

Mathematical Modeling of Salt Leaching of Saline Soils

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Abstract: Based on the solution of the equation of damping oscillatory process in mechanics and manufacturing simulation technology washing obtained calculation model leaching rates of saline soils and made the validation of the obtained mathematical models to study environmental reconstruction of saline lands.

Key words: Development • Salinization • Soil • Mode • Method • Process • Model • Modeling • Leaching • Washing • Filtration • Water loss • salt recoil, filtrate, water supply.

INTRODUCTION

The present level of development of a quantitative theory in the modern science of soil begin to allow the creation of models for quantitative and qualitative description of the soil-forming processes and hydro geochemical, using as a basic unit of mathematical modeling study. One of the main difficulties in the development of these models - the large number of parameters that need to be taken into account when considering the impact of environmental factors on the major components of soil-forming process, the formation of saline soils in the landscape systems. It is important that the constructed models reflect the major link between the most significant factors in the formation and functioning of the hydro geochemical processes and reproduction of the main components.

Since any model cannot reproduce the complex dynamics of salinization and desalinization, the task was to simulate those interactions between environmental factors and the natural processes that obey strictly the laws of nature. The development of dynamic models of the processes of salinization and desalinization of soils will explore the impact of natural environment on the most important processes of soil formation, to explain a number of features of the impact of these conditions on hydro geochemical conditions of soil formation, soil study the adaptive responses to changes in environmental conditions.

The aim of this work - to develop a mathematical model based on the leaching of salts solutions of damping oscillatory process in mechanics and flushed out of saline soils in cycles, providing a harmonic oscillation movement of water and salts in the soil mass, are the theoretical basis for the improvement of saline soil washing technology.

Methodology and Object of Research: Research processes salt recoil when flushing saline soils is based on the physical and mathematical modeling of soil and ecological processes, system dynamics analysis of moisture and salt transport in porous media.

Summarizing the experience of many years of leaching saline soils carried out in different conditions scientific and industrial organizations; V.R.Volobuev theorized derivation of the equation for the calculation of leaching rates [1]. In fact, the amount of water N filtered into the soil over time t , can be expressed as $N = V \cdot t$, where V filtration velocity - constant. This gives grounds to write:

$$-d[S]/dN = k[S] \quad (1)$$

$$-d[S]/[S] = k dN \quad (2)$$

Integration of this equation gives:

$$-\ln[S] = k \cdot N + C \quad (3)$$

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Taking the boundary conditions for salt leaching rate equal S_H and S_o (where S_H and S_o - initial and operating) and wash the norm ($N = 0$ and N that is $S = S_H$: when $N = 0$ and $S = S_o$ under $N \neq 0$), then we can write:

$$-\ln[S](S_o/S_p) = k \cdot N_o^N + C \quad (4)$$

After a series of transformations (4), we have

$$\ln(S_H/S_o) = k \cdot N \quad (5)$$

In the transition from natural logarithms to decimal dependence has the form:

$$2,303 \lg(S_H/S_o) = k \cdot N \quad (6)$$

as $\ln = 2.303 \lg$:

Solving the equation $2,303 \lg(S_p/S_o) = k \cdot N$ with respect to N , we obtain:

$$N = (2.303/k) \cdot \lg(S_H/S_o) \quad (7)$$

Easy to see that $2.303/k$ is a conditional factor reflecting the ability of the soil to the impact of salt, that is, when $2.303/k = \alpha$, we obtain the formula V.R. Volobuev. V.R. Volobuev according to the disclosure $N = \alpha \lg(S_H/S_o)$ found previously based on the aggregation of a large development and production material and withdrawal of its theoretically refers to the laws of chemical reaction kinetics [2].

The basis of this theory is the fundamental position of Guldberg and Waage [3, 4], according to which the rate of a chemical reaction is proportional to the active masses of the reactants. Application of this principle leads to a general expression for the rate of reactions in which each active mass concentration is raised, appropriate values of its coefficient in the reaction equation. In this case, the chemical reaction rate equation of the first order differential equation is written:

$$d[A]/dt = k[A] \quad (8)$$

where $d[A]$ - the change in concentration $[A]$ in an infinitely small time interval dt ; k - coefficient depending on the nature of the raw materials and other experimental conditions.

After a series of transformations and express the result in decimal logarithms, the equation of chemical reaction of the first order (8) will have the form:

$$2,303 \cdot \lg \left\{ \left[A_o / [A] \right] \right\} = k \cdot t \quad (9)$$

where $[A_o]$ - the original amount of the substance; $[A]$ - the amount of substance has changed over time.

Thus, the leaching of salts can be represented as the simplest form of the chemical reaction of the first order, assuming that the rate of leaching of salts V is a function of the amount of water N involved in the process, which has been the subject of research.

When washing any soil volume (example, 1 m³) it is saturated to field capacity ticks, i.e. following one after the other portions of water equal to the volume of water loss ($IIB - MI$), then the current downward (vertical filtering) with each volume of fluid loss from the outgoing soil taken out dissolved salts in this volume (ΔSi) and salts in the soil margin decreases exactly as ($S_{ni} = S_H - \Delta Si$) as the salts contained in the amount of water loss. Therefore, with the decrease of the volume of water loss each ordinary stock of soluble salts in the soil will be washed with a volume less and less and at some point reach toxic limit (S_{don}).

Thus, the number of volumes of fluid loss (n) multiplied by the volume of fluid loss will be the norm of the filtrate (Nn) needed to reduce the stock of salts in the soil from the source (S_H) to limit (S_o). This is the simplest mechanism for removal from the soil reserve of soluble salts by washing [5].

Object of research - saline lands Almaty and Zhambyl regions of Kazakhstan as a special form of rationalization of human activities to ensure environmental sustainability and food security of the population.

RESULTS AND DISCUSSION

Widespread saline soils and the need to learn at their cost, large volumes of water to rinse capital requires the study of the mechanism of the process of return and improve salt leaching technology, as well as methods for calculating leaching rates, ensuring the most efficient and economical use of water. As is well known, the study of the kinetics of chemical reactions, the intensity of soil desalinization under leaching can be strengthened by changing the speed of infiltration water flow by varying the amount of water supply to one cycle and inter-irrigation periods (Table 1) [6].

Results of experimental materials and systems analysis experience having washes at their various modes showed that the longer the interaction of the wash water with the soil, the more balance is achieved between the

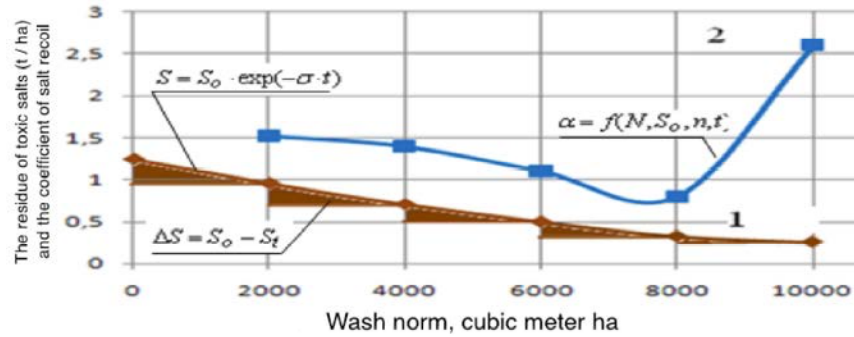


Fig. 1: Dynamics of soil desalinization (1) and the salt recoil factor (2) by washing in cycles

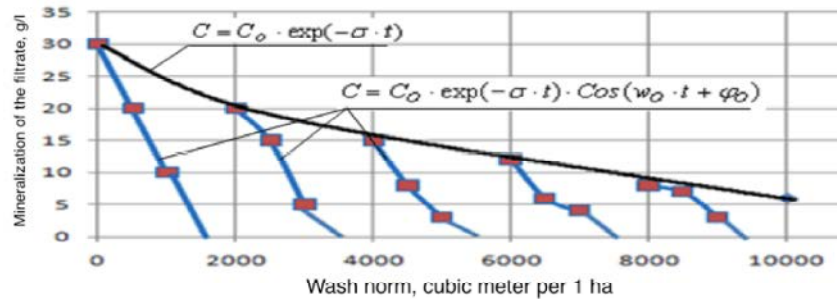


Fig. 2: Dynamics of infiltration water mineralization during leaching on cycles

Table 1: Change of salt regime of soils under different schemes of technological leaching

Leachingrequirement	One-time rate of leaching requirements	Deposits of salt, t / ha		Amount of washed salts (ΔS),t / ha	Saltrecoiffactor
		Initial - S_u	Residual, S_o		
1	2	3	4	5	6
Almatyoblast, Tentekarray					
Alkali- sulphate salinity (1.273% by weight of dry soil)					
18000	1000	227.4	57.94	169.46	3.03
	2000	227.4	18.08	159.32	3.44
	3000	227.4	79.66	147.74	3.95
24000	1000	225.6	47.53	181.07	3.40
	2000	225.6	53.13	172.17	3.84
	3000	225.6	65.30	160.30	4.46
30000	1000	220.7	28.85	191.85	3.40
	2000	220.7	47.60	173.10	4.50
	3000	220.7	64.96	155.79	5.56
Chloride-sulphate salinity (1.378% by weight of dry soil)					
18000	1000	234.5	58.63	175.87	2.99
	2000	234.5	64.48	170.02	3.21
	3000	234.5	73.28	161.22	3.56
24000	1000	230.6	38.68	191.92	3.10
	2000	230.6	52.07	178.53	3.72
	3000	230.6	61.00	169.60	4.16
30000	1000	237.4	23.13	208.27	3.30
	2000	237.4	42.24	195.16	4.00
	3000	237.4	49.52	187.88	4.41

Table 1: Continue

Leaching requirement	One-time rate of leaching requirements	Deposits of salt, t / ha		Amount of washed salts (ΔS), t / ha	Saltrecoefficient
		Initial $-S_0$	Residual, S_0		
1	2	3	4	5	6
Zhambyloblast, Tashutkel array					
Chloride-sulphate salinity (0.801 % by weight of dry soil)					
6000	1000	115.34	69.98	48.77	2.77
	2000	115.34	74.44	44.31	3.15
	1000	83.98	51.26	37.16	3.40
	2000	89.90	58.42	35.92	4.08
8000	1000	115.34	59.89	59.99	2.73
	2000	115.34	63.30	56.68	3.07
	1000	72.26	44.06	34.12	3.84
	2000	76.63	48.89	33.66	4.30
10000	1000	115.34	59.04	61.98	3.44
	2000	115.34	62.68	58.34	3.78
	1000	74.42	43.63	34.12	4.75
	2000	71.82	44.71	33.66	4.82
Chloride-sulphate salinity (1.223 % by weight of dry soil)					
6000	1000	176.11	113.18	66.34	2.92
	2000	176.11	115.80	63.72	3.29
	1000	114.88	77.47	41.85	3.37
	2000	117.44	83.07	38.07	3.72
	1000	77.86	54.14	27.69	3.52
	2000	84.23	64.38	23.82	4.12
8000	1000	176.11	93.16	87.49	2.90
	2000	176.11	94.07	86.52	2.95
	1000	94.75	64.51	36.16	3.66
	2000	95.59	65.31	36.20	3.71
	1000	64.90	50.68	19.52	4.44
	2000	65.70	50.82	20.18	4.44
10000	1000	176.11	92.02	87.77	3.54
	2000	176.11	91.74	86.06	3.54
	1000	94.03	64.22	37.21	4.56
	2000	93.80	65.58	35.52	4.67
	1000	64.79	49.96	21.45	5.48
	2000	66.20	50.24	22.58	5.51

concentrations of salts in the soil solution and the filtrate and the stronger the wash water is saturated with salts, which eventually increase the salt out of the soil, i.e. quantitative indicators of mineralization dynamics of seepage water, depending on the speed of their flow in the wash column and the degree of soil salinity.

It was found that the movement of water in reclaimed depth carried on damped oscillatory motion of the curve (Figure 1) [2].

This fact is realized in practice by leaching cycles, when the movement of water in reclaimed depth can be considered as an oscillation (when the washing is repeated regularly over time), taking place in a system with one degree of freedom and are in a state of stable equilibrium, a small

deviation from state when a harmonic oscillation occurs due to the fact that the body of the force, returning it to its position of equilibrium, that is, $R = -k.x$ where k - coefficient of restitution filtration properties reclaimed depth; x - path length of the wash water (Figure 2) [6].

Damping oscillatory process is widespread in nature and technology and this kind of movement is accomplished by the power of resistance $F = -\mu.(dx/dt)$ and strength of recovery $R = -k.x$. The minus sign indicates that these forces are directed opposite to the motion of the body, i.e. the movement of the leached water unreclaimed depth depends on the force of gravity. Then the movement of water in the soil-ground reclaimed depth described second order differential equation [6]:

$$m(d^2x/dt^2) = -k \cdot x \quad (10)$$

where m – mass of leaching requirements (one-time leaching requirement); d^2x/dt^2 – acceleration of rinsing water in reclaimed depth; k – recovery coefficient of filtration properties of reclaimed depth; x – the length of the path of the wash water.

Therefore, in this case, the acceleration of wash water in the soil ($m(d^2x/dt^2)$) proportional to the displacement and work in the opposite direction and is the strength of the recovery, which is characterized by losing the structure and swelling of the soil.

In real systems, besides a restoring force always forces act of another type, for example, the frictional force (resistance) – $F = -\mu(dx/dt)$ wherein μ – coefficient of friction (resistance). If they reach a considerable size, their influence can significantly disturb the harmony of vibrations. In this case, the equation of motion of water in meliorated thicker with intermittent water delivery differs from the equation of motion of water in reclaimed depth constant whose hydrogen-described differential equation of damped oscillations:

$$m(d^2x/dt^2) + \mu(dx/dt) + k \cdot x = 0 \quad (11)$$

force proportional to the velocity of water in reclaimed depth, that is $\mu(dx/dt)$ – resistance force, which are characterized by the friction of water with soil particles initially and later – on the water film covering the particles [88].

Since the change in the energy of the oscillating body should be equal to the work of frictional forces, then an elementary move dx body energy changes by:

$$-\mu \cdot (dx/dt) = -\mu(dx/dt)^2 dt = -k \cdot V^2 \cdot dt \quad (12)$$

or fluid flow obeys Darcy law it is determined from formula [7]:

$$F = \frac{v \cdot V \cdot \rho}{k \cdot \rho} [m_o \cdot f(x) \cdot dl] \quad (13)$$

where v – the absolute viscosity of the fluid ($g \cdot cm / sec$); V – filtration rate (cm / sec); k – permeability (cm^2); ρ – specific density (g/cm^2); m_o – porosity; $f(x)$ – cross-sectional area of groundwater flow (cm^2); dl – the thickness of the elementary section (cm). Then, the work done by the friction forces at the site dx , will be equal $A_i = F \cdot dx$, and $dx = V \cdot \Delta t$ where $\Delta t = t_2 - t_1$ and $\rho \cdot \mu \cdot f(x)$ is the mass of the liquid product in a volume element thickness dl , the value A_i will be equal to:

$$A_i = \frac{v \cdot m \cdot V^2 \cdot \Delta t}{k_i \cdot \rho} = \frac{m \cdot V^2 \cdot \Delta t \cdot g}{k \phi} \quad (14)$$

where $k\phi$ – coefficient of filtration; $v/\rho \cdot k_i = g/k\phi$; g – the acceleration of gravity.

If friction has little effect on the nature of the oscillations, we can assume that during the leaching rate period is extracted according to the law:

$$V = V_o \cdot \cos(w_o \cdot t + \phi_o) \quad (15)$$

then

$$m(d^2x/dt^2) + \mu[V_o \cdot \cos(w_o \cdot t + \phi_o)]^2 dt + k \cdot x = 0 \quad (16)$$

If, m , μ , k is indeed, when $\mu - 4 \cdot m < 0$ the roots $S = (-\mu \pm \sqrt{\mu^2 - 4 \cdot m \cdot k}) / 2 \cdot m$ will be complex. In this case, the general solution of the equations of motion of fluid in reclaimed depth is:

$$X(t) = X_o \cdot \exp(-\sigma \cdot t) [\sin(w_o \cdot t + \phi_o)] \quad (17)$$

where ϕ_o – the initial phase of the filtration rate, hail; $\sigma = -\mu/2 \cdot m$ – the coefficient of damping velocity amplitude filtering; $w_o = \sqrt{\mu^2 - 4 \cdot m \cdot k} / 2 \cdot m$ – own circular frequency or the angular frequency of damped oscillations.

Equation (17) is a modification of the formula V.R. Volobuev [1] obtained on the basis of solutions of equations of the rate of chemical reactions.

To identify the impact of the quantitative relationship saline soils with wash water filtration rate is plotted from experimental data paired values α of the coefficients and velocities V for each soil type. Obtain three separate series of points that are well-approximated curves (Figure 3), which characterize the salt out of soil – respectively light, medium and heavy mechanical composition.

Thus, controlling the infiltration flow in flushed thicker, you can change the intensity of the removal of salts from the washed column. This is achievable when you change the leaching by changing the volume of water per cycle and inter-irrigation periods, which is supported by many researchers [8-10], that is, with different methods of water supply of the same volume, we can achieve different effects.

As an illustration of the proposed method we present the results of experimental leaching data [8] carried out on the monoliths (Table 2).

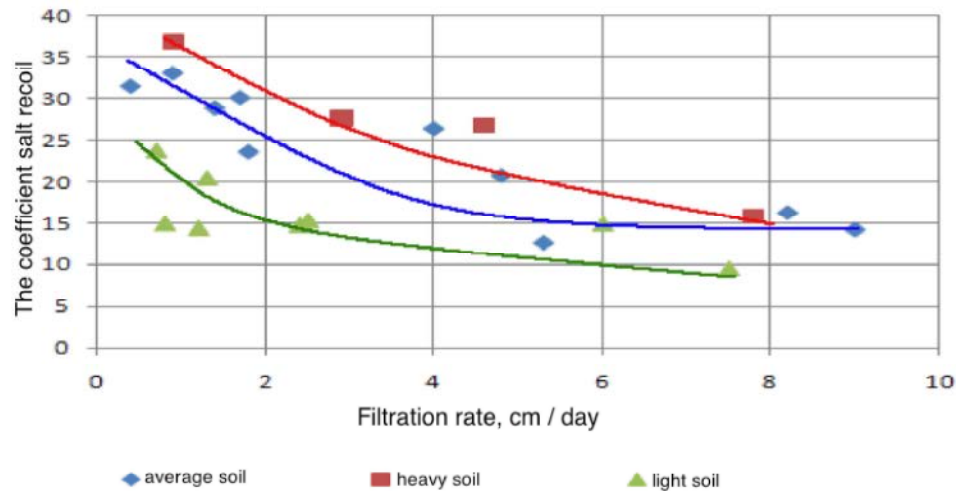


Fig. 3: Dependence of the impact of salt recoil from the filtration rate

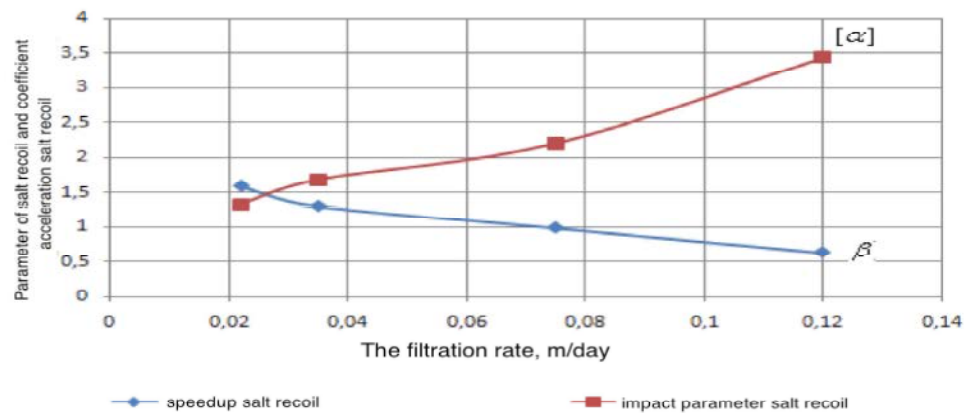


Fig. 4: Dependence of the parameter salt recoil ($[\alpha]$) and acceleration rate of salt recoil (β) from the wash water filtration rate (V).

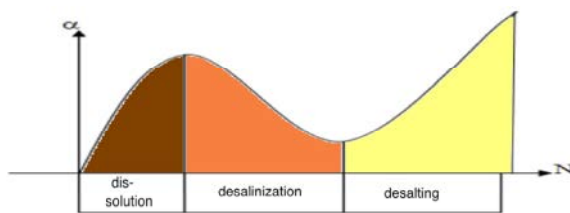


Fig. 4: Dependence of the parameter value from the volume of salt leaching rates (x-axis - setting salt recoil; ordinate axis - leaching rates, m³/ha)

As can be seen from Table 2, a prerequisite to reduce costs of water takeout salts meliorated thickness is to reduce the flow of water in a porous medium by changing irrigation technology, which reduces the size of leaching rates by more than 2 times.

Shown in Figure 4 curves $\alpha = f(V\phi)$ and $\beta = f(V\phi)$ based on the data in Table 2 show that the maximum intensity of salt removal from flushed thickness is achieved when the filtration rate of washing water 0.005-0.02 m / day.

This phenomenon has a clear physical meaning: the increasing rate decreases the contact time of each portion of water with soil salts, therefore, the water has time to dissolve fewer salts. In addition, more intensive removal of salts in slow outflow filtrational consequence of the mechanism of the leaching process and the coefficient β is meaningful acceleration factor salinity impact.

Therefore, the flow rate of washing water in reclaimed depth alters the duration of contact with the solvent and salts have a decisive influence on the speed and acceleration of soil desalinization.

Table 2: Dependence of the impact of salt dissolution rate and the rate of infiltration flow

Washing technology	Infiltration flow velocity, m / day	Salt content, t / ha		[α]	$\beta = \frac{[\alpha]}{\alpha}$	The actual leaching requirement, m3/ha
		S_H	S_k			
250 m / hadaily	0.022	151.1	81.04	1.31	1.68	3500
500 m / ha after 3 days	0.035	146.3	83.20	1.61	1.35	4000
1000 m / ha after 6 days	0.075	165.5	83.70	2.20	1.00	6500
2000 m / ha after 12 days	0.120	163.4	85.10	3.28	0.67	9300

In the process of flushing saline soils occur following natural phenomena (Figure 4) [11]:

- The process of dissolution - a period of complete saturation of the soil layer or fill layer being washed with water, that is the time of the leading edge of infiltrating water from the surface to the bottom of the front leached soil and dissolving crystalline salts "active" and "dead-end" pores of the soil, where the parameter salinity impact $\alpha \rightarrow \max$;
- Desalting process - during displacement active saline infiltrated with water, i.e. the time of passage of the trailing edge of water flushed through the lower edge of the soil being washed, wherein the parameter recoil salt $\alpha \rightarrow \max$;
- Demineralization process - during passive displacement of saline from the washed soil with infiltrating water where the salinity impact parameter is $\alpha \rightarrow \max$.

Presented by physical and chemical processes and thermodynamics of soil solutions in the annex to the issues flushing saline soils links well with the available experimental data obtained by flushing saline soil landscape systems Almaty and Zhambyloblasts of Kazakhstan. Matches the theoretical conclusions and results of long-term experiments generalization determines their appropriateness for the dual use and if necessary to clarify the parameters characterizing the rate of the chemical reactions between solid and liquid substances.

Thus there is a set in which case the mean value of the coefficient of salt recoil (α) logarithmic functions leaching of salts in surface water filtration in the soil accurately describes them: the systematization of processes or by separate processes.

Physical-Mathematical Model of Salt Recoil of Saline Soils: Disclosure of the nature of dependence $\alpha = f(V)$ turn to the laws of the

kinetics of chemical reactions. If the salt in the soil, considered as solids, during the washing of the reactions occurring between salts and water, you can imagine yourself as the simplest form of chemical reactions of solids from liquid.

Upon dissolution of the salt formed on its surface boundary layer (film) of water associated with the dissolved salts, thickness δ . At the external border of this film, directed to the pores, the salt concentration is equal $C(x,t)$ and its inner boundary of the contact with the salt in the solid phase, the concentration is equal to the limit of saturation of the solution C_H .

As shown by Noyes (Noyes, 1847), a uniform distribution of the particles of the dissolved substance in a solvent by moving the dissolution rate is proportional to the surface of its contact with the water and the differences between the available concentration of the solution and its concentration saturation:

$$\frac{dC}{dt} = \frac{D \cdot \theta}{\delta \cdot W} (C_H - C) = \gamma (C_H - C) \quad (18)$$

where dC is the increase in concentration over time dt ; θ - the surface of a solid body.

As shown by Brunner (Brunner, 1904), $\gamma = (D \cdot \theta / \delta \cdot W)$ if D - diffusion coefficient of rolling in a solution, δ - the thickness of the liquid layer that covers its crystals; W - the volume of solution for the reactions of solids with substances that are in the solution (product of the reaction takes place in the solution and hence, the conversion is only on the outer surface of solids) rightly equation, found Nerist (1904):

$$\frac{dC}{dt} = \frac{D \cdot \theta \cdot C}{\delta} \quad (19)$$

where in D - the diffusion coefficient of the solute, reacts with the solid δ - liquid layer thickness, the outer surface of the encapsulating substance, C - concentration of reactants in solution dC - increasing the amount of product per reaction time dt .

In deriving the Nernst equation assumed that the reaction rate is infinitely large compared to the diffusion rate of reactants, so that the concentration of the latter on the misused solid surface can be practically nil.

Equation (19) indicates that under these assumptions, the rate at which the solid is destroyed by reaction with the dissolved substances is determined exclusively by the speed with which the molecules and ions which react with the solids reach the surface by diffusion.

The diffusion equation describing the amount of solute dC diffusing per time dt in the direction from higher concentrations to lower the solution through q drop proportional to the concentration of the cross section in the direction dC/dt of the diffusion section q and can be represented as:

$$dC/dt = -D \cdot q \frac{dC}{dx} \quad (20)$$

When comparing this equation with equation (18) shows that the determining factor for the rate of dissolution is the rate of diffusion of a solute in a solvent, if, as is usually the case, the equilibrium dissolution of the substance on the surface is set so quickly that the solvent layer is constantly filled with the soluble substance.

The diffusion rate is determined based on Fick's law of diffusion (18). If instead q we substitute a solid surface and instead dC/dt of concentration falling reactive solutes in the fluid $(C - \theta) / \delta = C / \delta$ and enveloping layers to integrate the equation (20), assuming that the solid surface is equal to $C_t = (n_o - n_t) / W$ (where n_o - the amount of reagent present in the bulk solution W to the start of the experiment and n_t - the amount of reagent expended by the time t), we obtain the formula:

$$\ln \left[\frac{n_o}{n_o - n_t} \right] = D \frac{\theta \cdot t}{\delta \cdot W} \quad (21)$$

It is easy to notice that the resulting formula (21) is quite similar to the formula V.R. Volobuev (7). This equation allows us to calculate the rate of dissolution of the solid dissolved under the influence of any reagent if experimentally determine the value δ at the selected speed mixing. If we consider that, $k = D / \delta \cdot W$ and $C = n / W$ from the comparison of equations (18) and (19) that the speed of dissolution of the solid in the pure water

and the reaction rate of a saturated aqueous solution of that substance with another solid equal to one another (Brunner, 1940).

Thus, the parameter δ depends on the stirring speed and the controlling factor is the rate of dissolution of the solid, that is, the rate of chemical reactions. If leaching of salts can be represented as a simple chemical reaction, the rate of leaching of salts is a function of the amount of water (N) involved in this process, as well as the parameter (D - diffusion coefficient of the solute reactive solid) characterizing the transport of salt and stirring speed. In light of the above theoretical explanation patterns leaching salts from the soil on the basis of the law of chemical reaction kinetics, the parameter determining the ability of the soil to salinity impact, acquires an independent meaning. In this respect, special attention should be given to a comparative analysis of data on soil washing, characterized by different physical and chemical properties and leaching technology [8-10]. Analysis of the results of these leaching shows that the rate of salt recoil depends on the chemical properties of saline soil, which affects the ability of the soil migration (α) and flow rate of infiltration (V_ϕ). As the results of experimental studies R.K. Bekbayev [8] and J.E. Mitronkin [10], for all types of soil salinity specific recoils (α) decreases with increasing flow rate of infiltration. This phenomenon has a clear physical meaning: the increasing rate decreases the contact time of each portion of water with soil layers, consequently, the water has time to dissolve fewer salts.

As shown by M.G. Bazhenov [11], the diffusion coefficient $D = \lambda \cdot V = \alpha \cdot V$ (where λ - is the dispersion parameter). The dependence of the coefficient of convective diffusion filtration rate was known to hydrogeologists long ago and received confirmation for soils. It provides a detailed decode dependence of salt recoil not only on the physical and chemical properties of saline soils, but also on the flow rate of infiltration.

Taking in equation (21) the amount $\ln[n_o / (n_o - n_t)]$ equal to the logarithm of the relationship initial salinity, that is $\ln[S_i / S_o]$, we obtain:

$$V \cdot t \cdot \lambda = \frac{\theta}{W \cdot \delta} \ln[S_i / S_o] \quad (22)$$

As leaching norm is the product of the infiltration rate « V » leaching duration « t » that is $N = V \cdot t$ the formula (22) can be written as:

$$N = \left[\frac{2.303}{\lambda \cdot W} \right] \frac{\theta}{\delta} \ln[S_i/S_o] = \frac{\alpha}{\beta} \lg \left(\frac{S_i}{S_o} \right) \quad (23)$$

Taking into account the physical sense of the work that stands before the logarithm can be written as:

$$\alpha = \left[\frac{2.303}{\lambda \cdot W} \right] = \frac{V \cdot t}{\lg(S_i/S_o)}, \frac{1}{\beta} = \frac{\theta}{\delta}, [\alpha] = \alpha / \beta \quad (24)$$

where α -salt recoil coefficient; β - is a parameter that depends on the rate of mixing.

With regard to (24) the formula (23) has the form:

$$N = [\alpha] \ln[S_i/S_o] = \frac{\alpha}{\beta} \lg \left(\frac{S_i}{S_o} \right) \quad (25)$$

Thus, a parameter β depending on the speed of the solid dissolved in chemical reactions, but also the accelerator salt recoil soil by washing saline soils and makes sense acceleration factor salt recoil. Dependence of the rate β of infiltration flow V_ϕ approximated by the formula:

$$\beta = 2.02 \cdot \exp(-9.57 \cdot V_\phi) \quad (26)$$

As have shown results of the experimental materials for washing of saline soils [5; 8-10] and the above theoretical explanation parameter $[\alpha]$ in the formula V.R. Volobuev is a complex characteristic and stands as the product of salt recoil (α) and the acceleration factor salt recoil (β). The latter depends on leaching technology (fractional submission of leaching norm and drainage) and salt recoil coefficient (α) from salt content in the soil and is constant leaching, which can be defined in much less time and labour compared with parameters $[\alpha]$. The constancy β for the leaching of salts from the soil predetermines the possibility to limit the experiments, since the rate of acceleration of salt recoil does not depend on the salt content of the soil as a function of the velocity infiltration flow.

In the acute shortage of water wash the above mentioned dependence (25) allows to determine the optimal flow rate of infiltration at which water consumption for washing is the smallest and reclamation opens up new possibilities in desalinization,

as well as their base can develop technologies flushing saline soils, ensuring environmental sustainability and safety of the natural system [12-17].

CONCLUSION

The intensity of soil desalinization is a dynamic process and depends on the degree of instability in the process of hydraulic flushed thicker soils. At this rate of desalinization predetermined level reduction mineralization filtered water, which is characterized by the oscillation damping coefficient mineralization filtered water - " $[\alpha]$ " is a comprehensive indicator of the impact of salt, which is directly proportional to the ratio of salt recoil (α) and reverse acceleration coefficient salt recoil (β). This phenomenon has a clear factual sense: as the speed increases the contact time decreases each portion of water with soil salts, therefore, the water has time to dissolve the salts in fewer slow outflow of filtrate - a logical consequence of the mechanism of the washing process.

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