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The influence of the electric field on the sorption capacity of natural zeolite

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The sorption properties of zeolite were studied at different electric field strengths. It has been shown that the effect of a constant electric field on natural zeolite significantly increases its sorption capacity and exchange capacity with respect to iron and manganese ions. The increase in sorbent activity persists after removing the electric field.

Key words: iron ions; manganese ions; tension; sorbent; zeolite; electric field.

Sorption properties of zeolite at various values of intensity of electric field are studied. It is shown that the influence of constant electric field on natural zeolite essentially raises it sorption ability and exchange capacity in relation to iron and manganese ions. Increase of activity of a sorbent remains after electric field removal.

Key words: iron ions; manganese ions; intensity; sorbent; zeolite; electric field

IN practice cleaning water big spreading got technologies filtering solutions through various sorbents [1] . There are known methods for purifying water by passing it through quartz sand, expanded clay, and anthracite. The disadvantage of these filters is their weak sorption capacity and insignificant dynamic exchange capacity (0.1–0.2 mEq/g).

Natural minerals have developed specific surface And good adsorption– properties, besides they V tens times cheaper and more accessible synthetic. Os– the new challenge is selection local materials, optimal combining not high– what is the cost and sufficient depth cleaning. For water treatment enough wide zeolites are used (Kholinskoe place- birth, Buryatia), having hardness 5–7 on the Mohs scale, rich in content kli– noptillolite (60–70%). Available Also ceo– lithic rocks (Ishimskoye, Ulyanov– skaya region, Tatarsko-Ashtrashanskoe, Tatar– stan), the proportion of clinoptilolite in which Not exceeds 25% [2.3] .

Natural zeolite is promising as sorbent for purification of water and process liquids . The limiting factor is the insufficient sorption capacity for these purposes. zeolite

Natural minerals are characterized by the presence of "electron-hole" centers on crystal lattice defects, the number of which increases with various activation influences [4] . The application of an electric field to natural zeolite should lead to an increase in the number of active centers of the sorbent and an increase in its dynamic exchange capacity.

The purpose of this work was to study the influence of the electric field on the sorption capacity of zeolite.

Experimental Part And the discussion of the results

In this work we used Ulyanovskaya zeolites areas: porosity – 22%, microporosity – 65%, specific surface (By toluo- lu) – 70 m2 /g ′ pore volume in water – 0.12 cm^3/g.

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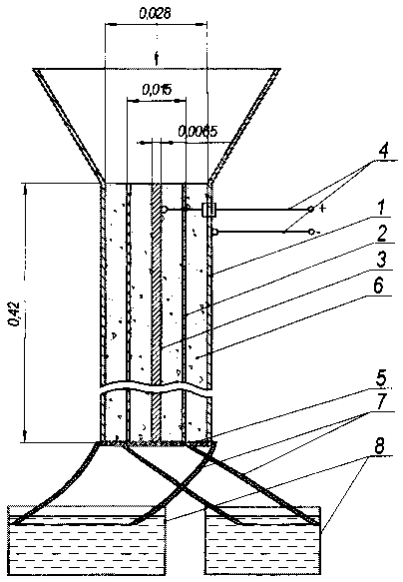
Permanganate was taken as a model impurity potassium Concentration ions potassium was determined according to GOST 26427-85, manganese - by changing the concentration of the $KMnO_4$ solution (GOST 11048-95). In the initial solution $KMnO_4$ pH value = 7.33.

The analysis results were processed using Microsoft Excel with the calculation of the arithmetic mean value ($\bar{x}$), his deviations ($d = x - \bar{x}$), standard deviations ($S = \sqrt{\sum d^2/(n-1)}$) and trust interval ($\bar{x} \pm e_a$ or $x \pm S \times t_{a,K}/n$). Meaning given confidential probabilities, a =0.95. Total number of definitions, n =4; number of degrees of freedom, $K = n - 1$=3. Coefficient value Student's t-test, $t_{a,K}$ =3.18 [5].

Scheme of a diaphragm electrolyzer to study the influence of the electromagnetic field on the sorption capacity of zeolite is presented in Fig. 1. The diaphragm electrolyzer is made in the form of a steel pipe (cathode), a steel rod (anode) located in the center of the pipe, a diaphragm - a canvas cover. The annular gaps (cathode and anode zones) were filled with granules zeolite size 1.0–2.5 mm, bulk density gra–
zero zeolite was ~ 50%. Water came in
from above into both zones by gravity, from both zones water was diverted into separate vessels. Various direct current voltages were applied to the electrodes.



Rice. 1. Scheme electrolyser: *1 – cathode; 2 – diaphragm ; 3 – anode; 4 – contacts; 5, 7 – water outlets; 6 – zeolite; 8 - vessels.*

In table 1 presents the results of experiments By influence permanent electric field to change the concentration of potassium ions in the cathode and anode zones. Initial concentration of $KMnO_4$ – 50 mg/l.

Reducing the concentration of free potassium ions in separated zones electrolyzer connected With absorption ions potassium sorbene– vol. The application of an electric field significantly increases the sorption activity of natural zeolite. Because the increase sorption ability comes as V anodic and cathodic zones; further experiments were carried out in an electrolyzer without diaphragm.

Table 1

Concentration of potassium ions in the anode and cathode zones of the electrolyzer depending on the electrical voltage fields

E, V/m	Concentration of K^+ ions, mg/l	
	In the anode	In the cathode
0	20.10	20.20
450	12.50	4.17
930	7.14	2.53
2330	2.84	1.12
4650	2.07	0.72
10 350	1.67	0.52
12 080	1.55	0.46
14,500	1.37	0.41
19 340	1.23	0.38

In table 2 shows the results of the influence electrical fields on dynamic exchange capacity of zeolite in relation to To ions K^+ and MnO_4^-.

It should be noted that with an increase in field strength, not only the exchange capacity increases significantly, but also the aftereffect of the field appears: after it is turned off, the zeolite continues to be in the activated state.

Developed model the electrolyzer was used to purify drinking water with a high content of iron and manganese ions to the standards: MPC (Fe^{2+})=0.3 mg/l; MPC (Mn^{2+})=0.1 mg/l. The results obtained are presented in table. 3.

The degree of extraction of metal ions was calculated using the formula:

$$\alpha\,(\%) = (From_{out} - From) \cdot 100 / From_{out},$$

where C_{ref} – concentration ions V original water, mg/l;
C – concentration of ions in purified water, mg/l.

table 2

Exchange capacity of zeolite for K^+ and MnO_4^- at different electric field strengths (*E*)

E , V/m	Exchange capacity for K^+, mEq/g		Exchange capacity for MnO_4^-, mEq/g	
	Under the influence of the field	When removing a field	Under the influence of the field	When removing a
0	1.46	–	0.07	–
1024	10.22	7.36	0.15	0.12
2150	19.55	15.15	1.22	0.66
4300	37.81	30.27	2.08	0.86

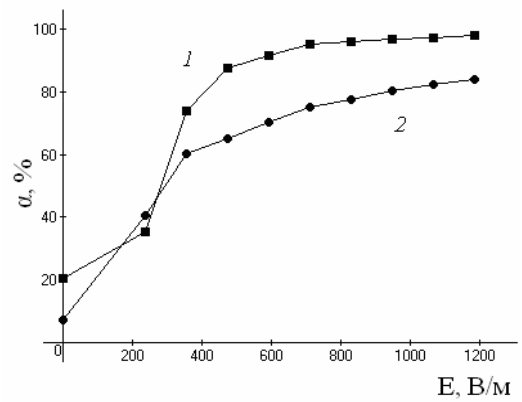
Table 3

Concentration in purified water (*C*) and degree of extraction (α) of metal ions at different electric field strengths (*E*)

C_{out} (Fetot) = 1.41 mg/l, C_{out} (Mn^{2+}) = 0.30 mg/l

E ,		0	236	355	473	591	709	827	946	1064	1182
Fe_{total}	*C* , mg/l	1.12	0.91	0.37	0.17	0.12	0.07	0.06	0.05	0.04	0.03
	α , %	20.57	35.53	73.76	87.66	91.56	95.04	95.82	96.67	97.38	98.00
Mn^{2+}	*C* , mg/l	0.28	0.18	0.12	0.10	0.09	0.07	0.07	0.06	0.05	0.09
	α , %	7.28	40.40	60.26	65.23	70.20	75.17	77.48	80.13	82.45	84.11

As tension increases electric field, the degree of purification of water from metal ions increases significantly and reaches 98% for iron and 84% for manganese. The dynamics of these processes are shown in Fig. 2.



Rice. 2. Addiction degrees extraction ions metals from tensions electrical fields: *1 – iron; 2 – manganese.*

A sharp increase in the degree of extraction of metal ions by zeolite is observed with increasing electric field strength in the range from 0 to 500 V/m.

Thus, the effect of a constant electric field on natural zeolite substantially increases his sorption ability and exchange capacity in relation to iron and manganese ions. With increasing electric field strength, the degree of extraction ions metals from purified water: iron – up to 98, manganese – up to 84%. A sorbent activated by an electric field largely retains its activity after removing the electric field. fields.

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