PERIODICO di MINERALOGIA Volume 89, No. 5, 2020

Treatment biotechnology of industrial wastewater with content of heavy metals

ELIZA PENA-LEONTE*, LUCIA DUMITRIU, ILEANA GHITA*, CIPRIAN DUMITRESCU*, ANA MARIA FAGHI**, MIHAELA LAZAROAE**, GABRIELA TEODOSIU****

**National Research and Development Institute for Industrial Ecology ECOIND 050663 Bucharest, sector 5, Sos. Panduri 90-92, Tel. 021/410.67.16, Fax 021/410.05.75*

***Romanian Academy-The Biology Institute-Microbiology Center Bucharest, Splaiul Independentei 296*

Abstract

The experiments have been made into a submersed fixed bed bioreactor with support plastic material in the following conditions: time of hydraulic retention (HRT) 12-24 h; specific hydraulic charge 0,02-0,05 m^3/h; mass charge 0,005-0,01 kg Zn/m^3 day.

The wastewaters had the metal ions content (over 4 mg Zn/l, 1 mg Mn/l, 2.5 mg Pb/l) over the discharge limits in surface water normalized by Romanian standard NTPA 001/2002.

The biological installation has been inoculated with Pseudomonas sp. 4, Enterobacter sp. 16, Corynebacterium sp. 17.

For HRT of 12 hours, the Zn was removed up to 0.56 mg/l and Mn and Pb concentrations were below the standard limits (0.5 mg Zn/l).

For HRT of 24 hours, the Zn, Mn and Pb remnant contents were below detection limits (< 0.001 mg Zn/l, < 0.003 mg Mn/l, < 0.01 mg Pb/l).

Keywords**:** heavy metals, removal efficiencies, submersed biofilter, bacteria inoculum

Introduction

The intensification of the industrial activity has recently had a great contribution to the increase of environmentally heavy metal content, especially in aquatic ecosystems.

Presence of these pollutants in the industrial and urban wastewaters is a threat for human life and others life forms, and for this reason, the removal of heavy metals has become a major concern [1,2]. If the organic pollutants may be biologically degraded into the final products CO_2 and H_2O, the heavy metals cannot be degraded by means of biological, physical or chemical processes.

At present, bioremediation of the heavy metals polluted environment has an increase attention for the application potential [3].

The aim of this work is the elaboration of biotechnology capable of removing heavy metals from industrial wastewater.

Materials and Methods

The experiments were conducted into a biological installation type-submersed biofilter with a plastic carrier material (photo).

- The operating parameters of the biofilter were as follows:
  - Hydraulic retention time (HRT) = 12-24 h;
  - Mass charge – (MC_{Zn}) = 0.005-0.01 kg Zn/m^3.d.;
  - Specific hydraulic charge – (SHC) = 0.02-0.05 $m^3/m^2/h$.
- Feeding water – industrial wastewater with a content of Zn = 4-6 mg/l, Mn = 1-1.5 mg/l, Pb = 2.5-4 mg/l, enriched in KH_2PO_4 as phosphorous source.
- The biological installation was inoculated with bacteria strains selected from natural environment. The main bacteria types were: *Pseudomonas sp.4, Enterobacter sp.16, Corynebacterium sp.17.*

Results and Discussions

In the first stage of the experiment the dynamic of the bacteria strains (*Pseudomonas sp.4, Enterobacter sp.16, Corynebacterium sp.17*) were measured on the liquid media, in the presence of Pb, Mn and Zn ions. The results are presented in the figures 1,2 and 3.

The growth dynamic of the bacteria strains has been measured, by optic density (nm), **in the presence of Pb ions**, for the concentrations values of 120, 300, 500 mg/l (fig. 1).

The measurements time periods were: 0, 24, 48, 72 and 96 hours. The *Pseudomonas sp.4* has the greatest growth rate in the presence of Pb ions.

The growth dynamic of the bacteria strains has been measured, by optic density (nm), **in the presence of the Mn ions**, in the same concentrations as Pb ions for the same time periods (fig.2). *Corynebacterium sp.17* has the greatest growth rate in the presence of the Mn ions.

The growth rate of the bacteria selected strains has been measured, by optic density (nm), **in the presence of the Zn ions,** for the same concentrations of Pb and Mn ions (fig. 3). *Bacillus sp.14* has the greatest growth rate in the presence of Zn ions.

In the second step, the capacity of aerobic heterotrophic bacteria strains to remove the heavy metals was tested, in culture media enriched with heavy metals (table 1.).

Pb ions were removed, after 96 hours, by *Pseudomonas sp.4, Enterobacter sp.16 and Corynebacterium sp.17,* from 120 mg/l to the concentrations below the method detection limits.

Zn ions were removed, after 96 hours, by the bacteria strains *Pseudomonas sp.9, Miceobacterium sp.13 and Bacillus sp.14*, from 12 mg/l to the concentrations ranging between 20-30 mg/l.

Bacteria inoculums, composed from *Pseudomonas sp.4, Enterobacter sp.16* and *Corynebacterium sp.17* were used in a biological continuous flow installation type biofilter, fed with industrial wastewater.

The obtained results are given in the tables 2 and 3.

The biofilter type installation has conducted at 12 and 24 hours HRT.

- At 12 hours HRT, Zn ions were removed to 0.56 mg/l, concentration over the NTPA 001/2002 limits. Mn and Pb ions were removed to the concentrations levels below the detection limits of the methods;
- At 24 hours HRT, Zn, Mn and Pb ions were removed to the concentrations levels below the detection limits of the methods.

Conclusions

- The experiments of heavy metals removal from industrial wastewater were conducted in a submersed biofilter, fed with wastewater from nonferrous ore processing industry, inoculated with the selected bacteria at HRT of 12 and 24 hours;
- At HRT of 12 hours the remnant content of Zn in the effluents had values over the NTPA 001/2002 concentration limit;
- At HRT of 24 hours, the Mn, Pb and Zn ions were removed below the detection limits of the analytical method. It was established that 24 hours is the optimal retention time for Mn, Pb and Zn ions removal.

References

1. ATKINSON B. W., KASAN H. C., *Water SA.* **24**, 129-136 (1998);
2. ECCLES H., *Trends in Biotechnology*, **17**, 462-465 (1999);
3. TEITZEL G. M., PARSEK M. R., *Appl. Environ. Microbiol*., **69,** 2313-2320 (2003)