E3S Web of Conferences **1**, 41019 (2013)
DOI: 10.1051/e3sconf/20130141019

Removal of Pb ion from water samples using red mud (bauxite ore processing waste)

A. Ghorbani[1], M. Nazarfakhari[2], Y. Pourasad[3] and S. Mesgari Abbasi [4]

[1] Department of chemistry, Saveh Branch, Islamic Azad University, Saveh, Iran,
[2] Department of chemistry, Saveh Branch, Islamic Azad University, Saveh, Iran,
[3] Department of engineering, Urmia University of Technology, Urmia, Iran,
[4] Department of engineering, Saveh Branch, Islamic Azad University, Saveh, Iran,

Abstract. This work presented the use of red mud (bauxite ore processing waste) in removal of lead ions in water samples. For this 0.1 g of red mud has been used as adsorbent which suspended in 10 ml of lead solution with the concentration of 50 mg l^{-1} for about 1 h. After that the lead concentration in the samples taken from the red mud treated lead solution measured with atomic absorption spectroscopy (AAS). The effect of some parameter which is important in adsorption of lead on red mud such as suitable adsorbent dosage, pH and contact time of solution and adsorbent was investigated. The result shows that red mud as solid waste and low-cost adsorbent can be successfully used for the removal of lead ion from aqueous solution.

Keywords: Red mud, Atomic Absorption Spectroscopy, Water sample.

Introduction

The presence of heavy metals in streams, lakes, and groundwater reservoirs has been responsible for several health problems with plants, animals, and human beings. Heavy metal contamination exists in aqueous waste stream from many industries such as metal plating, mining, tanneries, painting, car radiator manufacturing, as well as agricultural sources where fertilizers and fungicidal spray are intensively used (Nadaroglu et al., 2010).

A number of processes have been applied, with varying degree of success, to the treatment of water and wastewater. Some of these processes are coagulation, foam flotation, filtration, ion exchange, aerobic and anaerobic treatment, advanced oxidation processes, solvent extraction, adsorption, electrolysis, microbial reduction, and activated sludge. However, these technologies have shown some significant disadvantages, which include insufficient removal of pollutants, high capital costs, high reagents and/or energy requirements, and generation of toxic sludge or other waste products that require further safe disposal (Bhatnagar et al., 2011).

Red mud emerges as a residue during alkaline-leaching of bauxite in Bayer process. Roughly 1–2 tons of red mud residue are produced for a ton of alumina. Many have studied the application of red mud in wastewater treatment and red mud has been found to remove fluoride, chromium, hexavalent, dyes, heavy metals, and phosphate from aqueous solution (Zhao et al., 2009).

Lead is a nonessential heavy metal and general toxicant. It is a multimedia pollutant that causes pollution of soil, water and atmosphere (Ghorbani etal 2008). Lead enters into the environment and human food chain due to its usage in lead-based gasoline, paints, gunshot, batteries and alloys. Adults absorb 5-15% of interest lead and usually retain approximately 5% of what is absorbed. The entrance of lead at levels > 0.5- 0.8 µg/ml into blood causes various abnormalities. Lead is classified as a 2B carcinogen by the IARC. Because of very toxic effects, lead measurement for exposure monitoring is very important (Memon etal 2005).

So in this work removal of Pb ions from water with red mud as a adsorbent was investigated.

Materials and Methods

All chemicals used were of analytical-reagent grade. Deionised water was used throughout. Lead standard (various concentrations) and model solution were prepared by dilution of single element 1000 mg l^{-1} stock solutions (Merck).

Red mud has been obtained as bauxite waste in the manufacture of alumina and emerges as unwanted by-

products during alkaline-leaching of bauxite in Bayer process. The alkaline red mud-water pump has been dumped annually into specially constructed dams around the Aluminum Plant (Jajarm, Iran). The chemical composition of red mud is show in Table 1.The alkaline red mud was thoroughly washed with distilled water, dried in 110 °C for 48 h in oven and sieved with 60 mesh screen.

Batch experiments were carried out at room temperature (25±2 °C) using screw cap polypropylene test tube. 0.1 g of red mud adsorbent was weighted and put into the different test tube, into which 10 ml of Pb solutions with initial concentration 50 mg l^{-1} were added separately. The test tubes were capped tightly for all tests to avoid change in concentration, due to evaporation. Centrifuge test tubes and the solution was analyzed with atomic absorption (Shimadzu, AA611).

The pH was adjusted to the desired level by adding required amounts of 0.1 M NaOH or 0.1 M HCl solutions.

Table 1. Chemical composition of the red mud

Composition	Constituent (%w/w)
Fe_2O_3	28.41
CaO	21.35
SiO_2	19.29
Al_2O_3	17.25
TiO_2	7.36
Na_2O	1.79
MgO	1.75
Other composition	2.8

Results and Discussion

Effect of adsorbent dosage

The percentage of Pb adsorption with varying amounts of red mud is presented in Fig. 1. In general, an increase in adsorbent dosage increased the percent removal of adsorbate. As the figure shows by increasing the adsorbent dosage from 0 to 0.1 g for 10 ml of lead solution, the lead ions adsorbed a red mud increased.

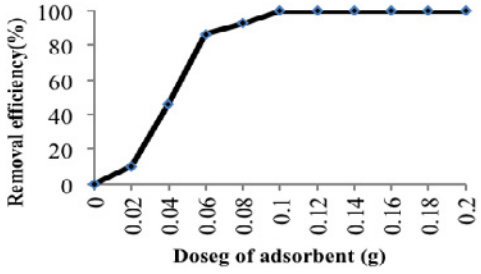

Fig. 1. The variation of Pb removal with red mud dose. Initial Pb concentration: 50 mg l^{-1}, pH 2.

Effect of pH

The effect of pH initial on the adsorption of Pb by red mud is presented in Fig. 2. It is evident that the removal of Pb by red mud fluctuates very little in the pH range 2–8. The removal rate remaining almost constant in such a wide pH range suggests that red mud is a good adsorbent for Pb removal.

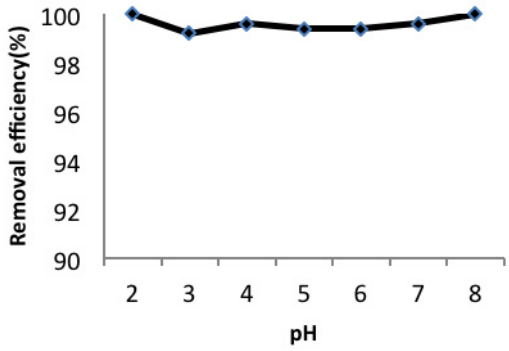

Fig. 2. The effect of initial pH on Pb removal. (Contact time: 1 h, red mud dose: 0.1 g, initial Pb concentration: 50 mg l^{-1}).

Effect of contact time

Fig. 3 shows the effect of contact time on the adsorption process. It can be observed that the removal of Pb increases with time in the first 30 min. Basically, the removal of Pb is rapid at this time but it gradually decreases with time until it reaches equilibrium. This indicates that the concentration of Pb in the solution decreased rapidly within 30 min and the removal was virtually completed within 60 min. Obviously, the removal of lead by the red mud is very little fluctuation.

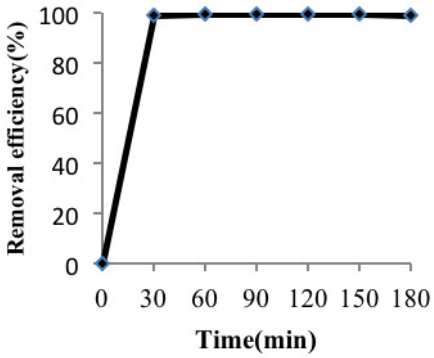

Fig. 3. Removal of Pb as a function of equilibrium time. (Red mud dose: 0.1 g, pH 2).

Conclusion

The aim of this study was lead ion removal from water sample by red mud as adsorbent in batch solid phase extraction (SPE) method. By adding the red mud to the lead solution, the concentration of lead in the leachate drastically decreased. Increase in adsorbent dosage increased the removal of lead ions in sample. The maximum adsorption was obtained in the following

conditions: adsorbent dosage 0.1 g and 1 h contact time for 10 ml of lead solution.

So this work introduced red mud (bauxite ore processing waste) as a low-cost and suitable adsorbent in lead removal in different media such as industrial and agriculture waste water.

References

H. Nadaroglu, E. Kalkan, N. Demir, Removal of copper from aqueous solution using red mud, Desalination, 2010, 251, 90-95.

A. Bhatnagar, V. Vilar, C. Botelho, R. Boaventura, A review of the use of red mud as adsorbent for the removal of toxic pollutants from water and wastewater, Enviromental technology, 2011, 32, 3, 231-249.

Y, Zhao. J, Wang. Zh, Luan. X, Peng. Zh, Liang. L, Shi. Removal of phosphate from aqueous solution by red mud using a factorial design, Journal of hazardous materials, 2009, 165, 1193-1199.

Ghorbani A, Mahmoodi M, Rabbani M, hosain S.W, Uncertainty estimation for the determination of Ni, Pb and Al in natural water samples by SPE-ICP-OES, Measurement Science Review 2008; 6: 151-157.

Memon S Q, Hasany S M, Bhanger. M I, Khuhawar M Y, Enrichment of Pb (II) ions using acid functionalized XAD-16 resin as a sorbent. Colloid and Surfaces A: physicochem. Eng Aspects 2005, 291, 84-91.