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J21516-001

Kiyanovskiy A.M.

**THE MOVEMENT OF THE MIXTURE OF SUBSTANCES IN THE
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Abstract. The paper discusses some questions of the general theory of sorption dynamics and chromatography, gives the reasons for differences in sorption properties of substances. The key ways of chromatography are highlighted - frontal, elution, and displacement chromatography. Examples of the use of radioactive tracers are presented. They allow significantly to enhance the ability of the experimental studies of sorption processes.

Keywords: dynamics of sorption, chromatography, separation of mixtures, radiochromatography.

Introduction. Chromatographic methods of analysis and separation of mixtures of substances are widely used in various fields of science and technology.

The theory of sorption dynamics and chromatography gives the general laws valid for all, now and various types of adsorption chromatography, to optimize chromatographic processes.

Literature review. Various aspects of the theory and practice of sorption dynamics and chromatography subject of numerous monographs and articles, for example, three-volume monograph [9].

The general theory of sorption dynamics and chromatography is described more fully in [2], but the issues of displacement sorption dynamics are considered sufficient. In [7, 8] refined the processes of formation exclusion chromatograms.

Practical application of radiotracers in chromatography reviewed in [10]. Similar studies were carried out successfully in the Timiryazev MR, some results are presented in [3-5].

The basic text. Let there be any medium with high surface area possessing sorptive capacity, and this medium is introduced into a mixture of substances in solution or gas flow.

When moving a mixture of substances through the layer of sorbent due to differences in the interaction (imbibition) components of the mixture is stronger sorbed substance displaces and pushes forward at least sorbed substances.

As a result, there is the local distribution of the components along the length of the column of the sorbent - formed chromatographic zone.

Borders - fronts move between zones with characteristic for each speed limit.

Differences in imbibition substances may be caused by different types of sorption. For example, two compounds interact differently with the sorbent, one - molecular type, and the second - on ion exchange type sorption.

In one form of the sorption substances differences can be quantified corresponding binding energies, or constants in the equation of sorption isotherm [1,2].

Differences in the sorption interaction may also be due to a purely structural and

geometric factors.

The impact of the sorbent structure and structural features of the sorbed substances in the course of the process is very large. This is manifested in the fact that, depending on the relative sizes of the internal pores of the sorbent grains, and the sizes of adsorbed molecules or ions, the interaction may take place on type ekstramitsellyarnoy or intramitsellyarnoy sorption.

From this viewpoint, sorbents internal porosity can be considered as a kind of sieve capable of sorbing different sorting and molecule or ions of various sizes.

The possibility of creating special conditions for the passage of mixtures of substances in the environment, absorbing virtually unlimited, which creates opportunities for the optimization of the process of sorption.

For active influence on the course of the sorption process can use chemical and physical methods, for example, complex, electrical, thermal and magnetic fields.

Regular arrangement of substances in the areas defined by the theory of sorption dynamics and chromatography.

The theory takes into account the balance of substances during their movement in the sorbent, and static sorption kinetics, the fluid dynamics of the process, the thermodynamic state parameters of the medium, the heat balance.

The distribution of matter in the absorbing medium is described by a system of partial differential equations of first and second order. Only in special cases and with the simplifying assumptions can obtain analytical solutions in more complex cases resort to numerical integration of differential equations.

The theory of sorption dynamics and chromatography can be successfully used to determine the composition and separation of mixtures of substances.

There are three main practical method for the chromatographic separation of mixtures of substances - receiving primary (front) chromatogram lavage (elution) and the displacement of [2, 7, 8].

Upon receipt of the frontal chromatogram substance mixture is passed through the sorbent column (fig.1).

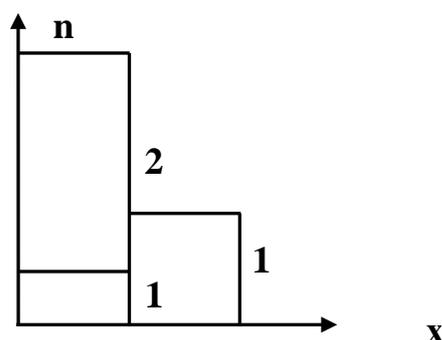


Fig. 1. Front chromatogram of two substances:

x - the length of the column; n - linear concentration - mass of the substance per unit length column sorbent; 1 and 2 - the first and second components. The second component is absorbed better than the first

Elution (rinsing) through a column of the received distribution front passes pure solvent (fig.2).

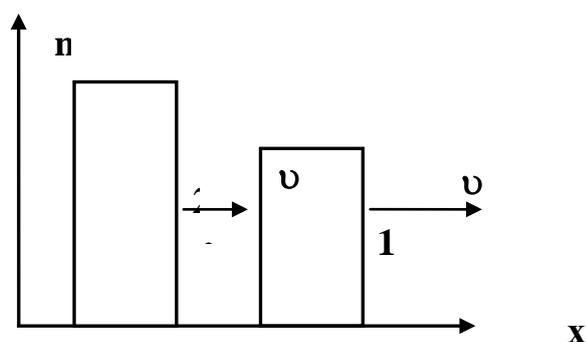


Fig. 2. Elution scheme chromatogram two substances.
Along the column extends the zone of the first and second components,
each with its own speed, $v_1 > v_2$

The displacement is carried out by passing through a column of sorbent formed frontal chromatogram of propellant - a substance more strongly sorbed components to be separated.

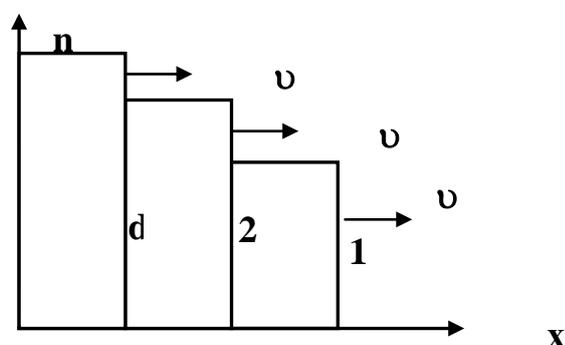


Fig. 3. Driving exclusion chromatograms:
1 and 2 - the first and second components of the mixture; d - the displacer.
On the stationary phase sorption rate components are the same, $v_d = v_1 = v_2$

The real process of sorption dynamics, as opposed to the ideal, shown in figures 1-3, due to the uneven distribution of matter border (edges) zones are blurred.

There are several reasons for blurring the front. Chief among them - the hydrodynamic and kinetic.

Hydrodynamic causes nonuniformity caused by the porous medium, resulting in uneven fluid movement; kinetic reasons - the finite time required to establish equilibrium sorption.

The decisive factor in the nature of the deformation of the front, is the kind of sorption isotherms, that is the factor of static sorption.

Thus, when a convex isotherm formed stationary front blurred, moving at a constant speed.

When the linear (and concave) sorption isotherms front expands.

The use of radioactive tracers allows to obtain experimentally true and clear picture of the distribution of matter in the sorbent in the process of sorption dynamics [3, 5, 10].

Figure 4 shows a series of radiochromatogram obtained by displacing an ion-exchange sorption dynamics of ions Rb^+ and Ca^{2+} . Radiolabeled rubidium ion carries.

Unlike the chromatograms shown in figures 1 and 3, due to the equivalence of ion exchange radiochromatograms shown in figure 4, the highest concentrations of the Rb^+ and Ca^{2+} ions in the mixed zone and Rb^+ ions in the "pure zone" Rb are identical; concentration - the mass per unit length equivalent exchanger. On radiochromatogram as shown initial distribution of substances - frontal chromatogram (order of the zones in figure 4 is opposite to that shown in figure 1, the left - less rubidium ion sorbent right mixed zone rubidium ions and calcium).

On radiochromatogram clearly visible parallel transport stationary fronts ion exchange $\text{Sr}^{2+}-\text{Ca}^{2+}$ and $\text{Ca}^{2+}-\text{Rb}^+$ (convex sorption isotherm) and expansion of the front of ion exchange Rb^+-H^+ (linear sorption isotherm) [8].

On speed (moving) the motion of boundaries chromatographic zones can be, in particular, to determine the constants of ion-exchange sorption dynamics.

Reduce the activity of radioactive drugs used in the determination of sorption constants allows a method of "waves labeled" [3, 4].

The resin column pre-saturated solution of the ions, then it is introduced trace the same ions, labeled tracer. After this initial solution is reintroduced. "Waves" labeled ions move in the ion exchanger, and the movement of the maxima does not depend on the activity of the indicator.

As defined by the constant shift of the maximum ion exchange.

Copies of the series radiochromatogram obtained by varying amounts of the solution of Na^+ and Cs^+ , introduced in the resin column, give an idea of the dynamics of promoting "tagged waves" in the column of the sorbent.

Fig. 5 labeled ions are introduced at the same time. For a better resolution of the peaks labeled ions is conveniently carried out separate "start" label (fig. 6).

Moving highs "tagged waves" is directly proportional to the volume of the stock solution introduced into the resin column.

Application of the theory of sorption dynamics is extensive. In particular, it can be successfully used in soil-reclamation studies [6]. In soils movement occurs solutions containing various mineral and organic substances. In agriculture, used fertilization method by watering the soil nutrient solutions. Soils are washed with clean water in the form of rainfall, with artificial irrigation. The soils occur during dynamic displacement of substance from the upper to the lower horizons, when moving through the soil solutions stripping agents. These processes occur in natural conditions, as well as during various chemical soil improvement.

Of course, in soils under natural conditions on dynamic sorption processes imposed by other physical, chemical and biological processes.

However, it is the dynamics of sorption laws stipulate the nature of the distribution of matter in the horizons of the soil profile.

Tracer greatly simplifies and enhances the experimental studies of transport of substances in soils [6].

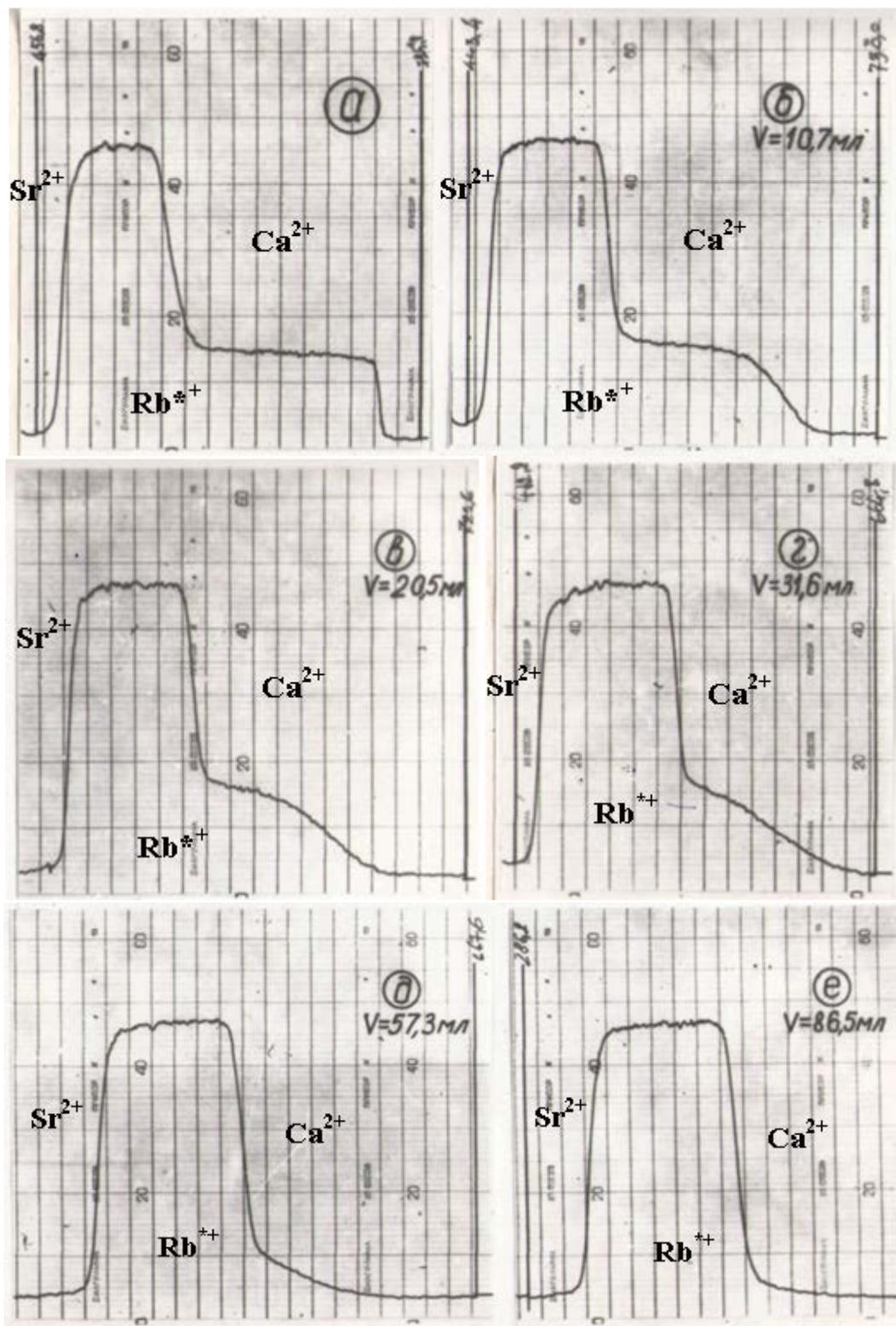


Fig. 4. Formation displacing ion exchange ions chromatograms Rb^{*+} and Ca^{2+} ($V_{\text{пачтв}} = 150 \text{ ml}$, $C_{\text{Rb}^{*+}}^0 = C_{\text{Ca}^{2+}}^0 = 0,05 \text{ i}$). Blowing - 0.1 n SrCl_2 . Each radiochromatogramme specified volume of propellant injected into the column. The column of the ion exchanger in the H^+ - form

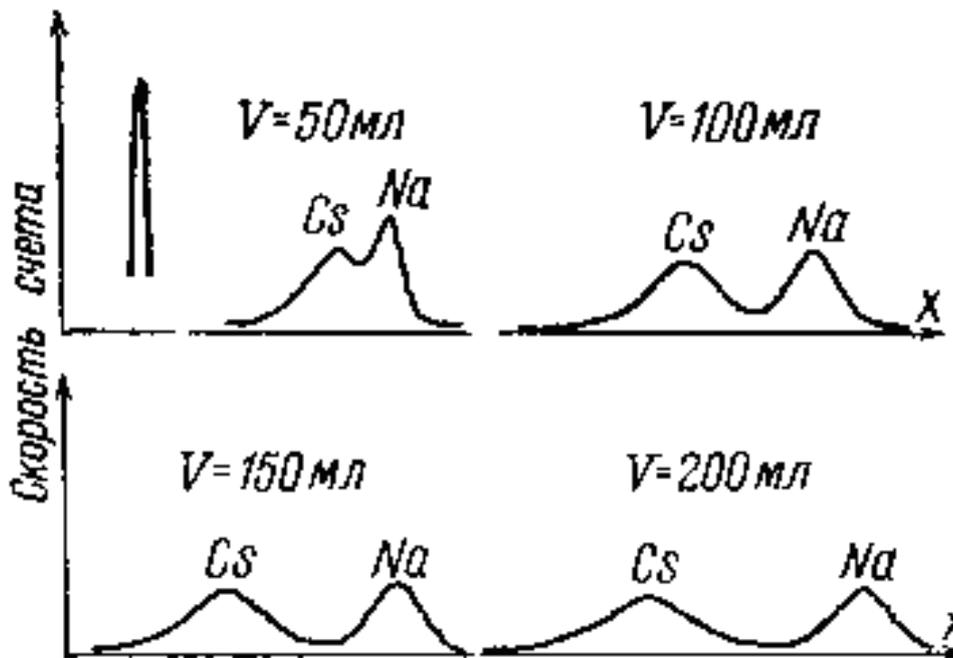


Fig. 5. Dynamics "tagged waves» Na⁺ and Cs⁺ (c_{Na}=c_{Cs}=0,05 n). Each radiochromatogramme specified volume of solution introduced into the column

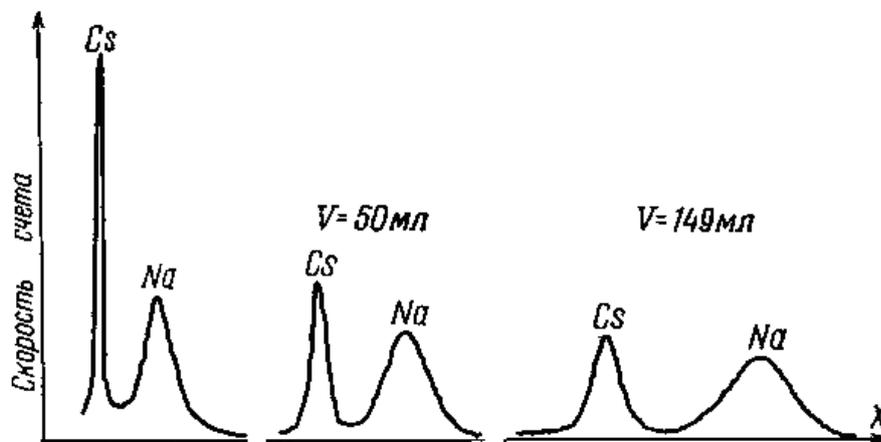


Fig. 6. Movement radioisotope labels of Na and Cs in the separate "Start" (c_{Na}=c_{Cs}=0,05 n). On radiochromatogrammah set the volume passed through the column starting solution

Conclusion and summary. The motion of the mixture of substances in the porous absorbing media, clarified the reasons for differences in imbibition mixture components, leading to the emergence of chromatographic zones.

The experimental confirmation of theoretical conclusions made.

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J21516-002

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FORMATION OF ION-EXCHANGE CHROMATOGRAM**1. THE FRONT AND ELUTION SORPTION DYNAMICS**

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Abstract. Allocation of substances on ion exchange column resin bed in the front, elution and displacement chromatography processes are considered from positions of the general theory of the dynamics of sorption and ion exchange equivalence law (the law of conservation of charge). To implement elution and displacement modes of sorption dynamics is necessary to create the primary frontal chromatogram. The values of ion exchange equilibrium constants and concentrations of ions in solution determine the course of the formation of the chromatograms. Velocities of borders of educated chromatographic zones - fronts ion exchange are defined. The constancy of velocities of the band boundaries determines monotonicity of frontal and elution sorption dynamics, constant structure of chromatograms. Increased initial solution are introduced into the column of ionite under frontal chromatography, it leads to an increase in the width of the chromatographic zones. The zones of the primary frontal chromatogram are changing in the displacement sorption dynamics and leading to a complete separation of the components of the original solution.

Keywords: ion exchange, dynamics of sorption, chromatography.

Introduction. Ion-exchange chromatography is widely used in various branches of science and technology for the analysis and separation of similar properties of both inorganic and organic substances.

The theory of dynamics of sorption allows, knowing the nature of the interaction of the components with the ion exchanger, the concentration of the mixture of substances and other conditions affecting the movement of the mixture, to obtain patterns of spatial distribution of substances in the ionite.

Review of the literature. The exceptional value of the method of ion exchange and ion exchange chromatography evidenced a great number of publications on the use of ion exchangers in research, biology, medicine, agriculture, various industries.

Suffice it to look at the list of references given even if only in certain well-known monographs and collections of scientific papers [1-7].

In ion exchange chromatography separation of mixture components occurs due to a reversible interaction of ionized substances with ionic groups sorbent.

Ion exchange chromatography can be used to separate any compound which is possible by some method to ionize.

The degree of ionization of components of the distributed mixture can be changed, in particular via complexing change in pH, which can significantly improve the efficiency of chromatographic processes, and to expand their range of applications.

Is possible, for example, chromatographic analysis of neutral sugar molecules, even in the form of their complexes with borate ion [5].

Expediency of using of a resin bed in each individual case is determined by its selectivity, exchange capacity, chemical and mechanical properties [1-3].

In studying the chromatographic process in the majority of work explored the output curves and only a few regarded the distribution of substances in the resin columns - ion exchange chromatograms [7, 9,10].

The main part. There are several theories that explain the mechanism of ion exchange reactions. Substantiated and productively to consider ion exchange as a heterogeneous chemical reaction, for which the fair law of mass action. Possible secondary interactions non-ionic nature, for example by adsorption or hydrogen bonds with the nonionic part of the matrix insoluble substances in the mobile phase, and others [2].

However ion exchange considered as a defining main.

The law of mass action, which characterizes an ion exchange reaction, it is advisable to record by analytical of ion concentrations. Using ion activity instead of concentration is difficult because of the limited literature data on the activity coefficients in mixed solutions [2].

Condition of electrical neutrality chromatographic system makes it appropriate expression in the mass concentration equivalents per unit length of the column of the sorbent:

$$\sum_{i=1}^j N_i = N_0 = const, \quad (1)$$

$$\sum_{i=1}^j n_i = n_0 = const, \quad (2)$$

where N_0 – exchange capacity of the ionite; N_i – concentration of i-th ion in the ion exchanger; n_i – concentration of i-th ion in solution. The value $n_0 = \sum_{i=1}^{\infty} n_i$ is the same at all points of the stationary front of ion exchange.

The concentrations of selected law of mass action, which is and sorption isotherm in the given conditions, is written in this form:

$$\frac{N_1^{1/Z_1}}{N_i^{1/Z_i}} = K_{1,i} \frac{n_1^{1/Z_1}}{n_i^{1/Z_i}}, \quad (3)$$

where $K_{1,i}$ – dimensionless constant is the concentration of ion exchange.

Differences imbibition by ions are determined by differences in the constants of ion exchange. The criterion imbibition ions may also serve as a distributive ratio

$$h_i = \frac{n_i}{N_i}. \quad (4)$$

There are three main ways of chromatographic processes.

At the front entrance to the chromatography column of the resin at all times maintain a constant initial concentrations of the sorbing of substances.

In elution chromatography (flushing) at entrance to the column is introduced a pure solvent.

In exclusion chromatography using into the column of sorbent is introduced a solution containing substances to be separated, formed by a frontal chromatogram. Then the column is introduced a solution of the component of the propellant.

The distribution of components in a zone of the primary the front chromatograms determines process the exclusion dynamics of sorption. When the displacement reduces the number of components in a chromatographic zones, because the number of zones increases initially, but subsequently decreases to a minimum at full separation of substances stock solution [6, 8-10].

To reveal the the dominant of regularities the ion-exchange sorption dynamics and chromatography consider the ideal model processes, envisaging immediate establishment sorption equilibrium in the absence of any disturbing factors. These simplifications are close to the real conditions in many cases, in consideration of other physical factors affecting the course of sorption processes, allows us to introduce the necessary amendments [6, 8].

Front sorption dynamics and chromatography. Assume that ionite comprising only one ion, the pores of the column filled with water. Mixture enter solution j ions constant concentration at a constant velocity u .

Because of the differences of the constants of ion exchange under multiple repetition reactions of sorption and desorption weaker sorbed ions are pushed forward, there is a certain distribution of ions on the resin column, formed chromatographic zone - formed front chromatogram [6, 8]. Figure 1 schematically shows the distribution of the ions in solution and the ion exchanger at the ideal model sorption.

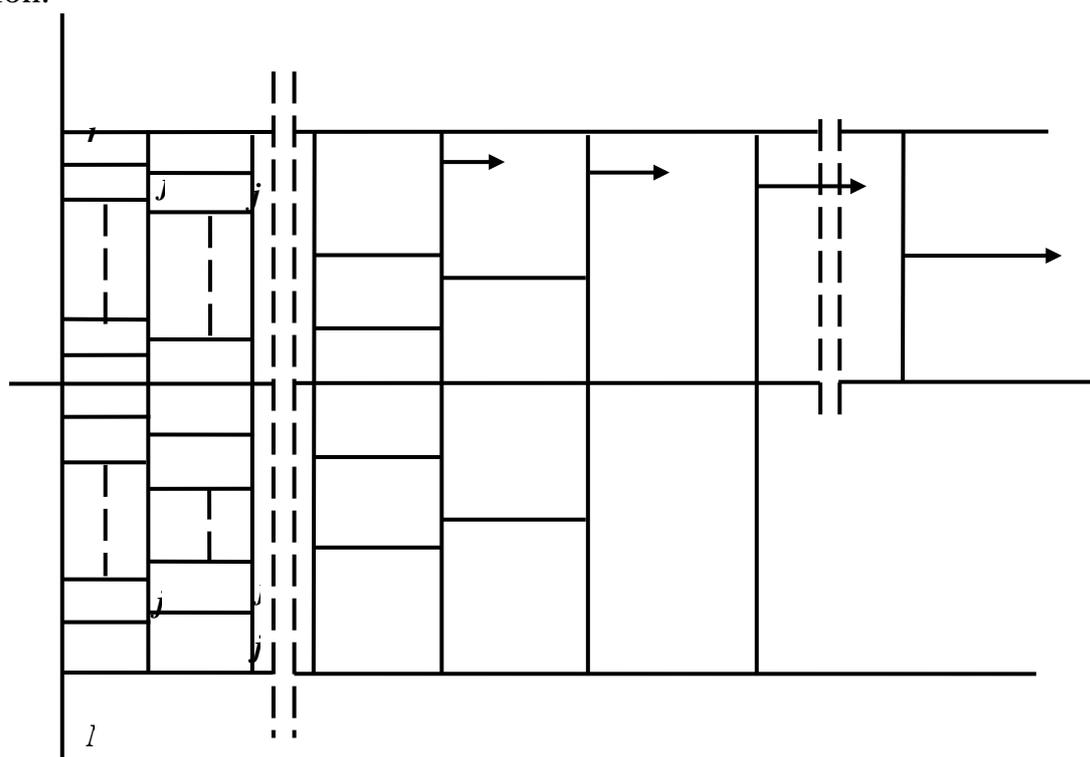


Fig. 1. Column frontal chromatogram at the ideal dynamics of sorption

Speed of boundaries zone is located in accordance with the general theory of sorption dynamics [1, 6] on the equations of balance of matter and the laws of the ion-exchange sorption (1) - (3).

Front solution displacing ion 1 moves with velocity of the mixture introduced u .

The speed of the last front "clean" area 2 is defined by the total concentration of ions n_0 in the incoming solution, since the concentration of ions of 2 in a solution and

ion exchanger $n_2 = n_0, N_2 = N_0$ then

$$v_2 = u \frac{n_2}{n_2 + N_2} = u \frac{n_0}{n_0 + N_0} \tag{5}$$

If one uses distributing ratio (4) then for zone 2 $h_2 = \frac{n_2}{N_2} = \frac{n_0}{N_0}$ and

$$v_2 = u \frac{h_0}{1 + h_0} \tag{6}$$

The speed of the anterior front of i -th zone is determined by the distributing ratio of ion having the highest sorption of all ions in this zone, i.e. in the i -th zone:

$$v_i = u \frac{h_{i,i}}{1 + h_{i,i}}, \tag{7}$$

where $h_{i,i} = \frac{n_{i,i}}{N_{i,i}}$ here and below the first index - the number of substances, the second - the number of zones.

The velocity of movement of the band boundaries (and hence the width of the mixed zone) ion concentration in the mixed zone (height "steps" in figure 1) depends on the ion exchange constants, and concentrations of ions in the source solution.

The concentration of the i -th ion in the latter, j -th zone is equal to the concentration of the ion in the solution, introduced into the column ion exchanger, $n_{i,j} = n_i^0$.

Structure frontal chromatogram depends on the affinity of the ions to the sorbent, the ratio of concentrations of ions in the source solution.

Fig. 2 allows you to compare the two front chromatographic process. Fig. 2, a shows a frontal radiochromatogramma solution of Rb^*Cl and $CaCl_2$, in fig. 2, б - radiochromatogramma $RbCl$ and $MgCl_2$ [9, 10].

The height of the "steps" on radiochromatogrammah proportional to the sum concentrations of labeled Rb^* ion in solution and ion exchanger. Because in both embodiments in the mixed zone concentration of the ion Rb^* in the solution is identical and equal to the concentration n_{Rb}^0 in the initial solution then ion Ca^{2+} strongly sorbs ion Mg^{2+} , $N_{Ca} > N_{Mg}$.

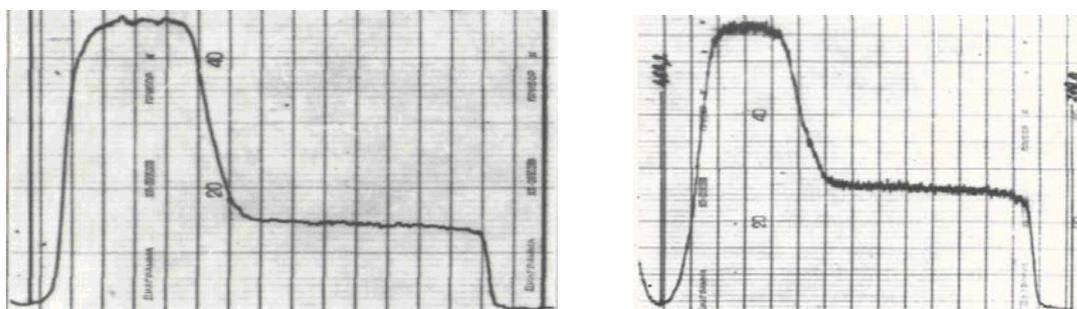


Fig. 2. Front radiochromatogrammy
a) solutions Rb^*Cl and $CaCl_2$; б) solutions Rb^*Cl and $MgCl_2$. Ionith
Dowex50Wx12 in H^+ -form. a) $C_{Rb}^0 = 0,05H$; $C_{Ca}^0 = 0,05H$; б) $C_{Rb}^0 = 0,05H$; $C_{Mg}^0 = 0,05H$

Fig. 3 shows radiochromatogrammy solutions Rb^*Cl and $MgCl_2$ at various ratios of ion concentrations ($C_0=0,1H$). The length of the mixed zone and clean zone Rb^* depends on the ratio of the concentrations of ions in solution.

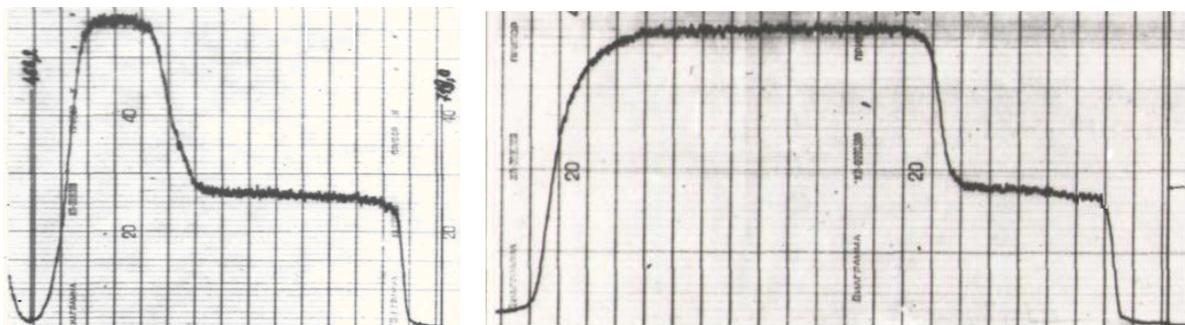


Fig. 3. Airbags Front radiochromatogrammy solutions of Rb^*Cl and of $MgCl_2$ different concentrations in column Dowex50 Wx12 exchanger in H^+ -form.
 a) $C_{Rb}^0 = 0,05H$; $C_{Mg}^0 = 0,05H$; б) $C_{Rb}^0 = 0,08H$; $C_{Mg}^0 = 0,02H$

Copy front radiochromatography 3 entering ions of $K^{++}-Mg^{2+}-S_2^{2+}$ shown in fig.4 [10].

The distribution of ion Rb in the resin column and in this case corresponds to the theory of sorption dynamics and chromatography.

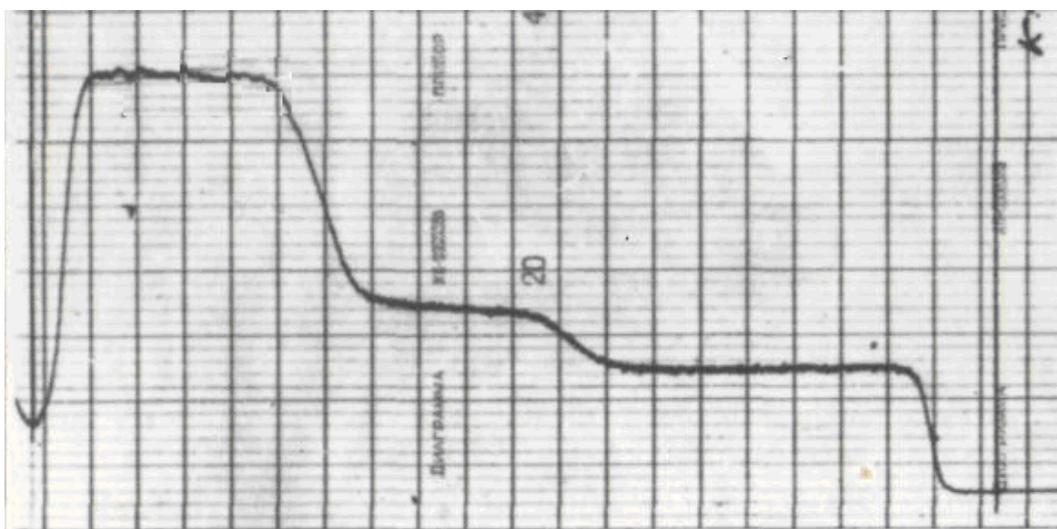


Fig. 4. Front chromatogram of solution K^*Cl , $MgCl_2$ and S_2Cl_2 in column Dowex50 Wx12 ion exchanger; $n_K^0 = n_{Mg}^0 = n_{S_2}^0 = 0,033H$

Figures 2-4 radiolabeled carries ion having the lowest affinity for the ion exchanger. In this case, you can clearly understand the distribution of substances in chromatographic zones in the resin column.

Measuring the speed of movement of the boundaries of zones confirm the correctness the formulas (5) - (7).

The velocities of movement of the ions in the mixed zone as defined by the "waves labeled" [8].

Since the velocity of the boundary zones of the chromatogram front are fixed, then in the increase the volume of initial solution introduced into the resin column, only increases the width of the chromatographic zones on a constant structure of the chromatogram.

Elution ion-exchange sorption dynamics. After the introduction of the resin into the column a mixture of ions microquantities of shared by column is washed with ion-macrocomponent.

If the ion 1 - macrocomponent, its concentration can be considered equal to the total concentration of ions:

$$n_1 = \sum_{i=1}^j n_i = n_0, \tag{8}$$

$$N_1 = \sum_{i=1}^j N_i = N_0. \tag{9}$$

Substituting (8) and (9) into (3), we obtain the equation of the linear sorption isotherms

$$N_i = \left(1/K_{1,i}^{z_i} \cdot h_0^{z_i/z_1}\right) n_i, \tag{10}$$

where $h_0 = \frac{n_0}{N_0} = \frac{n_1}{N_1}$.

This means that ions-microcomponents at elution sorption dynamics spread exchanger column independently of each other.

Narrow zones of each substance are blurred [7], but rate of movement the maximum sorption wave unchangeable [6, 8], distributing ratio is distributed $h_i = \frac{n_i}{N_i}$:

$$v_i = u \frac{h_i}{1 + h_i}. \tag{11}$$

Elution chromatography has become very popular for the analysis of complex mixtures of substances due to the success of high performance liquid chromatography.

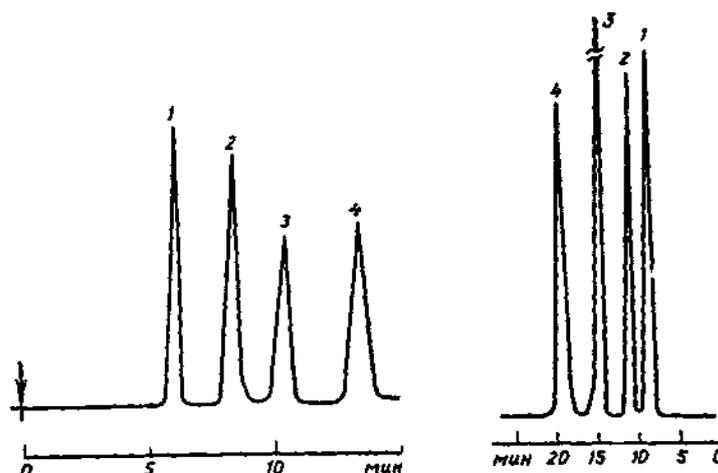


Fig. 5. Elution ion exchange chromatograms obtained by HPLC [5].

5, a - the chromatogram catecholamines (1 - noradrenaline, 2 – adrenaline, 3 – dopamine, 4 - metildopamin); 5, b - chromatogram inorganic anions (1- phosphate, 2 - chloride, 3 - nitrate, 4 - sulfate)

Modern technology makes it possible to separate and identify substances in very small quantities. In the experiments shown in Fig. 5, the sample volume is only 20 μl [5].

Fig. 5 also shows the time required to separate the mixture.

Conclusion. To reveal the the basic regularities of formation of ion-exchange front and elution chromatograms used the ideal model of sorption in which the studied equilibrium sorption dynamics in the absence of action kinetic and quasidiffusion factors of blurring fronts ion exchange - the boundaries of the chromatographic zones.

Radiochromatogrammy which are given in the article convincing evidence the advisability of such a model dynamics of sorption for describes the real chromatographic processes.

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STABLE BIOCIDES MATERIALS

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Abstract: The main aim of this work is to show the possibilities of creation really stable paper-like materials for food, packing and other industries.

Key words: basalt fiber, composite, cellulose, paper

Introduction. There is a problem actual for many kinds of industries: how to get stable, resistant media to protect from mould fungi and microorganisms for some time. As a rule, mould fungi live by the resource of basis of plastic mass, caoutchouc, paints, etc. We have several another media affected by this kind of threats like cellulose which is the most frequent carbohydrate in the Nature.

Input data and methods. The aim was to obtain the thin paper-like biocide material which consists of two types of fiber: cellulose and basalt in different proportion. As well, we used additional surface processing with starch and polyvinyl spirit (PVS) 1% of fiber weight. Electrokinetic potential of basalt and cellulose fiber was measured. Recharging of cellulose fibers was made by aluminium sulphate.

There were two stages of investigation: visual and physical-mechanical properties measurement.

Anti-fungi resistance was checked by three media: liquid mineral Van-Interson; on the surface of solid Chapek and in wet cell with relative humidity of 98%. Investigations were done during 150 days. The accretion extent was rated by 10-mark scale.

Table 1

Physical-mechanical and biocide materials properties

Cellulose fiber composition	Breakin g length, m	Breakage	Capillary absorption	Fungi growth		
				Liquid	Hard surface	Wet cell
1	2	3	4	5	6	7
20% cellulose fiber	78	32	48	3	3	3
	84	46	54	2	2	2
20% cellulose fiber+starch	158	42	44	7	7	8
	174	58	52	6	6	7
20% cellulose fiber+PVS	164	58	38	2	3	3
	186	70	42	2	2	2
50% cellulose fiber	1902	1400	56	7	9	10
	2700	1480	58	6	8	9
50% cellulose	2100	1514	42	7	8	9

fiber+starch	2850	1682	46	6	7	8
50% cellulose	2230	1580	36	3	4	4
fiber+PVS	2920	1616	42	2	3	3

Aspergillus oryzae, *Batrachium piluliferum* and *Chaeromium affine* were used. Non-active fungi were mixed with active ones, see table.

As one can see there was the strong effect of surface recharging.

PVS has reduced fungi reproductive functions very much.

Thin paper-like material based on basalt fiber (BAS) was used in composition with cellulose fiber and its ether – carboxymethylcellulose. Sorbic acid was used as fungicide-active medium. There are two ways of its insertion into the composition: surface blotting of material's base by water or spirit acid solution or water dispersion surface covering.

The fact that during spirit vaporization acid crystals growth was established. It leads to acid tearing from surface.

We used sorbic acid infliction method from water suspension with binding material (methylcellulose). As it was found out large amount of bindings (more than 10% of sorbic acid weight) decreases the area of fungi and microorganisms oppression because of fungicide activity reduction. So we used suspensions of 5-7% of methylcellulose. Sorbic acid contains dispersed particles with dimension up to 300 μm so pulverization in ball grinder was used as well to obtain particles with 15-20 μm of average.

Then obtained compositions were processed by 5% bactericide and dried up with 20-60 °C. Investigation includes bactericidal activity against the pathogenic microorganisms *Staph. Aureus* and *E. Coli* (*staphylococcus goldish* and *colon bacillus*). As bactericidal reagents nitrofurans were used (furalgin, gekacide) which decrease bacteria growth. Bactericidal properties were investigated by suspension infliction onto material's surface and putting in meat-pecton solution. Results are shown in the table.

Table 2

Biocide materials properties

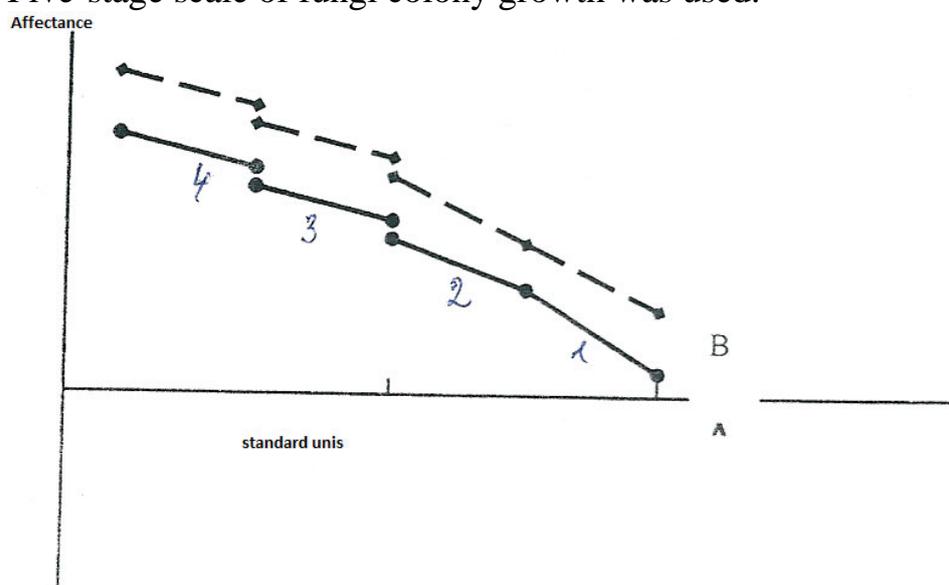
Composition	Microorganisms oppression area diameter, mm	
	<i>Staph. aureus</i>	<i>E. Coli</i>
50% SFI + 50% basalt + furalgin	12	15
50% SFI + 50% basalt + sorbic acid + furalgin	28	42
50% KMC + 50% basalt + gekacide	24	0,8
50% KMC + 50% basalt + sorbic acid + gekacide	52	34

The most effective antibacterial properties were obtained with basalt fiber based material with gekacide and sorbic acid inflated. It may be explained by the fact of sorbic acid fractional structure which leads to better fiber covering.

This investigation shows the possibility of usage of thin paper-like material with vegetative fibers composition (linen and cellulose) filling by Na-bentonite to obtain the biocidal materials.

There were the series of specimens consisting of 0,75 mcm diameter basalt fiber along with others (linens, sulphite and sulphate) in composition 1:1 as well as such compositions with 10% fillings (Na-benthonite). We used artificial ageing by thermostatic procession with 105 °C temperature during 72 hours. The results are shown on the picture. The following fungi cultures were used: *Trichoderma lignorum*, *Myrothecium verrucaria*, *Acrostalagmus cinnabarinus*.

Five-stage scale of fungi colony growth was used.



Picture 1. Comparison of basalt fiber composition 1: linen; 2: sulphate cellulose fiber; 3: cellulose sulphite fiber; 4: sulphate fiber with Na-benthonite; 5: sulphite fiber with Na-bethonite; A: affection before; B: affection after aging.

Dotted line characterized artificial aging. Materials' properties are presented in the table.

Table 3

Physical-mechanical materials properties

Composition	Break length, m	Break, ch.d.p.	Air current resistance, mm.rt.st	Capillary saturation	Free outflow time, min.
50% basalt + 50% sulphate cellulose	1902	1068	18	56,4	1,00
50% basalt-	1852	968	16	52,2	0,92

cellulose + 50% sulphite fiber					
50% basalt + 50% linen fiber	2215	1178	18	58,0	0,98
Basalt + sulphate fiber 90:10% + filler	1890	902	24	50	0,88
Basalt + sulphate fiber + filler 10%	1800	884	20	52	0,76

Conclusions.

1. Sorbing characteristics of clay materials increase after acid and thermal processing. Materials which consists of 85% basalt fiber and 15% Montmorillon have increased the stability after acid processing.

2. Clay materials may be used as fillings during the production of thermo-stable materials of inorganic fiber, basalt for example.

3. Practically all of used materials were affected by various types of fungi in different levels.

4. This composite material may be recommended for usage in the normal and high-temperature media for cosmic, food and medical industries i.e. where the problem of products safeness is actual.

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