Sorption of Cr(III)-Containing Cations on Strongly Basic Anion Exchangers

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ABSTRACT: It is shown that strongly basic anion exchangers AV-17 and Varion-AD in definite conditions are able to retain Cr(III)-containing ions from Cr(III) sulfate solution. It is found that the sorption of Cr(III)-containing ions on the polymers is essentially dependent on the pH, temperature, and Cr(III) sulfate concentration. The maximum temperature dependence of sorption was found to be about 60°C. The sorption isotherms are well described by Langmuir's equations. The sorption kinetics is determined by the diffusion of Cr(III)-containing ions into polymer's phase. It is assumed that the Cr(III)-containing ions are retained through formation, in polymer's phase, of the *jarosite*-type mineral compounds: $R_4N[Cr_3(OH)_6(SO_4)_2]$, $H_3O[Cr_3(OH)_6(SO_4)_2]$, and $K[Cr_3(OH)_6(SO_4)_2]$. For comparison of sorptional capacities, the sorption of Cr(III)-containing ions was determined on different cation and anion exchangers. © 2006 Wiley Periodicals, Inc. J Appl Polym Sci 102: 3978–3985, 2006

Key words: ion exchangers; transition metal chemistry; mineral

INTRODUCTION

The strongly basic anion exchangers in certain conditions are able to retain Fe(III) or Al(III) containing ions from $Fe_2(SO_4)_3$ or $Al_2(SO_4)_3$ solutions.[1–4] The retention of these ions takes place through the formation of the *jarosite*- or *alunite*-type mineral compounds in the polymer's phase: $R_4N[M_3(OH)_6(SO_4)_2]$, $K[M_3(OH)_6(SO_4)_2]$, and $H_3O[M_3(OH)_6(SO_4)_2]$, where R_4N^+ are polymer's groups, and M^{3+} are Fe^{3+} or Al^{3+} ions. The *jarosite*-type compounds in polymer's phase are in the form of fine-sized particles. On boiling in aqueous medium Fe(III)-containing compounds in polymer's phase are converted into β-FeOOH.[5]

The strongly basic anion exchangers are practically not selective toward anions sorption. But being modified with metal-containing compounds, they become selective toward some ions. So, strongly basic anion exchangers modified with Fe(III) compounds are selective for sorption of NCS^-, NCO^-, and CN^- ions.[6]

In the present article Cr(III) ions sorption isotherms, kinetics, and the influence of temperature and pH of the solutions on Cr(III)-containing ions sorption on the strongly basic anion exchangers are discussed.

The obtaining of Cr(III) compounds in the phase of crosslinked ionic polymers with strongly basic groups is of theoretical and practical interest. It is well known that Cr(III) compounds are distinguished by their high chemical stability. Thus, the sorbents obtained by modification of polymers with chromium (III) compounds can be used in a more aggressive media than similar sorbents containing Fe(III) or Al(III) compounds. On the other hand, Cr(III) and Fe(III) *jarosite*-type compounds could serve as models with peculiar magnetic properties.[7]

EXPERIMENTAL

The strongly basic commercial anion exchangers AV-17 (Cl) (containing $—N^+(CH_3)_3$ groups) and Varion-AD (containing $—N^+(CH_3)_2C_2H_4OH$ groups) were used. The resins have a polystyrene–divinylbenzene matrix and are of gel type. Their full exchange capacity is 3.5–4.0 mg equiv/g.[8]

Comparatively, sorptional studies have been performed on some commercial strongly basic anion exchangers, sulfonic and carboxylic cation exchangers, exchangers containing quaternary pyridinic nitrogen and atoms donor of electrons obtained at the Institute of Macromolecular Chemistry ''P. Poni,'' Iasi, Romania.

For preparation of solutions $KCr(SO_4)_2·12H_2O$ has been used. Dried samples (0.2 g) of the polymers were contacted with 100 mL of $KCr(SO_4)_2·12H_2O$ solutions. The pH of the solution–sample systems was maintained by using either H_2SO_4 or KOH solutions.

The sorption isotherms were obtained at 30, 50, and 60°C. The temperature dependence of the sorption of Cr(III)-containing cations in $4 × 10^{-2}M$ $KCr(SO_4)_2·12H_2O$ solutions with pH 4.0 was investigated over the temperature range 30–80°C. The system
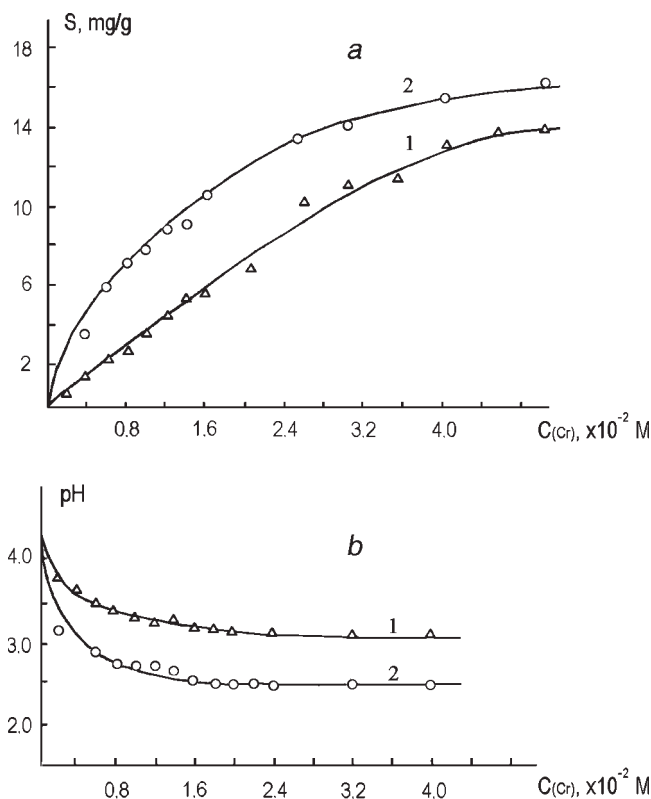
Figure 1 Sorption isotherms of Cr(III)-containing ions by anion exchanger AV-17 (a) and equilibrium pH of solution after sorption (b) at 30°C (1) and 50°C (2).

temperature was maintained constant with an error of ±1°C. There was no evidence of the resins degrading at these temperatures.

The kinetic curves of Cr(III)-containing ions sorption from $4 \times 10^{-2}M$ KCr(SO$_4$)$_2$·12H$_2$O solution with pH 4.0 were obtained at 60°C. Some kinetic models were used to describe sorption kinetics.

To identify the nature of the Cr(III) compounds in the polymer's phase of the AV-17(SO$_4$), K[Fe$_3$(OH)$_6$(SO$_4$)$_2$], obtained as previously described,[9] the IR spectra of the samples of AV-17 containing Fe(III) compounds and AV-17 containing Cr(III) compounds were recorded over the interval 400–4000 cm^{-1} on a Specord M-80 spectrometer. The samples were run as KBr discs (Composition 1:200).

The Cr(III) content of the samples was determined photocolorimetrically[10] after desorption of the ions with a solution of $1M$ H$_2$SO$_4$.

RESULTS AND DISCUSSION

Sorption isotherms of Cr(III)-containing ions

Strongly basic anion exchangers AV-17 and Varion-AD were allowed to interact with aqueous solutions of KCr(SO$_4$)$_2$·12H$_2$O. The samples of polymers were kept in contact for 24 h at 30 and 50°C with KCr(SO$_4$)$_2$·12H$_2$O solutions of various concentrations having an initial pH

of 4.35. Obtained sorption isotherms and pH of contacting solutions after sorption are presented in Figures 1 and 2. As is shown in these figures, the sorption processes of Cr(III)-containing ions take place with a pH decrease of polymer–solution system.

The decrease in pH of the solution contacting with the polymer takes place because of both Cr^{3+} cations hydrolysis and Cr(III)-containing ions sorption. The degree of hydrolysis of Cr^{3+} ions in the polymer phase differs from the one in solution. As is seen in Figures 1 and 2, the Cr(III)-containing ions sorption on strongly basic anion exchangers essentially depends on pH and temperature of polymer–solution system.

Cr(III) containing ions sorption depending on pH and temperature

The polymer samples were kept in contact, at 30°C for 24 h, with $4 \times 10^{-2}M$ KCr(SO$_4$)$_2$·12H$_2$O solutions having various pH values, maintained at a constant. Figure 3 shows that Cr(III)-containing ions sorption by the polymers takes place at pH > 1.5 and essentially increases at pH > 3.

Comparing Figures 1–3, we can see that Cr(III)-containing ions sorption at pH 2.5 in Figure 3 is much
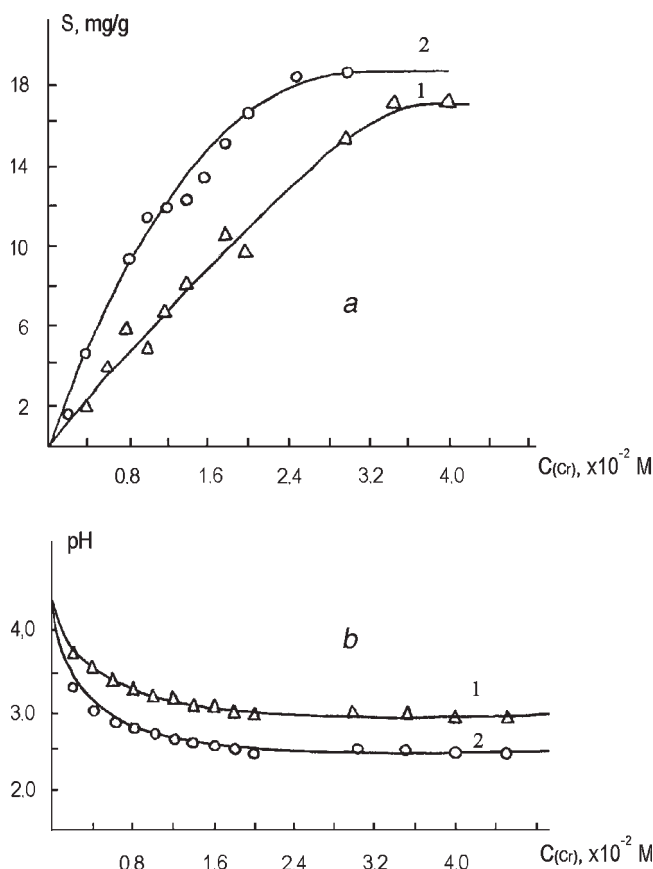

Figure 2 Sorption isotherms of Cr(III)-containing ions by anion exchanger Varion-AD (a) and equilibrium pH of solution after sorption (b) at 30°C (1) and 50°C (2).
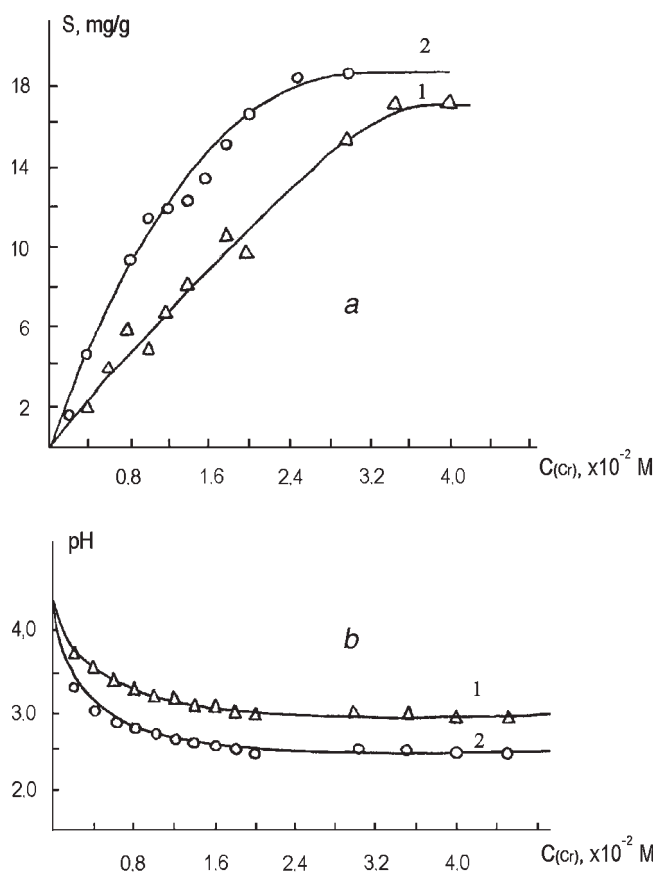
Figure 3 pH dependence of the Cr(III)-containing ions sorption on anion exchangers Varion-AD (1) and AV-17 (2).

lower that the one in Figures 1 and 2 at the same pH. This fact denotes that the Cr(III)-containing ions sorption on strongly basic anion exchangers is not reversible with the solution's pH variation. Variation of pH leads to the modification of solution and polymer's phase composition. According to Fishtic and Vataman,[11] in the solutions of $KCr(SO_4)_2 \cdot 12H_2O$ used there are some kinds of Cr(III)-containing ions: $[Cr(H_2O)_6]^{3+}$, $[CrOH(H_2O)_5]^{2+}$, $[Cr_2(OH)_2(H_2O)_8]^{4+}$, and $[Cr_3(OH)_4(H_2O)_{10}]^{5+}$. Not all of these cations are able to participate in the formation of Cr(III) compounds in the exchanger's phase. With increasing pH, the concentration of $[Cr(H_2O)_6]^{3+}$ cations in solution decreases, but sorption of the Cr(III)-containing ions on strongly basic anion exchangers grows. From solutions of pH $\leq$ 1.5 the sorption of Cr(III)-containing ions is absent. So, $[Cr(H_2O)_6]^{3+}$ cations do not take part in the formation of the Cr(III) compounds in the polymer's phase. It is known[12] that polynuclear cations cannot easily be restructured to form new units. Consequently, during the formation process of the Cr(III) compounds in the polymer's phase it is probable that the $[CrOH(H_2O)_5]^{2+}$ cations participate, the concentration of which increases at pH > 1.5.

Since the ionic composition of the $KCr(SO_4)_2 \cdot 12H_2O$ solution depends on temperature, it was expected that

the Cr(III)-containing ions sorption on strongly basic anion exchangers will depend on temperature, too. Therefore, in the investigations of Cr(III)-containing ions sorption on such polymers the influence of temperature is of interest.

As is shown in Figure 4, the sorption of Cr(III)-containing ions from the $KCr(SO_4)_2 \cdot 12H_2O$ solutions with constant pH at 4.0 on exchangers AV-17 and Varion-AD (depending on temperature) passes through a maximum at about 60°C.

The important conclusion from the pH and temperature dependence of the Cr(III)-containing ions retention on polymers is that the sorption is not a physical but a chemical process. This fact excludes ion exchange as a possible process for the sorption of Cr(III)-containing ions. It also excludes sorption due to the formation of a $Cr(OH)_3$ precipitate in the polymer's phase. We suggest that the retention of the Cr(III)-containing ions on the strongly basic anion exchangers is due to the formation of *jarosite*-type compound in the polymer's phase, as in case of Fe(III) containing ions retention on such polymers.[3,5]

The pH and temperature influence on the Cr(III)-containing ions sorption is explained to be due to the modification of $[CrOH(H_2O)_5]^{2+}$ ions concentration in solution contacting with polymer. During the contact of the polymers in Cl^- form with $KCr(SO_4)_2 \cdot 12H_2O$ solution the anion exchange processes take place according to eq. (1):

$$2\,R_4NCl + SO_4^{2-} \leftrightarrow (R_4N)_2SO_4 + 2Cl^- \qquad (1)$$

The rate of the process (1) is more than of the Cr(III)-containing ions sorption. In the polymer's phase the concentration of SO_4^{2-} ions is much higher than in the contact solution and the equilibriums (2) and (3) may be established:
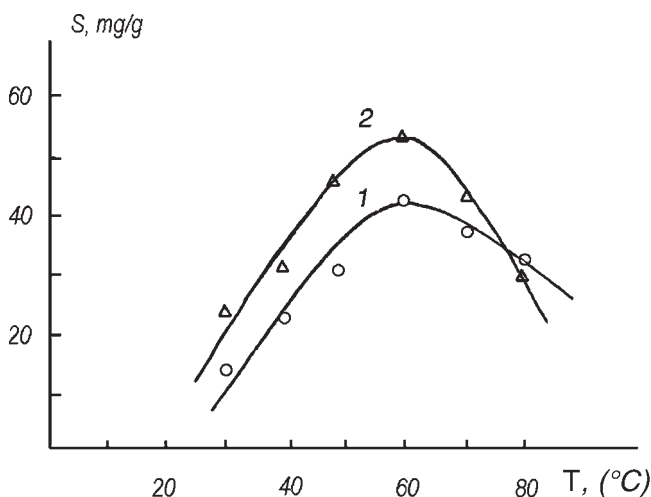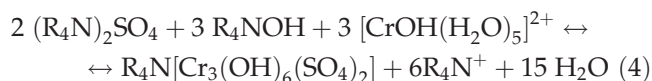

Figure 4 Temperature dependence of the Cr(III)-containing ions sorption on anion exchangers Varion-AD (1) and AV-17 (2).

$$(R_4N)_2SO_4 + HOH \leftrightarrow R_4NHSO_4 + R_4NOH \quad (2)$$

$$2R_4NHSO_4 \leftrightarrow (R_4N)_2SO_4 + 2H^+ + SO_4^{2-} \quad (3)$$

With increasing pH of the contacting polymer solution the number of R_4NOH groups in polymer's phase increases as well. The R_4NOH groups of polymer take part in the formation of *jarosite*-type compounds in the polymer's phase. Unfortunately, the particles of the Cr(III) *jarosite*-type compounds in polymer's phase are too small and have low crystallinity to use the X-ray diffraction method for their identification. The low crystallinity is characteristic for synthetic jarosites.[13] According to Lurie,[9] jarosite particles are in the superparamagnetic state, characteristic of ultrafine particles (with radius less then 4 nm for Fe_2O_3[14]). The IR spectra of the Cr(III)-containing polymers are a little informative because they contain a very large absorption band at about 1100 and 620 cm^{-1}. The large absorption band (Fig. 5) is a superposition of some bands from SO_4^{2-} and HSO_4^- ions (retained electrostatically by R_4N^+ groups of polymer) and from SO_4^{2-} coordinated with three metallic ions.[13]

Since the sorption of Cr(III)-containing ions from the $CrCl_3$ solutions does not take place on the strongly basic anion exchangers, we assume the sorption mechanism from the Cr(III) sulfates solutions to be the same

as the Fe(III) containing ions sorption investigated by more informative method of Mössbauer spectroscopy.[2,3,5] Therefore we suggest that the Cr(III) compounds in the phase of strongly basic anion exchangers are formed according to scheme (4):

$$2\,(R_4N)_2SO_4 + 3\,R_4NOH + 3\,[CrOH(H_2O)_5]^{2+} \leftrightarrow$$
$$\leftrightarrow R_4N[Cr_3(OH)_6(SO_4)_2] + 6R_4N^+ + 15\,H_2O \quad (4)$$

Some of the Cr(III) compounds in polymer's phase may be in the form of $K[Cr_3(OH)_6(SO_4)_2]$ and $H_3O[Cr_3(OH)_6(SO_4)_2]$ as in cases of *jarosite* compounds.[3]

Because the pH and temperature essentially influence the Cr(III)-containing ions sorption on strongly basic anion exchangers, we considered it necessary to obtain sorption isotherms at 50 and 60°C with and without maintaining $KCr(SO_4)_2 \cdot 12H_2O$ solutions' pH constant. In these investigations the polymer samples interacted for 24 h with $KCr(SO_4)_2 \cdot 12H_2O$ solutions having constant pH 4.2 during the sorption process at 60°C, and having an initial pH of only 4.2 at 50°C. As is seen in Figure 6, the sorption of Cr(III)-containing ions at 60°C from solution with constant pH 4.2 is much more than in the cases of sorption at 50°C from the solutions with decreasing pH from 4.2 to about 2.5 (see Figs. 1 and 2).
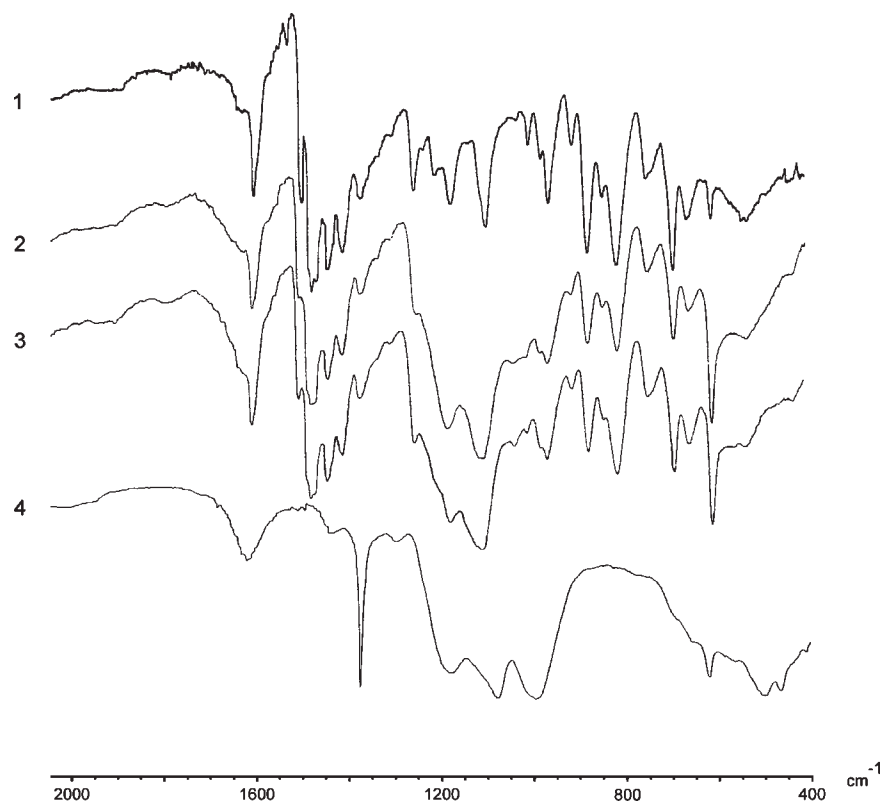

Figure 5 IR spectra of the samples: unmodified AV-17(SO_4^{2-}) polymer (1), AV-17 containing Cr(III) compounds (2), AV-17 containing Fe(III) compounds (3), and $K[Fe_3(OH)_6(SO_4)_2]$.
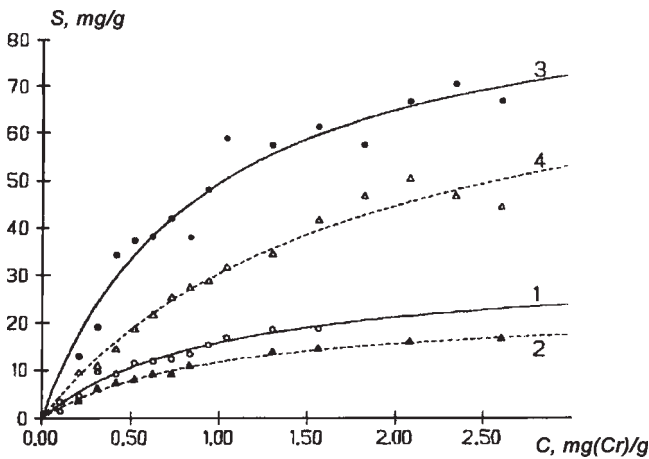
Figure 6 Sorption isotherms of Cr(III)-containing ions on Varion AD (1, 3) and AV-17 (2, 4) polymers at 60°C from the solution with constant pH 4.2 during the sorption process (3, 4) and at 50°C from the solutions with initial pH of only 4.2 (1, 2).

The sorption isotherms obtained at 60°C are well described by Langmuir sorptional model for a single type of equivalent active centers:

$$S = S_{max}KC/1 + KC$$

where S is the sorption (mg Cr/g), C is the concentration of Cr(III) ions in solution (mg/mL), and K and S_{max} are constants. The calculated isotherm constants are $K = 0.667$ mL/mg and $S_{max} = 100$ mg Cr/g for Varion-AD; $K = 0.417$ mL/mg, and $S_{max} = 100$ mg Cr/g for AV-17.

(For sorption isotherm obtained at 50 and 60°C (Fig. 6), new portions of polymers were used.)

Kinetics of Cr(III)-containing ions sorption

The kinetic curves of Cr(III)-containing ions sorption were obtained at 60°C using $4 \times 10^{-2}M$ KCr(SO$_4$)$_2$·12H$_2$O solutions with constant pH 4.2 (Fig. 7). Their analysis was performed using different models:

1. Assuming that ions sorption kinetics is limited by external diffusion, eq. (5) may be applied[15]:

$$\ln(1 - F) = -k\tau \tag{5}$$

where $F = S/S_{max}$, S is the sorption at given time τ, S_{max} is maximal sorption at equilibrium, and k is the rate constant.

The constant k can be calculated using eq. (6):

$$k = \frac{3D^l}{r_o l k_d} \tag{6}$$

where D^l is diffusion constant through liquid layer around polymer granule, r_o the granule radius, l the thickness of liquid layer around the granule, k_d the ion distribution constant, expressed by the ratio of ion content in the polymers at equilibrium (mmol/g) and in solution (mmol/mL).

The kinetics of the process limited by external diffusion can also be expressed according to Nernst's theory about the external mass transfer.[16]

$$\ln(1 - F) = -\frac{A\beta\tau}{Wk_d} \tag{7}$$

where A is the surface of polymer spherical granule, W the granule volume, and β the empiric coefficient of mass transfer (mm/s).

For spherical particles $A/W = 3/r_o$ and

$$\ln(1 - F) = \frac{3\beta\tau}{r_o k_d} \tag{8}$$

In these conditions the ratio $-\frac{3\beta}{r_o k_d}$ is a constant, expressed further through γ. Thus, eq. (8) converts into eq. (9):

$$\ln(1 - F) = \gamma\tau \tag{9}$$

2. Assuming that the limiting stage is the internal diffusion, the kinetic eq. (10) could be expressed as[15]

$$F = 1 - \frac{6}{\pi^2} \sum_{n=1}^{\infty} \frac{1}{n^2} \exp\left(-\frac{D^i \pi^2 n^2 \tau}{r_o^2}\right) \tag{10}$$

where D^i is the internal diffusion constant.

Taking $\beta = D^i \pi^2 / r_o^2$, eq. (10) changes into eq. (11):

$$F = 1 - \frac{6}{\pi^2} \sum_{n=1}^{\infty} \frac{1}{n^2} \exp(-\beta n^2 \tau) \tag{11}$$

It is considered that for $F < 0.05$ (Ref. 15) only the external layer of the granule contains ions.

$$F = 1.08\sqrt{\beta\tau} \tag{12}$$

Thus, the characteristic element of internal diffusion for low values of τ is the linear dependence $F = f(\sqrt{\tau})$.

3. Assuming that the sorption rate is limited by the chemical process in the polymer phase, the kinetics may be described by eq. (13) (Ref. 15):
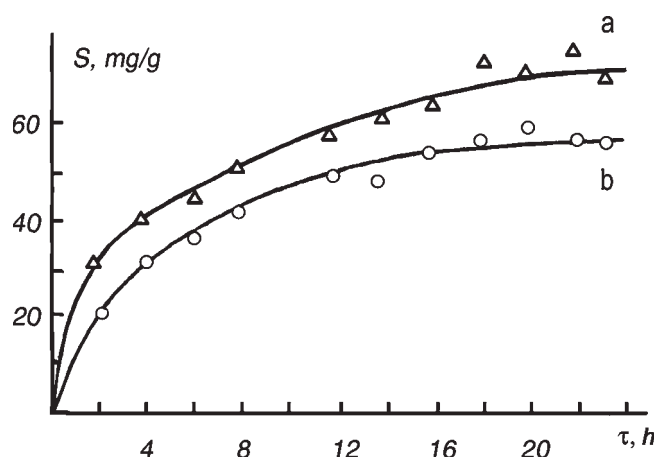
$$\ln(1 - F) = -k\tau \tag{13}$$

Figure 7 Kinetic curves of Cr(III)-containing cations sorption at 60°C on polymers AV-17 (a) and Varion-AD (b).

TABLE I
Parameters of Kinetic Equations Regarding Sorption of Cr(III) Ions on the Polymers AV-17 and Varion-AD

Anion exchanger	S_e (mg/g)	β (cm/s)	r_o (cm)	k_d
Equation (8) – diffusion through external layer of liquid				
AV-17	60.7	8.46×10^{-6}	0.0164	21.6
Varion-AD	54.9	6×10^{-6}	0.0163	21.6

	S_e (mg/g)			k (1/s)
Equation (13) – chemical process in the polymer				
AV-17	60.5			7.63×10^{-5}
Varion-AD	54.7			5.18×10^{-5}

	S_e (mg/g)			β (1/s)
Equation (11) – internal diffusion through polymer granules				
AV-17	70.5			2.45×10^{-5}
Varion-AD	67.3			1.60×10^{-5}

	S_e (mg/g)	k 1/s	N	β (1/s)
Equations (11) and (14) – internal diffusion through polymer granules				
AV-17	65.6	3.83×10^{-5}	0.85	3.25×10^{-5}
Varion-AD	65.4	2.21×10^{-5}	0.72	1.60×10^{-5}

Formally, eq. (13) for the chemical process and eq. (5) for the external diffusion are similar, but these kinetic mechanisms can differ, taking into account that the rate of a chemical reaction depends neither on sorbent granules size nor on solution stirring degree but is dependent only on concentration and temperature.

The main factors that are considered to determine the sorption rate are k_d and r_o. In certain conditions of temperature and stirring of solution, the ratio between them determines the value of β constants in eqs. (5) and (6). The sorption rate is limited by the external diffusion if $\beta/k > 1$. As eqs. (5) and (11) are formally identical, the influence of external diffusion of chemical reaction on sorption speed can be determined using these equations.

Thus, the verification of the hypothesis about the influence of chemical rate could be evaluated by means of eq. (13), the hypothesis about the influence of external diffusion using eq. (8), and the hypothesis about the internal diffusion is verified applying eq. (11). The role of diffusion in sorption kinetics will be checked using the ratio β/k:

$$\beta/k = N \quad \text{or} \quad \beta = kN \qquad (14)$$

where N can have a value higher or lower than 1.

The significance of k in eq. (14) results from eqs. (5) and (6), which unfortunately could not be applied in these forms because of formal identity with eq. (13). By combining eqs. (14) and (11) arises the possibility of determining constants k and N.

Equations (5) and (13) can be solved either graphically[15] or by method of linear regression analysis. More efficient is the method of nonlinear regression analysis which we have applied.

The parameters of kinetic equations, calculated for different kinetic methods of Cr(III) sorption by the AV-17 and Varion-AD polymers are presented in Table I.

The analysis of the obtained data demonstrated that the experimental kinetic curves are most efficiently described by the equations of internal diffusion [eqs. (11) and (14)]. The verification using eq. (14) has denoted that the value N is lower than 1, a fact confirming that Cr(III) ions kinetic sorption by the polymers is determined by the internal diffusion (through polymers granules).

The thickness of diffusion layer l around the granules can vary in the range of 5×10^{-4}–5×10^{-3} cm.[16] The eq. (15) is obtained from eqs. (6) and (8):

$$D^l/1 = \beta \quad \text{or} \quad D^l = \beta 1 \qquad (15)$$

It has allowed estimating the range of diffusion values D^l through liquid layer around the polymer granule (Table II).

TABLE II
The Constants of Internal Diffusion of Cr(III) Ions through Particles

	Anion exchanger	
	AV-17	Varion-AD
D^l (cm^2/s)	$4.2 \div 8.5 \times 10^{-9}$	$3 \div 6 \times 10^{-9}$
D^i (cm^2/s)	6.7×10^{-10}	4.3×10^{-10}
D^i (cm^2/s) from eqs. 11 and 14	8.8×10^{-10}	4.3×10^{-10}

TABLE III
The Values of Sorption (S) from Solutions of Cr(III)-Containing Ions by Different Polymers at 60°C

No.	Polymer	Place of manufacture	Functional group	DVB (%)	S (mg Cr/g)
1	AV-17 (Cl)	Russia	$-N^+(CH_3)_3$	8	71.8
2	AV-17-2P	Russia	$-N^+(CH_3)_3$	2	66.1
3	Varion-AD	Hungary	$-N^+(CH_3)_2C_2H_4OH$	8	55.9
4	Purolite A-400	England	$-N^+(CH_3)_3$	8	30.2
5	Amberlite IRA-410	USA	$-N^+(CH_3)_2C_2H_4OH$	8	45.2
6	4-VP-AN	Romania	$\rangle\overset{+}{N}-CH_2CH_2CN$	8	78.0
7	4-VP-AM	Romania	$\rangle\overset{+}{N}-CH_2-CH_2-CONH_2$	8	78.6
8	4-VP-MVC	Romania	$\rangle\overset{+}{\underset{-}{N}}-CH_2-CH_2-COCH_3$	8	58.9
9	KU-2	Ukraine	$-SO_3H$	8–10	88.8
10	KB-2	Russia	$\rangle C-COOH$ $\mid$ $\rangle C-COOH$	2–3	89.5
11	KB-4	Russia	$\rangle CH-COOH$	6	45.9
12	KB-4P2	Russia	$\rangle CH-COOH$	2.5	43.1
13	Amberlite IRC-50	USA	$\rangle CH-COOH$	8	35.8

The value of β estimated using eqs. (11) and (14) represents the relation between D^i and r_o.

As one can see from Table II, the values of the D^l constant are 5–10 times higher than those of the corresponding D^i constant. The ratio between D^l and D^i constants is generally very close to that obtained by Boyd et al.,[15] this being a supplementary confirmation of the hypothesis that the internal diffusion is the limiting stage of the kinetics.

The small values of D^i can be explained by the fact that Cr(III) hydrocomplexes have the same electric charge as do the polymer matrix. In this case, the cations diffusion take place through the liquid layer in the polymer phase and not through jumping from one functional group to another, like cations diffusion in the phase of sulfo-cationites.[17]

Sorption capacity of different exchangers

The ability of strongly basic anion exchangers to retain metallic cations from solutions is an unusual phenomenon. The chemistry of the metallic cation retention on such kind of polymers completely differs from the one on sulfo- or carboxylic cation exchangers. Therefore it is interesting to compare the capacity of Cr(III)-containing ions sorption of different kinds of exchangers. For investigation, samples of polymers that interacted at 60°C for 18 h with 0.038M KCr(SO$_4$)$_2$·12H$_2$O solution having constant pH 4.2. Characteristics of utilized commercial exchangers are given in Ref. 8. The obtained sorptional capacities of the investigated exchangers are listed in Table III. As is seen in Table III, the metallic cations sorption capacity of strongly basic anion exchangers is comparable with the capacity of cation exchangers.

The small sorption capacity of the KB-4, KB-4P2, and Amberlite IRC-50 is due to low dissociation degree of the carboxylic groups of polymers at pH 4.2, although sorption takes place through the complex formation. The higher sorption capacity of the carboxylic exchanger KB-2 is thanks to its ability to form chelate compounds with Cr(III) cations.

CONCLUSIONS

Strongly basic anion exchangers are able to retain Cr(III) ions from sulfate solutions under certain values of pH. With increase in the solution pH (pH >2) the sorption of Cr(III) ions goes up essentially. Sorption of Cr(III)-containing ions, dependent on temperature, passes through a maximum at about 60°C. The sorption isotherms are well described by the Langmuir's model. The kinetics of Cr(III) ions sorption is limited by internal diffusion of cations in the polymer granules. The sorption of Cr(III) ions by strongly basic polymers is a result of a chemical process of formation in the polymers phase of *jarosyte*-type mineral compounds. Under optimal values of temperature and pH the sorption of Cr(III) ions by strongly basic anion exchanger is of the same extent as their sorption by cationites.

References

1. Gutsanu, V.; Luca, C.; Turta, C.; Neagu, V.; Sofranschi, V.; Cherdivarenco, M.; Simionescu, B. C. J Appl Polym Sci 1996, 59, 1371.

2. Gutsanu, V.; Luca, C.; Neagu, V.; Sofranschi, V.; Turta, C. React Funct Polym 1999, 40, 123.

3. Gutsanu, V.; Drutsa, R.; Rusu, V. React Funct Polym 2001, 46, 203.

4. Gutsanu, V.; Drutsa, R. BOPI 2003, 8, 25. Pat. MD 2241.

5. Gutsanu, V.; Gafiichuk, V.; Shofransky, V.; Turta C. J Appl Polym Sci, to appear.

6. Gutsanu, V.; Munteanu, D.; Rosca, I. In Proceedings of International Conference of the Chemical Societies of South-Eastern European Countries on Chemistry in the New Millennium—An Endless Frontier, Bucharest, Romania, September 22–25, 2002; Book of Abstracts, Vol. 2, p 39.

7. Townsend, M. G.; Longworth, G.; Roudaut, E. Phys Rev B 1986, 33, 4919.

8. Lurie, A. A. Sorbents and Chromatographic Carriers; Nauka: Moscow, 1972 (in Russian).

9. Ohyabu, M.; Ujihira, Y. J Inorg Nucl Chem 1981, 43, 1948.

10. Marcenko, Z. Photometrical Determination of Elements; Mir: Moscow, 1971 (in Russian).

11. Fishtic, I. F.; Vataman, I. I. Thermodynamics of the Metallic Ions Hydrolysis; Stiintsa: Chisinau, Moldova, 1988.

12. Belozerskii, G. N.; Baicov, M. V.; Boldyrev, V. V. Kinetika i kataliz 1974, 15, 929 (in Russian).

13. Archipenko, D. K.; Devyatkina, E. T.; Palchik, N. A. Crystallochemical Particularities of Synthetic Jarosites; Nauka: Novosibirsk, Russia, 1987 (in Russian).

14. Suzdalev, I. P. Gamma Resonance Spectroscopy of Proteins and Model Compounds; Nauka: Moscow, 1987.

15. Boyd, G. E.; Adamson, A. V.; Myers, L. S. J Am Chem Soc 1947, 69, 2836.

16. Kokotov, I. A.; Pasecinic, V. A. Equilibrium and Kinetics of Ionic Exchange; Khimia: Leningrad, Russia, 1970 (in Russian).

17. Suzdalev, I. P.; Placinda, A. S.; Macarov, E. E.; Dolgopolov, V. A. Zh Fiz Khim 1967, 41, 2831.