Compositions of clay suspensions for fixing moving sands and soils

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Abstract. This article discusses the development of compositions of new, effective, water-soluble fixatives-reagents based on local raw materials and industrial waste. A technology has been developed for obtaining and using new types of complex additives-fixers based on hydrolyzed polyacrylonitrile polyelectrolyte, which can be recommended for implementation when fixing saline soils and sands of the Aral region. Chemical reagents and materials have been selected to create a structured crust and a three-dimensional structure in a system of moving sands and soils. The processes of creating compositions of clay suspensions for fixing moving soils and sands were studied, for which alkaline bentonites of the Krantau deposit and alkaline earth bentonite of the Beshtyubenskoye deposit were selected. As a result of the studies carried out, the features of the chemical fixation of moving sands using local raw materials were established to prevent salt and dust release into the environment and improve its environmental conditions.

1 Introduction

Environmental protection is an integral part of the concept of sustainable development of human society, which provides for the needs of people living today without compromising the satisfaction of the needs of future generations. Environmental pollution can be called a change in the quality of the environment; it can be called a change in the quality of the environment that can cause negative consequences [1,2].

Currently, one of the problems of environmental protection and applied colloidal chemistry is the chemical fixation of soil and moving sand, which, along with others, studies important issues of regulating soil structure, fixing soils, as well as obtaining materials with specified colloidal structural characteristics and strength properties.

In [3], for the first time, they began to successfully use the corresponding reagents of macromolecular compounds in order to increase the agrochemical value of soils, chemical reclamation, i.e. creating structure in soils.

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In the Central Asian region, as is well known, little or structureless soils prevail, therefore, the creation of an artificial structure is of great importance, and what is very important, along with increasing the agronomic value of soils, it is possible to solve the problem of preventing water and wind erosion by creating a structured crust on them. surfaces. Soil scientists [4,5], together with colloid chemists, have joined in to solve this problem. Scientists led by academician K.S. Akhmedov took part in the creation of a number of water-soluble polyelectrolytes, called preparations of the K series, which were tested in the field together with soil scientists and received a positive assessment.

The scientific foundations for the use of new synthesized preparations on nonsaline sierozem soils [5] were developed on the basis of the simultaneously expanded work on elucidating the role of polymers in structure formation and revealing the mechanism of their action.

Significant experimental material has been accumulated on fixing soil and moving sand with various structure-forming agents, various methods have been developed to evaluate the physical and mechanical properties of the obtained anti-deflation protective coatings, the requirements for chemical ameliorants have been systematized, and finally, a technology has been developed for the production of work on fixing sand, to study the effect of coatings on habitat conditions, survival, growth and development of sand-loving plants, a fairly large amount of material has also been collected [6].

The study of the essence of the chemical reclamation of moving sands made it possible to conclude that the transfer of sand from a free-dispersed state. (i.e. when the particles of the dispersed phase are able to move independently and are not connected to each other) into a coherently dispersed state by means of a binder, in which a bond is formed between the particles of the solid phase, resulting in the formation of spatial frameworks. From the point of view of physical and chemical mechanics, scientists [1-4] argue that it is precisely such sand structures that are carriers of specific properties that reveal the influence of surface phenomena on structure formation and destruction of dispersed structural bodies and materials.

According to scientists [5], chemical reclamation refers to methods of fixing the surface, which consists in applying melts or solutions of ameliorants to the surface of sand, forming as a result, as they say [4], a multicomponent system: sand–dispersion liquid medium–chemical ameliorant. The authors of [6] revealed the presence of forces of different nature between the components of this system: these are repulsive forces, which determine the stabilization of the system, and attractive forces, it is they that determine the processes of aggregation at close and long distances.

In the world for the mechanical, biological, chemical fixation of moving desert sands during chemical reclamation, scientific research is being carried out to create a composition of fixative reagents that can withstand water and wind erosion, forming a structure on their surface. In this regard, the choice of easily soluble water-soluble surfactants, forming a solid surface structure for a large area; including the use of reagent compositions based on local industrial waste; it is necessary to justify the development of technology for the use of the composition of fixing reagents, selected in accordance with the parameters of hardening of mobile soils and sands.

2 Research object

Salt moving soils and sands of the Aral Sea, water-soluble polymers, surfactants, technogenic wastes of the Kungrad soda plant (ash, lime, sawdust), secondary raw materials of Navoiyazot JSC and its hydrolyzed form using various hydrolyzing agents were used as an object. as well as compositions of fixative reagents. As an additive to the fixing solution, we also used sodium silicate ($Na_2O[SiO_2]n$) corresponding to GOST 13078-81.

The aim of the work is to develop new, effective, water-soluble fixative compositions based on local raw materials and industrial waste. A technology has been developed for obtaining and using new types of complex additives-fixers based on hydrolyzed polyacrylonitrile polyelectrolyte, which can be recommended for implementation when fixing saline soils and sands of the Aral region.

The work is devoted to the actual problem of colloid chemistry and environmental protection associated with the selection of new types of reagents based on calcium-containing wastes and the study of their structure-forming characteristics.

3 Research methods

The water resistance of the crust structure was carried out according to the Pavlov method [9], which was used to characterize the content of water-resistant aggregates (more than 0.25 mm in size). The kinetics of structure formation is characterized by the value of plastic strength (Pm), which was measured on a Rehbinder consistometer [8].

4 Results and discussion

The developed compositions of soil and moving sand fixers include a number of chemical reagents and industrial wastes that change certain properties of the resulting structure formers. Therefore, before formulating a composition, it is advisable to group them according to their properties in order to reduce research work both in the laboratory and in the field [7].

Table 1 shows the types of chemical reagents and industrial waste used to obtain soil and moving sand fixers. The table shows that each chemical reagent and industrial waste is capable of changing certain properties of the obtained soil and moving sand fixer compositions.

In order to create a composition of soil and moving sand fixers, 5 industrial wastes and 7 chemical reagents were selected, on the basis of which more than 50 combinations can be obtained. It is well known that such a large number of fixatives makes it difficult to study both in the laboratory and in the field. Considering this circumstance, based on the similarity of the properties of chemical reagents and industrial wastes, we have optimized the amount of obtained compositions of soil and moving sand fixers.

Table 2 presents our selected variants of the composition of soil and moving sand fixers, obtained on the basis of 7 types of chemical reagents and industrial waste, which were used in further studies. It was also found that when fixing soil, the consumption of individual reagents increases up to 50% relative to fixing moving sand.

Table 1. Types of chemical reagents and industrial waste used to obtain composite fixing compounds soil and moving sand.

Characteristics of crust	**Types of chemical reagents and wastes that change the corresponding properties of the fixative composition for:**	
	Soil	**moving sand**
mechanochemical crust strength	DB, Na_2SiO_3, $CaCO_2$, $Ca(OH)_2$	DB*, Na_2SiO_3, $CaCO_2$, $Ca(OH)_2$
crust water resistance	Na_2SiO_3, K-4, Uniflok, GR, OS, Ca-OPAN	Na_2SiO_3, K-4, Uniflok, GR, OS, Ca-OPAN
surface layer with organic fertilizers	OF	OF

salt resistance of the crust	Uniflok, K-4, GIPAN, KFS	Uniflok, k-4, GIPAN, KFS

Note: DB – dispersed alkaline bentonite of the Krantau deposit; DB* - dispersed alkaline earth bentonite of the Beshtyubenskoye deposit; OU – organic fertilizer, Gipan –A brand; Gipan* - B brand; KFS–KF-MT-15 brand; KFS* - KF-ZSH brand, NS - oil sludge, GS - gossypol resin, Ca-OPAN- hydrolyzed polyelectrolyte.

At the first stage of the development of soil and moving sand fixers, we studied the following characteristics: thermal effects by DTA, air specific gravity, layer porosity, crust porosity, and sums of the pore volume of the resulting structure.

Table 2 shows the results of the analyzes of the above indicators, the developed compositions of soil and moving sand fixers.

Table 2. Composition of fixers and their compositions based on selected chemical reagents and industrial waste.

№ of fixer	**Chemical reagents and materials used to obtain the composition of soil and moving sand fixers, %**			**Industrial waste used in the preparation of the composition of soil and moving sand fixers, %**			**H_2O, %***
	Bentonite	**Na_2SiO_3**	**Ca-OPAN**	**OF**	**$Ca(OH)_2$**	**GS**	
Fixer composition for soil:							
1	2.0	0.3	0.5	5.0	1.0	0.25	rest.
2	3.0	0.3	0.5	5.0	-	0.50	rest.
3	2.0	0.3	0.5	5.0	1.0	0.25	rest.
4	3.0	0.3	0.5	5.0	-	0.25	rest.
Fixer composition for moving sand:							
5	3.0	0.5	0.75	7.5	2.0	0.25	rest.
6	3.0	0.5	0.75	7.5	-	0.50	rest.
7	3.0	0.5	0.75	7.5	2.0	0.25	rest.
8	3.0	0.5	0.75	7.5	-	0.50	rest.

Note: * - calculation of the composition of the fixer was carried out according to the total amount of 100%.

Selected alkaline earth bentonites are more heat resistant than alkaline ones; At the same time, the porosity of alkaline bentonite layers is 40.3%, and that of alkaline earth layers is 37.1%. Moreover, the porosity of alkaline earth bentonite is much higher (45.4%) than alkaline (45.4%). The total pore volume for alkaline bentonites is 0.58 cm^3/g, and for alkaline earth 0.66 cm^3/g.

In this article, the best results are obtained using the fixer sample №1 for soil and №5 for moving sand, and the lowest values for soil are sample №4, and for moving sand - № 6.

It has been established from literary sources that the mechanical strength of the peel for soil and moving sand should not exceed 3.0-3.5 MPa, because above this, the growth of seeds is difficult and some of them cannot stay through cracks or channels for coming out into the light. The results show that the samples of the fixer composition № 2 for soil and № 6 for moving sand meet these requirements.

With this in mind, we have studied the effect of the composition of fixative compositions on the water resistance of the obtained crusts in soil and moving sand.

And also, the best water-resistant soil-clay and sandy crusts are obtained using a fixer of sample № 2 for soil and № 6 for moving sand, and the worst - for soil - sample № 3, and for moving sand - № 7.

The high-water resistance of the fixative composition containing GS additives is explained by its hydrophobic properties and chemical composition containing water-repellent substances.

With this in mind, we have studied the effect of the composition of fixative compositions on the water resistance of the obtained crusts in soil and moving sand.

It is known that the chemical fixation of moving soils and sands is carried out using various chemical reagents and materials that can dissolve in water and form a protective layer-crust (film) on their surface.

At the present stage, organic high-molecular polymers, primarily of the acrylic series, are considered promising in the fight against soil erosion and for improving soil fertility, which are distinguished by a good structure-forming effect at low dosages of the drug.

A new approach was applied in the selection of structurant reagents. The principle of the new approach lies primarily in the fact that a combined method was chosen, combining surfactants with organic or inorganic compounds capable of interacting with the salts contained in soil and moving sand.

Due to the need to fix very large areas to be treated, for economic reasons, structurants based on industrial waste and new synthesized ones were used.

The author of [4] found that the crust-forming effect of structure formers reduces the degree of soil salinity, however, it was found that the influence of this factor is less than the change in pH and ionic strength of the solution. As it turned out, it has a great influence on the structure-forming effect of additives and the valency of ions in the soil solution. It has been shown that the effectiveness of structurant reagents is increased by introducing alkali into the soil dispersion.

Based on the above, calcium oxide (hydroxide) and fly ash containing calcium oxide were chosen as the inorganic component of the complex additive. Additive CaO is a product of a lime plant, which is obtained by burning limestone - $CaCO_3$; $Ca(OH)_2$ - CaO quenching. The content of CaO in the samples used was 85-95%.

The mineralogical composition of the ash is a mixture of quartz, feldspars, Fe oxides, carbonates, CaO, and partially $Ca(OH)_2$. The specific surface area of the ash, determined by the method of I. Tovarov, is 21-32 cm^2/g, the bulk density is 0.7-0.9 g/cm^2, and the specific gravity is 2.0-2.2 g/cm^3.

It has been established that the introduction of CaO into liquid glass slows down the formation and diffusion of Ca^{2+} ions, which contributes to the implementation of the most important principle of structure formation, according to which the rate of a chemical reaction is equal to the rate of formation of a dispersed structure with the participation of calcium hydrosilicates and silica gel.

It should be noted that the use of $Ca(OH)_2$ together with liquid glass makes it possible to obtain a stable fixing structure, but as a pure chemical reagent it is expensive, and at the cost of the process of fixing soil and moving sand of Aral negatively affects the country's economy [10-12].

The composition based on bentonite powder, hydrolyzed OPAN, organic fertilizers and gossypol resin show increased structure-forming characteristics at low cost compositions.

It is known that the effectiveness of the chemical method of fixing soil depends on the strength of the adhesion of their particles to each other through a binder - fixer. The bond strength depends on the size of the structural-kinetic units of the fixer at the moment of contact with PPG particles, since the contact surface of the latter is relatively small, therefore, to maximize the strength, it should be achieved by filling the contact zone with an ameliorant-fixer.

Compositions based on bentonite, liquid glass, synthesized PE, organic fertilizers and local water-soluble surfactants and calcium-containing industrial wastes are proposed based on the study of chemical compositions, as well as colloid-chemical patterns as soil and moving sand fixers.

5 Conclusion

Taking into account the patterns of structure formation, the practical possibility of fixing dispersions of mobile soils and sands of desert regions with selected surfactants, polymers, chemical reagents, etc. is shown. obtained on the basis of calcium-containing industrial waste. The mechanism of interaction between water-soluble surfactants and dispersions has been established, taking into account the granulometric composition and the amount of water-soluble salts of the moving sands of the Aral Sea. Thus, as a result of the research, the features of the chemical fixation of moving sands were established using local raw materials and industrial waste to prevent salt and dust from being released into the environment and improve its environmental conditions.

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