STUDIES ON COLUMN ADSORPTION OF ARSENIC (V) FROM A REAL WATER ON DEHPA-IMPREGNATED XAD-8 RESIN

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ABSTRACT

Arsenic contamination of drinking water is a widespread problem of international interest. Arsenic is released from the soil through natural processes or due to human activities. In the paper was studied the possibility of removal of arsenic from drinking water using a column filled with Amberlite XAD-8 resin impregnated with di-(2-ethylhexyl) phosphoric acid (DEHPA). The efficiency of arsenic removal from water was established by studying the dependence of arsenic residual concentration and arsenic removal degree on the volume of the water passed over the adsorbent material. The adsorption process had an efficiency of ~90% and the arsenic residual concentration was smaller than 10 μg/L. The studies concerning the influence of other ions present in water (Na^+, K^+, Ca^{2+}, Mg^{2+}, Fe^{n+}, Mn^{n+}, NO_2^-, NH_4^+, NO_3^-, PO_4^{3-}, Cl^-) showed that these ions do not interfere with arsenic adsorption process.

KEY WORDS: column adsorption, arsenic, Amberlite XAD-8, impregnated resin, DEHPA

INTRODUCTION

Environmental protection is a matter of major interest, in order to preserve the ecological balance, to maintain and improve the quality of natural factors and to ensure the living and working conditions, adequate for present and future generations.
Arsenic is an element that enters the environment from a variety of natural and anthropological sources. In underground and surface waters arsenic is present as arsenate (As^{5+}) or arsenite (As^{3+}). Arsenic is highly toxic and tends to be mobile in the environment. Contamination of drinking water with arsenic raises serious problems because of the effects of chronic arsenic poisoning. Chronic effects often include skin disease (pigmentation, skin cancer), cardiovascular disease, neurological, hematological, renal and respiratory diseases, and diseases of the lung, bladder, liver, kidney and prostate cancer. Most people affected by arsenic contamination are from poor backgrounds or small communities [1-3].
Removal of arsenic from drinking water is a major concern and urgency. Until now, several techniques were developed including processes of coagulation-precipitation, membrane separation, adsorption and ion exchange [3-13].
The paper presents studies on the removal of arsenic from drinking water using a column filled with Amberlite XAD-8 resin impregnated with di-(2-ethylhexyl) phosphoric acid (DEHPA). It was also studied the influence of other ions present in water on arsenic adsorption process.

MATERIALS and METHODS

For the adsorption of arsenic from the underground drinking water an Amberlite XAD-8 resin impregnated with di-(2-ethylhexyl) phosphoric acid (DEHPA) was used. The water sample used in experiments was analyzed to determine its composition before and after arsenic adsorption to study the influence of ions present in water on the adsorption process.
For the experiments the resin was placed in a column of 30 cm height and 2 cm diameter. The height of adsorbent layer was of 5 cm. The underground water containing 80 μg As(V)/L was passed over the resin with a flow of 0.5 L/h.
In order to establish the efficiency of arsenic removal from water it was studied the dependence of arsenic residual concentration and arsenic removal degree on the volume of the water passed over the adsorbent material. For the study samples of 25 mL from the effluent were collected.
Arsenic concentration in the samples was determined by means of atomic adsorption spectrometry with hydride generation, using a VARIAN SpectrAA 110 spectrophotometer with a VARIAN VGA 77 hydride generation system. Concentrations of Na^+, K^+, Ca^{2+}, Mg^{2+}, Fe^{n+} and Mn^{n+} were determined through atomic adsorption spectrometry, with a VARIAN SpectrAA 280FS spectrophotometer. NO_2^-, NH_4^+, NO_3^- and P_2O_5 were determined through UV-VIS spectrophotometry using a VARIAN Cary 50 spectrophotometer. Concentration of Cl^- was determined by titration with $AgNO_3$ solution, using K_2CrO_4 as indicator. The pH of the samples was measured using a CRISON Multimeter MM41.

RESULTS

1. Analysis of underground water
The results of the analysis of the initial underground water used in the adsorption studies are presented in Table 1. Data show that the water contains iron ions, which is an advantage for arsenic adsorption, due to the high affinity of arsenic towards iron [7-13]. pH of the water sample was of 7.3 and arsenic concentration was 80 μg/L.

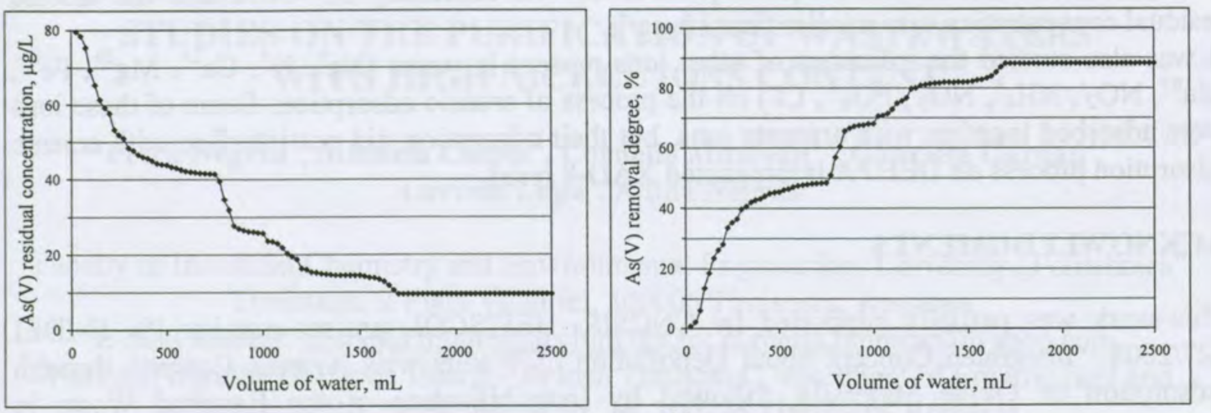
Table 1. Composition of the initial underground water

Parameter, mg/L									
Na^+	K^+	Ca^{2+}	Mg^{2+}	Fe^{n+}	Mn^{n+}	NO_2^-	NH_4^+	NO_3^-	P_2O_5
91.8	2.5	26.9	16.1	2.0	0.6	0.6	1.5	40.2	4

2. Dependence of arsenic removal efficiency on the volume of water
Experimental data regarding the dependence of arsenic residual concentration and arsenic removal degree on the volume of water passed through the column are presented in Figs. 1.a and 1.b, respectively.
The removal degree of As(V) ions from the water was calculated using the following equation:

$$\eta = \frac{C_i - C_{res}}{C_i} 100 \quad (1)$$

where C_i and C_{res} are the initial and the residual concentrations of As(V), respectively.
Data presented in Fig. 1.a show that after a volume of 1700 mL water passed through the column, arsenic residual concentration in the effluent remains constant and its value is smaller than the maximum permitted value for drinking water (10 μg/L). From Fig. 1.b one may notice that a ~90% removal degree was reached.



(a) (b)

Fig. 1. Dependence of arsenic removal efficiency on the volume of water passed through the column

3. Influence of other ions present in the underground water

In Fig. 2 are presented for comparison the data for the chemical analysis of the water before and after treatment through adsorption in view of arsenic removal.

One may notice that the other ions present in the initial water sample do not interfere with arsenic adsorption process on DEHPA impregnated XAD-8 resin. Data also show that some of these ions are adsorbed together with arsenate ions, their concentrations becoming somewhat smaller after passing through the column. It is especially the case of iron ions that are almost totally retained on the adsorbent material, their concentration becoming under the detection limit.

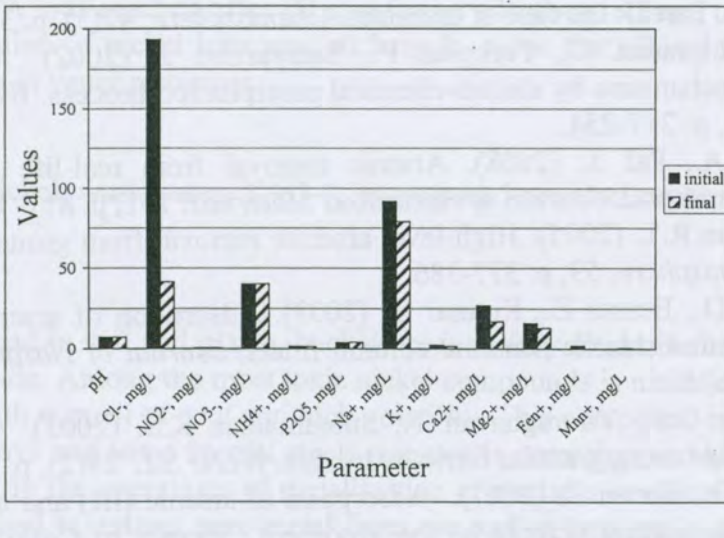


Fig. 2. Composition of water before and after the adsorption process

CONCLUSIONS

In the present work was studied the possibility of removal of arsenic from drinking water using a column filled with Amberlite XAD-8 resin impregnated with di-(2-ethylhexyl) phosphoric acid (DEHPA).

The efficiency of arsenic removal from water was established by studying the dependence of arsenic residual concentration and arsenic removal degree on the volume of the water passed

through the column. The adsorption process had an efficiency of ~90% and the arsenic residual concentration was smaller than 10 µg/L.
It was also studied the influence of other ions present in water (Na^+, K^+, Ca^{2+}, Mg^{2+}, Fe^{n+}, Mn^{n+}, NO_2^-, NH_4^+, NO_3^-, PO_4^{3-}, Cl^-) on the process of arsenic adsorption. Some of these ions were adsorbed together with arsenate ions, but their adsorption did not interfere with arsenic adsorption process on DEHPA impregnated XAD-8 resin.

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