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Removal of Cr^{6+} and Pb^{2+} from Aqueous Solutions by Natural Zeo-Bentonite

KH. HASHEMI[1], R. ZAHIRI[2,*] and H. HASHEMI-MOGHADDAM[3]

[1]Department of Economic Geology, School of Earth Sciences, Damghan University, Damghan, Iran
[2]School of Earth Sciences, Damghan University, Damghan, Iran
[3]Department of Chemistry, Damghan Branch, Islamic Azad University, Damghan, Iran

*Corresponding author: E-mail: zahiri@du.ac.ir

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In this study the ability of zeo-bentonite (zeolite-bentonite) to remove Cr(VI) and Pb(II) ions from water resources has been studied. The analysis conducted on the use zeo-bentonite shows that illite, montmorillonite and clinoptilolite are the most important minerals in the zeo-bentonites. The effect of various parameters such as initial concentration of the metal, pH solution, contact time and temperature in is considered. Results showed that, in the initial volume of 100 mL of solution and initial concentration of 0.005 mol/L, 1 g of adsorbent amount and temperature of 100 ºC, absorption of chromium 6 in pH = 5 and pH = 3 in lead 2 absorption maximum is adsorption process for both the metal is very good and very good zeo-bentonite as absorbent to absorb these metals are considered.

Key Words: Zeo-bentonite, Adsorption, Cr^{6+}, Pb^{2+}.

INTRODUCTION

Heavy metals are typical and persistent environmental pollutants[1,2]. Pollution by heavy metals is currently of great concern. The increased awareness of the potentially hazardous effects of elevated levels of these materials in the environment. Heavy metals are not biodegradable and tend to accumulate in organisms, causing numerous diseases and disorders[1,2]. Several methods, such as oxidation, restore, precipitation, filtration membranes, cation exchange and adsorption for the separation of metal ions from water solutions has been used. The adsorption capacity of montmorillonite for heavy metal ions has been concerned since 1960s. This group can be activated carbon, resins, zeolite and bentonite. Clay used as adsorbent of pollutants is growing dramatically. It also features more attractive than other absorbents[3]. Lead is one of the metals present in water sources. In man and animals, the Pb^{2+} caused mainly deposition of calcium and strontium in the bones with the assembly and maturation of bone marrow involvement in the natural. It also prevents the synthesis of hemoglobin in the cells. More human lifetime intake of lead in bone can be collected. Given the age of soft body tissue and organs such as liver, kidneys and pancreas with different concentration of lead in bone, but are much less than. Various studies show that the activity of many enzymes are also involved[4]. About chromes, which appears to slightly absorbed by any route chromium (III) toxic chromium(VI) is attributed mainly to chromium can be absorb by the lungs and digestive system and even a large amount of skin to be absorbed[5]. The maximum allowable amount of chromium for discharge to groundwater is approximately 0.5 mg/L by the Environmental Protection Agency as with respect to this value, removal of the metals from the environment seems essential.

The aim of our work was to study the adsorption and retention mechanisms of Cr^{6+} and Pb^{2+} on zeo-bentonite.

EXPERIMENTAL

The zeo-bentonite used in this study obtained from the Reshm mine, Semnan province, Iran. Its mineralogical composition and chemical components are listed in Tables 1 and 2. Zeo-bentonites were ground and sieved to obtain aggregates less than 200 mesh for use in present experiments.

All other reagents used were of analytical grade and were obtained from Merck. Metal salts of $Pb(NO_3)_2$ potassium dichromate ($K_2Cr_2O_7$) were used to prepare metal ion solutions. The solutions (1000 g/L) were prepared by dissolving appropriate amounts of metal salts in doubly distilled water. pH Adjustments of these solutions were made by 1 M HNO_3 solutions.

Adsorption on the samples was determined in batch sorption experiments in the single species system. Adsorption experiments were carried out by shaking a certain particle size of the bentonite with 100 mL of metal ions solution at a certain concentration in covered poly-ethylene containers. The pH of

TABLE-1
MAJOR MINERALS PRESENT IN ZEO-BENTONITE

Montmorilonite
Clinoptilolite
Illite
Cristoballite
Gypsum
Feldspar
Quartz

TABLE-2
MAJOR COMPONENTS OF ZEO-BENTONITE

SiO_2	77/67	13/36	1/69
SO_3	07/0	22/0	–
MgO	93/1	93/0	64/1
Y_2O_3	01/0	01/0	–
SrO	03/0	04/0	–
ZrO_2	03/0	03/0	–
TiO_2	18/0	30/0	29/0
CaO	35/0	34/0	91/1
Cl	61/0	90/13	–
K_2O	90/0	48/1	55/1
Fe_2O_3	43/1	54/1	34/0
Na_2O	75/2	04/26	78/1
Al_2O_3	90/11	36/7	2713
L.O.I.	05/12	59/11	6/6

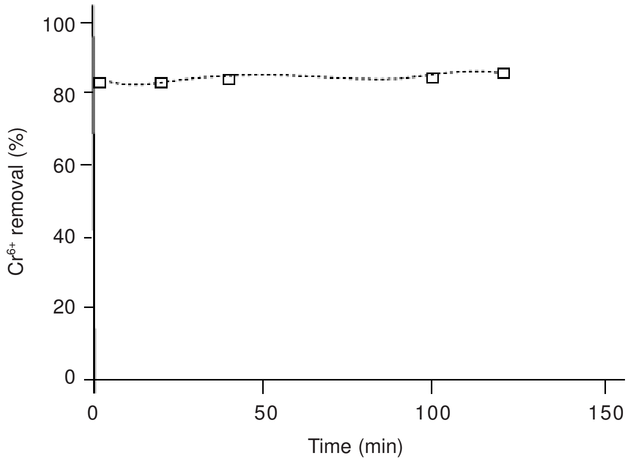
the solution was kept constant by the addition of HNO_3 solutions as needed. the suspension was stirred on the magnetic stirrer at controlled temperature and stirring rate. The sorption rate (P %) were calculated as:

$$P (\%) = 100(C_0\text{-}C_e)C_0$$

RESULTS AND DISCUSSION

Effect of contact time: A fixed particles size of the adsorbents reagent (through 200 mesh) was added to 100 mL of Cr and Pb ions solution which adjusted pH to 5 at concentration 0.005 mol/L, with liquid-to-solid ratio of 100 mL/g at 27 ºC. At different time an interval of 2-120 min, the adsorption rate of Cr^{6+} and Pb^{2+} on the bentonite adsorbents has shown in Fig. 1.

Effect of temperature: In order to evaluate the effect of temperature on adsorption characteristics of the bentonites, the experiment was studied at a constant initial concentration of 5×10^{-3} mol/L, bentonite particles size through 200 mesh,



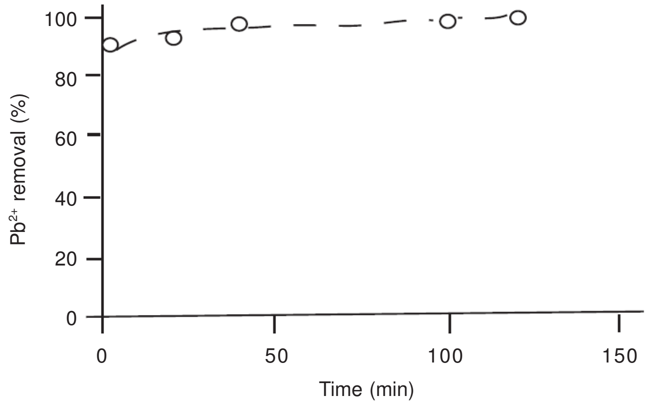


Fig. 1. Effect of contact time on the adsorption of Cr^{6+} and Pb^{2+} ions onto zeo-bentonite

liquid-to-solid ratio of 100 mL/g and pH 5 at stirring speed of 1200 rpm, adsorption time 2 h. The results of the studies on the influence of temperature on cation adsorption are presented in Fig. 2.

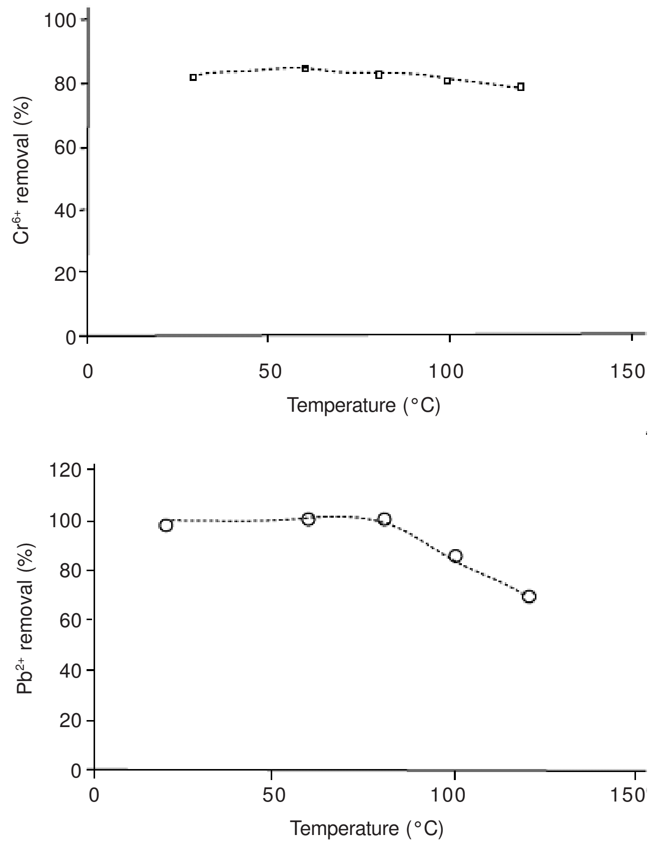


Fig. 2. Effect of solution temperature on the adsorption of Cr^{6+} and Pb^{2+} ions onto zeo-bentonite

Effect of initial concentration: The effect of initial concentration was investigated under the following conditions: the bentonite particles size (through 200 mesh), liquid-to-solid ratio (100 mL/g), pH (5), temperature (27 ºC), stirring speed (1200 rpm), adsorption time (2 h) (Fig. 3).

Effect of pH: To determine the pH necessary for adsorption, liquid- to-solid ratio is 100 mL/g of solution containing 0.005 mol/L metals ions and particles size through 200 mesh

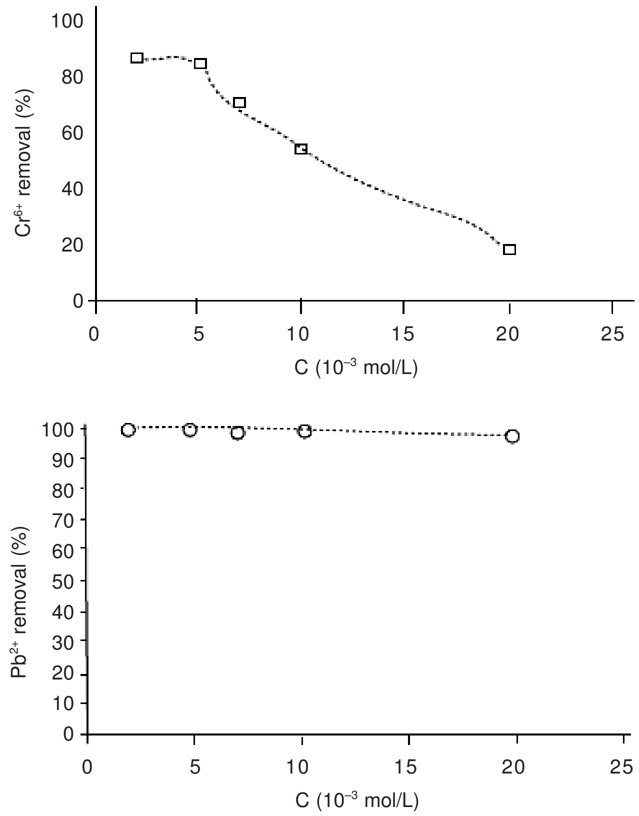
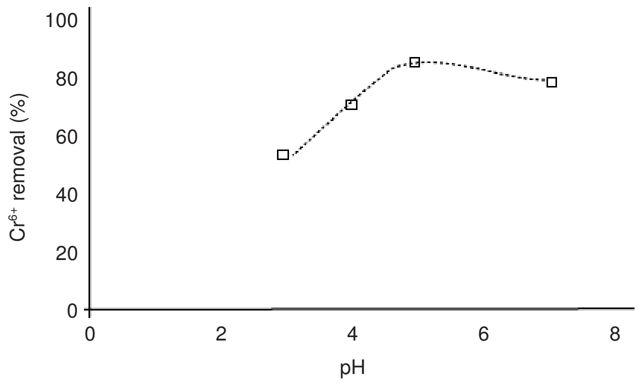


Fig. 3. Relationship between initial metal ion concentration and Cr^{6+} and Pb^{2+} adsorption

were stirred at 1200 rpm at varying time intervals (2-120 min) at 27 ºC. Fig. 4 indicates that the adsorption capacity was dependent on pH.



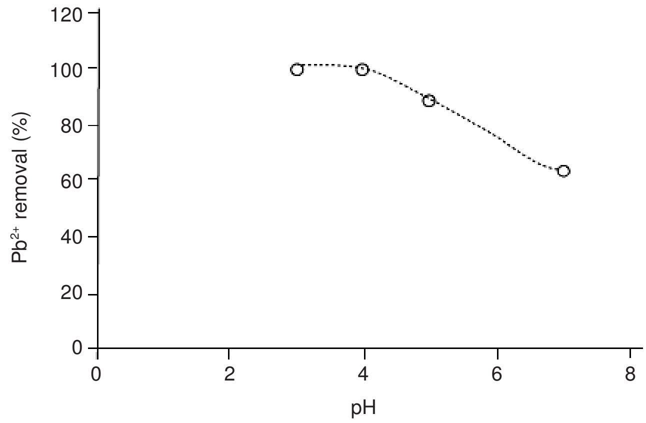


Fig. 4. Effect of pH on the adsorption of Cr^{6+} and Pb^{2+} ions onto zeo-bentonite

Conclusion

Local zeo-bentonite was tested as adsorbent material for the removal of Cr^{6+} and Pb^{2+} ions from waste solutions. The results indicate that removal by zeo-bentonite is good. Compared to the published data in the same field, it is found to be in agreement with most of them. The adsorption experiments were conducted under different conditions. The extent of zinc adsorption increased with increase in pH, temperature, contact time and initial concentration.

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