DOI: http://doi.org/10.21698/simi.2020.ab15

PILOT EXPERIMENT FOR HEAVY METALS REMOVAL FROM SYNTHETIC ACID SOLUTIONS

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Keywords*: adsorption studies, bio-material, metals, fixed bed system, outflow*

Introduction

Wastewater from mineral processing contains high concentrations of heavy metals that cause serious environmental issues. In order to treat that type of wastewater variety of technologies can be applied that present both advantages and limitations related to their efficiency, installation and maintenance costs. Adsorption proved to be an eco friendly method, especially when using adsorbent materials that require minimal processing such as vegetable waste or their by-products. In the majority of cases the adsorption efficiency is influenced by the complexity of the system to be treated. Further improvements of the adsorption process based technologies can contribute to the efficient treatment of wastewater containing high concentrations of heavy metals.

In the present study, a pilot installation was developed in which shredded maize stalk up to 1 mm have been used in adsorption process for treatment of synthetic acid water that simulates mine water. The experiments were performed at laboratory level.

Materials and methods

The synthetic acid water was prepared as follows: 2500 mL deionized water was acidified with 1 mL of 64% H_2SO_4. Subsequently, different volumes of synthetic solutions of $Pb(NO_3)_2$, $Cr(NO_3)_2$, $Fe(NO_3)_3$, $Cu(NO_3)_3$ were pipetted for obtaining 1.2 mg/L Pb(II), 0.4 mg/L Cr(III), 2.5 mg/L Fe(III) and 1.2 mg/L Cu(II) concentrations in aqueous medium. Also, different amounts of gypsum $CaSO_4$ $2H_2O$ and $MgSO_4$ $7H_2O$ were added, to achieve concentrations of 50 and 200 mg/L, respectively. The AAS-method was used for analysis of metallic ions in effluent and calibration curves were linear over the whole concentration range studied.

The installation is composed from a column with 2.5 cm internal diameter and its height was 25 cm. Thus, 3.3 g of shredded maize stalk material was swollen in water and transferred in column and it was obtained a height of 16 cm for the adsorbent bed. Subsequently the swollen activated material was transferred into column. The inflow solution was transported using a peristaltic pump and the flow through the column was in down flow mode. For this experiment, a flow rate of 10 cm/min (1.2 m/h) was established (figure 1). Initially column loaded with maize stalk was washed with ultrapure water for 30 minutes at the previously established constant flow rate.

Figure 1. Pilot installation

The inflow pH value was maintained at 2.5 throughout the experiment. The temperature was also kept constant at 25 ± 2°C. The retention time of 7.9 minutes was calculated taking into account the pore volume after the biomaterial bed was wet. Samples were collected from the outflow at every 120 mL that passed through the column. Within 205 minutes, 17 samples were collected for analysis to determine Fe(III), Cu(II) Pb(II) and Cr(III) by AAS.

Results and conclusions

The experiment was performed for 2040 mL inflow solution and samples were taken at various intervals to determine the time when adsorption equilibrium was achieved. A decreased metal ions concentration were obtained for first 600 mL (36 minutes) of outflow. When the adsorption capacity of material was reached no more significant variation were detected (figure 2).

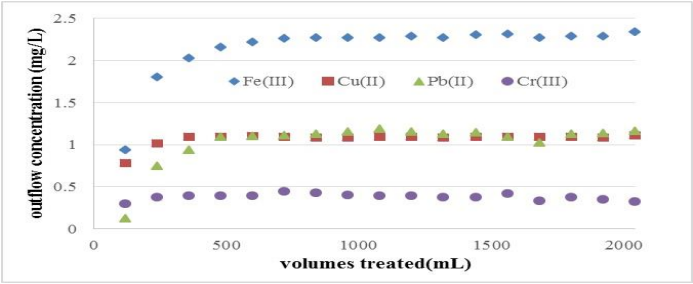

Figure 2. Concentrations of Fe(III), Cu(II), Pb(II) and Cr(III) in outflow

Based on the obtained experimental results, the maize stalk based material proved to be a promising adsorbent for heavy metals, however more work is needed in order to optimise the process.

Acknowledgement

The authors are grateful for the financial support received from the Ministry of Education and Research through Program Nucleu, contract no. 20N/2019, Project code PN 19 04 03 01.