APPLICATIONS OF GEORGIAN ZEOLITES FOR THE EXTRACTION OF USEFUL COMPONENTS FROM NATURAL AND WASTE WATERS

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Present investigation reveals that Ni-modified Khekordzula clinoptilolyte is characterized by high adsorption capacity against hydrogen sulfide, and HNaX- modified Khekordzula clinoptilolyte has high adsorption capacity against potassium and ammonium ions. Therefore, present zeolites may be used for selective adsorption of hydrogen sulfide, potassium and ammonium ions.

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Introduction

Useful energy resources and fossil fuels are limited and declining day by day at a very fast rate. Therefore, in previous years this problem attracted the attention of researchers to solve this huge problem.

Currently, the problem of searching of alternative energy sources is very important. One of the possible methods of obtaining of hydrogen (ecologically acceptable fuel) may be the use of the natural hydrogen sulfide from the hydrosulphurous water of the Black Sea. This water is rich in potassium ions and water of the rivers which flow into the Black Sea is rich in ammonium ions.

One of the extraction methods of these valuable components from natural waters is sorption concentration. Ion-exchanging materials are facing the challenges to obtain these objectives. Georgia is rich in sedimentary natural zeolites, which belong to calcium- sodium- potassium clinoptilolytes, according to available data.[1]

Some results of the trial experiments, conducted at the beginning of the investigations, with the aim of finding out adsorption possibilities of the above mentioned components on the native natural zeolites from different deposits of Georgia and also their modified forms, are the subject matter of the present investigation.

The results of the chemical analysis of Georgian natural clinoptilolytes[2] are shown in Table 1. A number of works[3-6] have been dedicated to the study of the adsorption properties of the natural and modified clinoptilolytes. Further, a step-by-step extraction of useful components from the complex solutions has not been conducted so far. Purposefully adsorption of hydrogen sulfide, potassium and ammonium ions on Dzegvi and Khekordzula clinoptilolytes in natural water and synthesized solutions has been studied in present work. A comparative study has been done with Cation exchanger KY-2-8.

Experimental

The experiment was carried out in static conditions at the room temperature. Determination of the under test components in solutions was carried out by iodometric, spectrophotometric and atomic absorption methods. Sorption curves for natural waters and synthetic solutions were received.

Results and Discussions

Volume capacity of the given zeolites concerning tested ions has been established. The results of the experiment are given in the Tables 2-4 and Figs. 1-3.

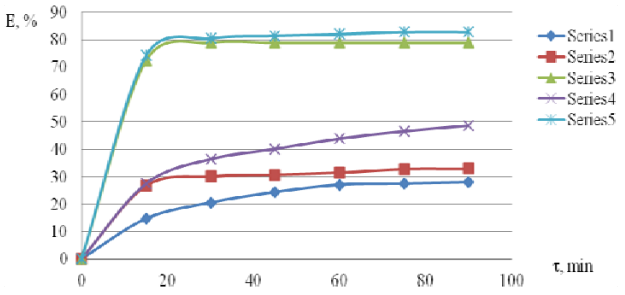

Figure 1. Kinetics of adsorption of hydrogen sulfide on the clinoptilolyte from natural sulfur-containing water. 1-Dzegvi untreated; 2-HNaX-modified Khekordzula; 3-Ni-modified Khekordzula; 4- 2 M HCl-modified Khekordzula; 5-KY-2-8.

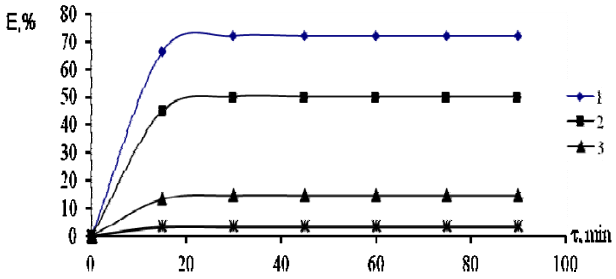

Fig. 2. Kinetic of adsorption of potassium ions on the clinoptilolyte from synthesized solutions. 1-Dzegvi untreated; 2-HNaX-modified Khekordzula; 3-Ni-modified Khekordzula; 4- 2 M HCl-modified Khekordzula; 5-KY-2-8.

Table 1. Chemical composition of dehydrated clinoptilolytes of Georgia.

Deposit	Oxid components, weight %							Molar ratio SiO_2/Al_2O_3
	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2O	
Khekordzula	68.69	13.70	3.46	5.63	1.57	2.29	4.20	8.54
Dzegvi	68.04	14.40	3.99	6.99	2.00	1.30	2.00	8.09

Table 2. Volume capacity, equilibrium concentration and extraction efficiency of hydrogen sulfide recovery by zeolites from the natural sulfur-containing water (C_0=22.1 mg L^{-1}) after 48 hours of delay.

Clinoptilolite	C_p, mg L^{-1}	*a*, mg g^{-1}	*E*, %
Dzegvi untreated	10.2	1.19	92.4
HNaX- modified Khekordzula	0.7	2.14	96.9
Ni-modified Khekordzula	0.0	2.21	100.0
2N HCl - modified Khekordzula	0.02	2.19	99.2
Ky-2-8	0.00	2.21	100.0

It is revealed from the experimental results, Ni-modified Khekordzula clinoptilolyte and cationite Ky-2-8 are characterized by high adsorption capacity. Adsorption capacity of the Dzegvi untreated clinoptilolyte is relatively less as compared to the treated one. Although, all tested zeolites almost completely adsorb hydrogen sulfide after 48 hours of delay.

Table 3. Volume capacity, equilibrium concentration and extraction efficiency of the potassium ion removal by zeolites from synthesized solutions (C_0=400.0 mg L^{-1}) after 48 hours of delay.

Clinoptilolyte	C_p, mg L^{-1}	*a*, mg L^{-1}	*E*, %
Dzegvi untreated	342.0	5.8	14.5
HNaX- modified Khekordzula	112.0	28.8	72.2
Ni-modified Khekordzula	388.4	1.16	2.9
2 M HCl - modified Khekordzula	387.0	1.3	3.4
Ky-2-8	200.0	20.0	50

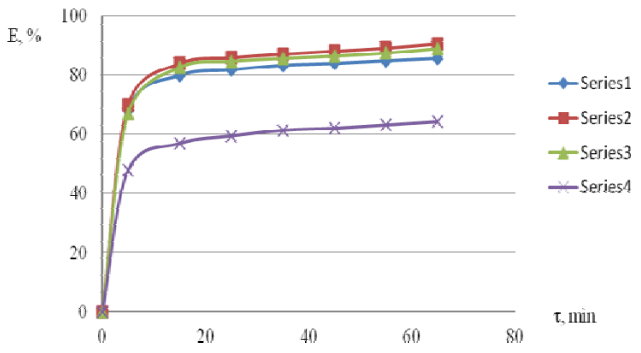

Figure 3. Kinetic of adsorption of the ammonium ions on the clinoptilolyte from synthesized solutions: 1-Dzegvi untreated; 2-HNaX-modified Khekordzula; 3-Ni-modified Khekordzula; 4- 2 M HCl-modified Khekordzula;

Table 4. Volume capacity, equilibrium concentration and extraction efficiency of ammonium ion removal by zeolites from synthesized solutions (C_0=34.0 mg L^{-1}) after 48 hours of delay

Clinoptilolyte	C_p, mg L^{-1}	*a*, mg g^{-1}	*E*, %
Dzegvi untreated	4.47	2.95	87.0
HNaX- modified Khekordzula	3.06	3.1	91.1
Ni-modified Khekordzula	3.4	3.06	90.0
2 M HCl-modified Khekordzula	11.9	2.21	65.0

Under sorption of ammonium ions from solutions with initial concentration 34.0 mg L^{-1}, the highest adsorption capacity has Khekordzula clinoptilolytes, modified by HNaX and Ni, and also untreated clinoptilolyte from Dzegvi.

Conclusion

It is evident from the results of the investigators, Ni-modified Khekordzula clinoptilolyte is characterized by high adsorption capacity against hydrogen sulfide, and HNaX-modified Khekordzula clinoptilolyte has high adsorption capacity against potassium and ammonium ions. Thus, above mentioned zeolites may be used for selective adsorption of hydrogen sulfide, potassium and ammonium ions.

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