending the process to industrial level, which is the ultimate aim of all biosorption research. Key to the commercialization of

Biosorption is successful design of hybrid reactors and the regeneration of used biosorbents. Upcoming of investigation in the field of biosorption will lead to development of the next generation biosorption-based treatment technologies in a cost-effective manner toward commercialization.

ACKNOWLEDGEMENTS

These results are part of the projects supported by the Ministry of Education and Science of the Republic of Serbia, TR 31003 and TR34013

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