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Section 1. Materials Science

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THE STUDY OF MIXED PROBLEM FOR ONE CLASS FOURTH ORDER DIFFERENTIAL EQUATIONS

Abstract. In this paper, we study the almost everywhere solution of one dimensional mixed problem for one class fourth order differential equations and some a priori estimates are obtained for the almost everywhere solution of the mixed problem under consideration.

Keywords: mixed problem, differential equation, a priori estimate.

In this work, we study the almost everywhere solution of the following one dimensional mixed problem:

$$\begin{cases} u_{txx}(t, x) - \alpha u_{xxxx}(t, x) = F(t, x, u(t, x), u_x(t, x), u_{xx}(t, x), u_{xxx}(t, x)) (0 \leq t \leq T, 0 \leq x \leq \pi), & (1) \\ u(0, x) = \phi(x) (0 \leq x \leq \pi), & (2) \\ u(t, 0) = u(t, \pi) = u_{xx}(t, 0) = u_{xx}(t, \pi) = 0 (0 \leq t \leq T), & (3) \end{cases}$$

where $\alpha > 0$ is a fixed number; $0 < T < +\infty$; F and ϕ are the given functions, and $u(t, x)$ is a sought function, and under the almost everywhere solution of problem (1)–(3) we understand the following:

a) $u(t, x), u_x(t, x), u_{xx}(t, x), u_{xxx}(t, x),$
 $u_t(t, x), u_{tx}(t, x) \in C([0, T] \times [0, \pi]);$
 $u_{xxxx}(t, x), u_{txx}(t, x) \in C([0, T]; L_2(0, \pi));$

b) equation (1) is satisfied almost everywhere in $(0, T) \times (0, \pi)$;

c) all the conditions (2) and (3) are satisfied in ordinary sense.

There have been many works devoted to the study of mixed problems for nonlinear fourth order (see [1; 2; 3; 5] and references therein).

As the system $\{\sin nx\}_{n=1}^{\infty}$ forms a basis in the space $L_2(0, \pi)$, then it is obvious that every almost everywhere solution $u(t, x)$ of problem (1)–(3) has the following form:

$$u(t, x) = \sum_{n=1}^{\infty} u_n(t) \sin nx, \quad (4)$$

where

$$u_n(t) = \frac{2}{\pi} \int_0^{\pi} u(t, x) \sin nxdx \quad (n = 1, 2, \dots; t \in [0, T]). \quad (5)$$

In the next, after applying Fourier method, the finding of functions $u_n(t)$ ($n = 1, 2, \dots$) is reduced to solving the following countable system of nonlinear integral equations:

$$u_n(t) = \phi_n \cdot e^{-\alpha n^2 t} - \frac{2}{\pi n^2} \cdot \int_0^t \int_0^\pi \Phi(u(\tau, x)) \sin nx \cdot e^{-\alpha n^2(t-\tau)} dx d\tau$$

$$(n = 1, 2, \dots; t \in [0, T]), \quad (6)$$

where

$$\phi_n \equiv \frac{2}{\pi} \int_0^\pi \phi(x) \sin nx dx \quad (n = 1, 2, \dots), \quad (7)$$

$$\Phi(u(t, x)) \equiv F(t, x, u(t, x), u_x(t, x), u_{xx}(t, x), u_{xxx}(t, x)), \quad (8)$$

Using the definition of almost everywhere solution of problem (1)–(3), it is easy to prove (see [3]) the following

Lemma. If $u(t, x) = \sum_{n=1}^{\infty} u_n(t) \sin nx$ is any almost everywhere solution of problem (1)–(3), then functions $u_n(t)$ ($n = 1, 2, \dots$) satisfy the system (6).

We denote by $B_{\beta, T}^\alpha$ the set of all functions $u(t, x)$ of the form (4) such that $u_n(t) \in C[0, T]$ and $\sum_{n=1}^{\infty} \left(n^\alpha \cdot \max_{0 \leq t \leq T} |u_n(t)| \right)^\beta < +\infty$, where $\alpha \geq 0, 1 \leq \beta \leq 2$.

We define the norm in this set as follows:

$$\|u\|_{B_{\beta, T}^\alpha} = \left\{ \sum_{n=1}^{\infty} \left(n^\alpha \cdot \max_{0 \leq t \leq T} |u_n(t)| \right)^\beta \right\}^{\frac{1}{\beta}}. \quad (9)$$

It is known (see [5]) that all these spaces are Banach spaces.

Theorem.

1. Let the right side of equation (1) be as follows:

$$F(t, x, u, u_x, u_{xx}, u_{xxx}) = f_0(t, u_{xx}) \cdot u_{xxx} + f(t, x, u, u_x, u_{xx}, u_{xxx}), \quad (10)$$

where

$$a) f_0(t, V) \in C([0, T] \times (-\infty, \infty)); \quad (11)$$

$$b) f(t, x, u_1, \dots, u_4) \in C([0, T] \times [0, \pi] \times (-\infty, \infty)^4)$$

and in $[0, T] \times [0, \pi] \times (-\infty, \infty)^4$

$$\int_0^\pi u_{xx}^6(\tau, x) dx \leq \|u_{xx}(\tau, x)\|_{C([0, \pi])}^2 \cdot \|u_{xx}(\tau, x)\|_{C([0, \pi])}^2 \cdot \int_0^\pi u_{xx}^2(\tau, x) dx \leq \pi \int_0^\pi u_{xxx}^2(\tau, x) dx \cdot \frac{\pi^2}{2} \|u\|_{B_{2, \tau}^3}^2 \cdot C_0 = \frac{\pi^3}{2} \cdot C_0 \cdot \int_0^\pi u_{xxx}^2(\tau, x) dx \cdot \|u\|_{B_{2, \tau}^3}^2, \quad (19)$$

$$f(t, x, u_1, \dots, u_4) \cdot u_3 \leq C \cdot (1 + u_1^2 + u_2^2 + u_3^2) + \delta \cdot u_4^2, \quad 0 < \delta < \alpha, \quad (12)$$

where $C > 0$ is a constant and $\alpha > 0$ is a number appearing in the equation (1).

2. $\forall R > 0$ in $[0, T] \times [0, \pi] \times [-R, R]^2 \times (-\infty, \infty)^2$

$$|F(t, x, u_1, \dots, u_4)| \leq C_R \cdot (1 + |u_3|^3 + |u_3| \cdot |u_4| + |u_4|), \quad (13)$$

where $C_R > 0$ is a constant.

Then the following a priori estimate holds for all the possible almost everywhere solutions $u(t, x)$ of problem (1)–(3):

$$\|u(t, x)\|_{B_{2, T}^3} \leq C, \quad (14)$$

where $C > 0$ is a constant.

Proof. Let $u(t, x) = \sum_{n=1}^{\infty} u_n(t) \sin nx$ be any almost everywhere solution of problem (1)–(3). Then, by virtue of above lemma, functions $u_n(t)$ ($n = 1, 2, \dots$) satisfy the system (6).

From system (6) we obtain $\forall t \in [0, T]$:

$$\|u\|_{B_{2, t}^3}^2 \leq a_0 + \frac{2}{\alpha \pi} \cdot \int_0^t \int_0^\pi \{\Phi(u(\tau, x))\}^2 dx d\tau, \quad (15)$$

where

$$a_0 \equiv 2 \sum_{n=1}^{\infty} (n^3 \cdot \phi_n)^2. \quad (16)$$

Then, using conditions of this theorem for $R = R_0$, we obtain from (15) that $\forall t \in [0, T]$:

$$\|u\|_{B_{2, t}^3}^2 \leq a_0 + \frac{2}{\alpha \pi} \cdot C_{R_0}^2 \cdot 4 \int_0^t \int_0^\pi \{1 + u_{xx}^6(\tau, x) + u_{xx}^2(\tau, x) \cdot u_{xxx}^2(\tau, x) + u_{xxx}^2(\tau, x)\} dx d\tau. \quad (17)$$

Now, using following estimates from [3]

$$\|u_{xx}(t, x)\|_{C([0, \pi])}^2 \leq \frac{\pi^2}{2} \cdot \|u\|_{B_{2, t}^3}^2, \quad (18)$$

$$\int_0^\pi u_{xxx}^2(\tau, x) dx \leq \frac{\pi}{2} \cdot \|u\|_{B_{2, \tau}^3}^2,$$

$$\int_0^\pi u_{xx}^2(t, x) dx \leq C_0, \quad \forall t \in [0, T],$$

we obtain $\forall t \in [0, T]$:

$$\int_0^\pi u_{xx}^2(\tau, x) \cdot u_{xxx}^2(\tau, x) dx \leq \|u_{xx}(\tau, x)\|_{C([0, \pi])}^2 \cdot \int_0^\pi u_{xxx}^2(\tau, x) dx \leq \frac{\pi}{2} \cdot \|u\|_{B_{2,\tau}^3}^2 \cdot \int_0^\pi u_{xxx}^2(\tau, x) dx = \frac{\pi^2}{2} \cdot \int_0^\pi u_{xxx}^2(\tau, x) dx \cdot \|u\|_{B_{2,\tau}^3}^2, \quad (20)$$

$$\int_0^\pi u_{xxx}^2(\tau, x) dx \leq \frac{\pi}{2} \cdot \|u\|_{B_{2,\tau}^3}^2. \quad (21)$$

Then, using estimates (19)–(21), from (17) we obtain that $\forall t \in [0, T]$:

$$\|u\|_{B_{2,t}^3}^2 \leq a_0 + \frac{8T}{\alpha} \cdot C_{R_0}^2 + \frac{8}{\alpha\pi} \cdot C_{R_0}^2 \cdot \int_0^t \left\{ \left(\frac{\pi^3}{2} \cdot C_0 + \frac{\pi^2}{2} \right) \cdot \int_0^\pi u_{xxx}^2(\tau, x) dx + \frac{\pi}{2} \right\} \cdot \|u\|_{B_{2,\tau}^3}^2 d\tau. \quad (22)$$

Applying Bellman's inequality [4, p.188, 189], from (22) we obtain:

$$\|u\|_{B_{2,T}^3}^2 \leq \left(a_0 + \frac{8T}{\alpha} \cdot C_{R_0}^2 \right) \cdot \exp \left\{ \frac{8}{\alpha\pi} \cdot C_{R_0}^2 \cdot \left[\left(\frac{\pi^3}{2} \cdot C_0 + \frac{\pi^2}{2} \right) \cdot \int_0^T \int_0^\pi u_{xxx}^2(\tau, x) dx d\tau + \frac{\pi}{2} \cdot T \right] \right\} \leq \left(a_0 + \frac{8T}{\alpha} \cdot C_{R_0}^2 \right) \cdot \exp \left\{ \frac{8}{\alpha\pi} \cdot C_{R_0}^2 \cdot \left[\left(\frac{\pi^3}{2} \cdot C_0 + \frac{\pi^2}{2} \right) \cdot C_0 + \frac{\pi}{2} \cdot T \right] \right\} \equiv C^2,$$

that is, all the possible almost everywhere solutions $u(t, x)$ of problem (1)–(3) are a priori bounded in $B_{2,T}^3$. Theorem is now proved.

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Section 2. Technical sciences in general

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IMPROVING MOBILE APP QUALITY THROUGH OPTIMIZED TESTING STRATEGIES

Abstract. This article explores the complexities and challenges associated with the testing process on many devices, particularly in the context of mobile applications. It highlights the importance of optimizing the testing process to ensure high-quality products and reduce time to market. The article also discusses alternative approaches to address these challenges, such as utilizing cloud services, automated testing, and integrating with CI/CD systems, which can improve efficiency and product quality.

Keywords: testing process, mobile applications, optimization, cloud services, automated testing, CI/CD integration.

Introduction

In the present study, the development and implementation of an optimized method for initiating automated tests utilizing Remote Procedure Call (RPC) is examined. The objective of this research is to establish an efficient and versatile system for automated software testing, which will facilitate a reduction in time and resources expended on test execution, while ensuring enhanced scalability and adaptability to diverse testing platforms and libraries.

Peculiarities of the Testing Process on many Devices

Ensuring high product quality in the market is inextricably linked to the proper organization of the testing process. Consider the case of a mobile application designed for warehouse management that utilizes a device's camera for recognizing product barcodes. There exists a multitude of mobile device manufacturers that differ in both hardware characteristics and software components. Each hardware and software combination may affect the camera and

sensor performance; therefore, the developed application must be adapted for each case [1; 2].

Conducting software testing on all available devices and hardware-software combinations is impractical. As a result, the most popular devices in the market are typically selected and tested first. However, even such a sample may comprise 50–100 devices.

Performing local tests on such a quantity of devices entails several complexities. Local testing on multiple mobile devices requires reliable connection and management provisions. Connecting and managing many devices can prove to be a complicated and fragile process, necessitating substantial efforts and time for setup and maintaining stable operations. Furthermore, compatibility issues may arise between various devices and operating systems, complicating the connection and management process.

Under local conditions, using multiple mobile devices may result in device failures due to hardware malfunctions, power issues, overheating, or improper usage. Recovering devices after such failures can

be a complex and costly process, requiring additional expenditures on repair or equipment replacement.

Addressing the problems associated with local testing on multiple mobile devices may demand considerable time and financial resources. This may include equipment repair or replacement costs, technical support expenses, and time spent diagnosing and resolving issues. All these factors reduce testing efficiency and may lead to delays in software product development and release [3].

Given the complexity and costs involved in addressing the problems, developers and testers should consider alternative approaches to organizing the testing process. Possible solutions may include using cloud services for conducting testing on remote devices, applying automated tests, and integrating with CI/CD systems. These approaches can alleviate the team's workload, ensure flexibility, and reduce the time spent on testing, ultimately enhancing software product quality, and expediting its market launch.

Optimization of the Testing Process through the Application of RPC

To enhance the testing process, the following technical solution has been proposed. A task scheduler (figure 1) has been developed to control the testing process on remote devices. This solution enables the application of existing automated testing approaches without the need to make significant changes to the existing infrastructure. The task scheduler incorporates a module for remotely initiating tests and facilitating communication with them. In addition, a module for data exchange with the task scheduler is installed on cloud devices [4; 5].

In a test cloud, several devices of the same model may be present. In this context, the task scheduler is capable of uniformly distributing the set of test scenarios among devices of the same model or devices with identical hardware and software configurations.

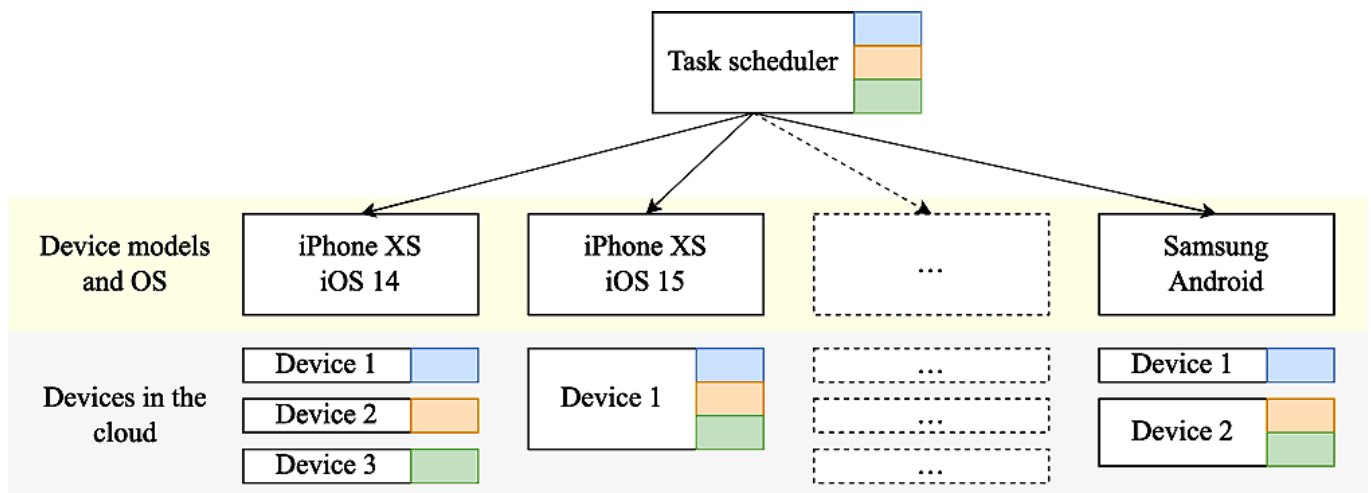


Figure 1. Test cases distribution between cloud devices

The test initiation module and the wrapper (figure 2) for the tested library are generated automatically. Consequently, the system creates a compatible interface for each library, significantly saving time in preparing the testing process, as this step occurs almost instantaneously. The proposed solution is cross-platform, allowing developers to describe test scenarios once, which are then executed uniformly

across all tested platforms. Otherwise, it would be necessary to create a prototype application with user interface components for subsequent development of automated platform-dependent tests.

It consists of three main stages: initialization of the testing process, test execution, and generation of testing reports. These steps are discussed in more detail below.

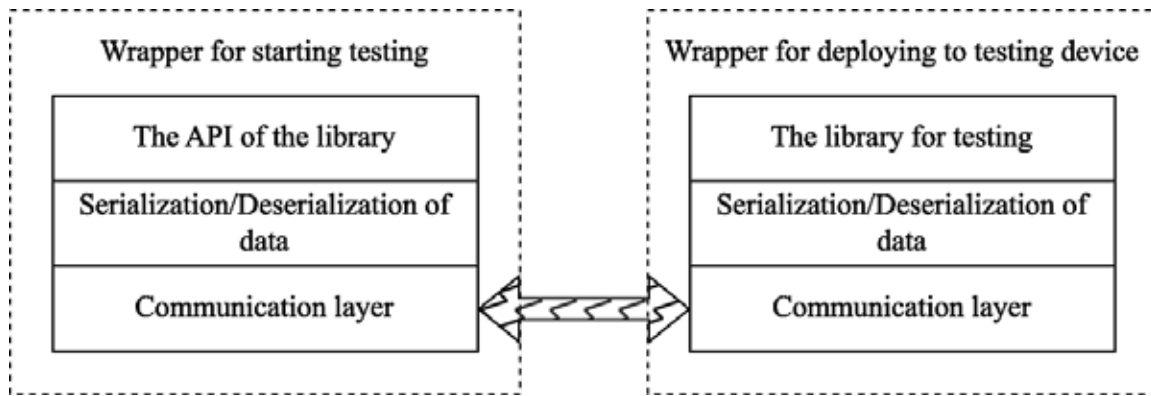


Figure 2. High level architecture of testing wrappers

The interaction process of the system components for initiating tests is represented in the diagram (figure 3).

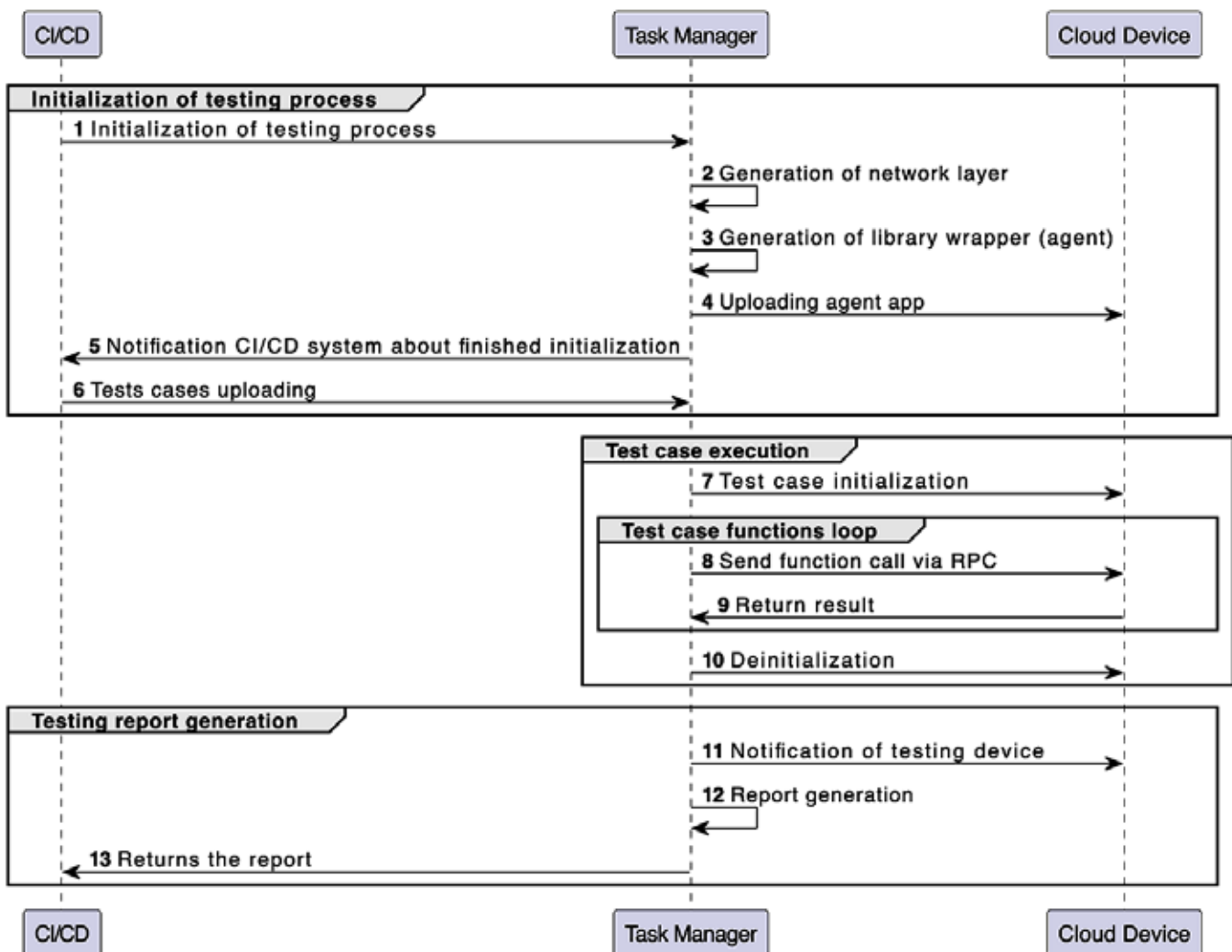


Figure 3. Diagram of communication process between CI/CD, Task Manager and Cloud device

During the testing process initialization stage, the CI/CD system activates a procedure by contacting the task scheduler. At this point, data on the tested library, including its software interface and binary code, are

transmitted. Based on the received information, the network layer and agent application containing the tested library and network layer for interaction with the scheduler are generated. The agent application is then loaded onto the test devices. Although only one device is depicted in the diagram, in practice, the number can be arbitrary. Ideally, no more than one hundred devices should be assigned to one scheduler instance. At the conclusion of this stage, the task scheduler informs the CI/CD server about the completion of the initialization process and readiness for the next stage [6].

The test execution stage involves receiving control commands from the CI/CD system and transmitting calls to agent applications in the cloud. Initially, the device prepares for the execution of the test

scenario, for which the task scheduler sends corresponding initialization commands to the agent. Subsequently, a cycle of remote procedure calls begins, with the results being returned to the controlling server for analysis. Upon completion of this stage, the environment is deinitialized after the scenario has concluded. The system is ready for testing subsequent test scenarios.

The final stage is the test completion process. At this stage, the devices on which testing was conducted are deinitialized, followed by the generation of a test report and notification of the CI/CD service about the completion of the testing process.

During the testing process, results were obtained, as presented in the chart (figure 4).

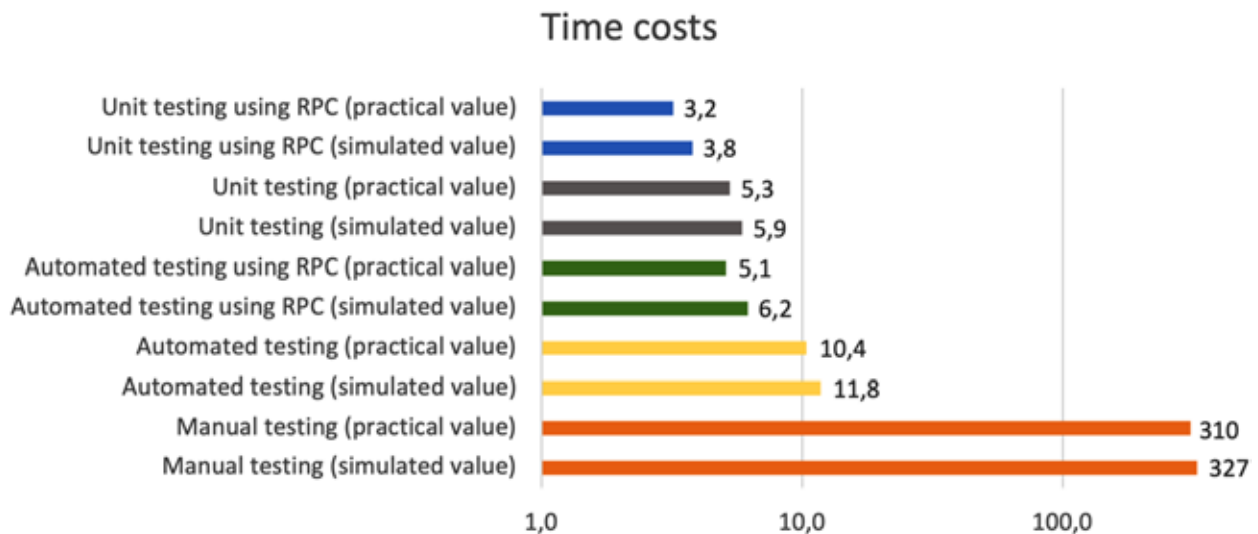


Figure 4. Time costs of testing methods

Time expenditure modeling was conducted for various testing methods, including manual testing, unit testing, automated testing, and enhanced versions of unit and automated testing using the RPC method. As expected, manual testing consumes the most time, due to the inherent characteristics of this approach. Measuring the time spent on manual testing enables an evaluation of the model's accuracy. According to the obtained results, the modeling error was approximately 16%. This can be attributed to the influence of human factors and technical factors previously discussed in the study [7; 8].

As for unit and automated testing, the difference between practical results and modeled values was not as significant. This attests to the high accuracy of the developed model and suggests that these results can be applied for further optimization of the testing process.

Now, let us focus on the results obtained using the RPC method and the conventional approach. Based on the graph, testing with the RPC method requires, on average, 45% less time for the given test environment configuration. However, it should be noted that results may vary for other testing

purposes and test environments. In this approach to testing, the complexity of the tested library's functionality and its volume play a significant role.

Conclusion

In conclusion, it can be stated that, throughout the practical experiment, a task scheduler was successfully developed and implemented, effectively

managing the testing process on remote devices. This approach allows for the integration of existing automated testing methods without the need for making significant alterations to their structure. This ensures the optimization of the testing process and a substantial reduction in time expenditure.

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STUDY AND DEVELOPMENT OF WEIGHTED DRILLING FLUIDS BASED ON LOCAL RAW MATERIALS

Abstract. The article shows the importance of obtaining weighted drilling fluids based on chemical reagents from local raw materials and industrial wastes for drilling oil and gas wells. In the process of building oil and gas wells to maintain the stability of the walls, to prevent the flow of salts, and to prevent the penetration of formation fluids into the well, it becomes necessary to increase the density of the drilling fluid, which can be accomplished by introducing components with increased density. For obtaining and stabilization weighted drilling fluid were investigated and recommended new compositions of chemical reagents based on local and raw materials of Uzbekistan.

Keywords: chemical reagents, drilling fluids, stabilization, weighting agent, barite, viscosity, density, oil and gas well.

Introduction

At the present for processing of drilling fluids, environmentally friendly modifications of natural polymers have become widespread, opening up additional opportunities for the preparation and use of drilling fluids with high technological characteristics that have a minimal impact on environmental components during their use, disposal and safe disposal. For stabilization the properties of mineralized drilling fluids, starch reagents related to natural polysaccharides are used. Additions of starch reagents to the drilling fluid can effectively reduce the filtration rate of mineralized drilling fluids, while they have complete solubility in salt solutions used to prepare the drilling fluid. The construction of oil and gas wells is invariably associated with the occurrence of various complications, the final cost of drilling depends on the choice of a method for solving which. One of the common problems is catastrophic loss of drilling fluid.

Present time for obtaining and stabilization of drilling fluids for drilling oil and gas wells use more than 3000 kind of chemicals in the world. Such as Carboxymethylcellulose, polyacrylamide, hydrolyzed polyacrylonitrile, ferrochrome-lignosulphonate, grafite, chrompick, NaOH, Na₂CO₃ and others. In the Republic of Uzbekistan for drilling oil and gas wells use about 3.5–4 thousand ton chemical reagents every year. Based on the analysis of basic research in the field of chemistry and biochemistry of carbohydrates, generalizing the practice of drilling wells, polysaccharides are used as polymer reagents for regulating the filtration and rheological properties of lighted and weighted drilling fluids. The main reason for the choice of polysaccharides is their ability to chemical and biological destruction, due to which is possible to destroy and remove the formed clogging layer during the drilling process, and almost complete recovery of reservoir properties [1–3].

In all cotton producing countries and factories proceeding cotton seeds gossypol resin is formed as a final product, which has a viscous-fluid consistency, and now find its effective implementation. The transformation of the viscous fluid gossypol resin into a powdered material by modification of the various ingredients of the organic and inorganic origin can bring to the commercial introduction of the products and to expand the field of efficient use in large-tonnage quantities. The most important weighting additive in drilling fluids is barium sulfate (BaSO_4). Barite is a dense mineral comprising barium sulfate. The specific gravity of barite is at least 4.20 g/cm^3 to meet API specifications for producing mud densities from 9 to 19 lbm/gal. However, a variety of materials have been used as weighting agents for drilling fluids including siderite (3.08 g/cm^3), calcium carbonate ($2.7\text{--}2.8 \text{ g/cm}^3$), hematite (5.05 g/cm^3), ilmetite (4.6 g/cm^3), and galena (7.5 g/cm^3).

Methods and materials

The American Petroleum Institute (API) publishes documents relating to oilfield standards, including drilling fluids testing procedures. As with any laboratory procedure requiring the use of potentially hazardous chemicals and equipment, the user is expected to have received proper training and knowledge in the use and disposal of these potentially hazardous materials. The user is responsible for compliance with all applicable local, regional, and national requirements for worker and local health, safety, and environmental liability.

For stabilization and obtaining weighted drilling fluids were used following materials: water-soluble modified powdered gossypol resins, carbonate-polymer sludge-waste of "Ferganazot" JSC, Na-carboxymethylcellulose "Carbonam" with 500 polymerization degree, soda ash and caustic soda. As a weightings were used red clay, marble flour, dolomite, scale, hematite and barite.

The technology of obtaining for production of composite polymer reagents by using of low molecular weight sodium carboxymethylcellulose, al-

kali, and organic-mineral additives of various ratios to improve the physical and chemical properties of drilling fluids have been developed. Water-soluble modified powdery resin contains hydrophobic additives based on sodium salt of fatty acids and ionic surfactants. The use of these reagents for drilling fluids used in drilling oil and gas wells ensures the preservation of the regulated rheological and filtration properties of polymer systems at $80\text{--}190 \text{ }^\circ\text{C}$ for 30–40 hours. Method of obtaining new composite chemical reagents based on physical and chemical modification of initial materials on various ratios, environment and regime. All the physical, chemical and technological parameters of drilling fluids based on composite chemical reagents have been tested in accordance with API standards [1–3].

In the development of new composite chemical reagents for stabilization drilling fluids for drilling oil and gas wells we used mainly waste of oil and fat production-gossypol resin, as well as low mass carboxymethylcellulose. Gossypol resin consists of 52 to 64 of free fatty acids and their derivatives, and the rest-a product of condensation and polymerization of gossypol and its transformation, resulting from extraction of cottonseed oil, mainly in the process of distillation of fatty acids from soapstok. In the gossypol resin found 12% of the nitrogen containing compounds, 36% of the transformation products of gossypol fatty and oxide fatty acids. It is a homogeneous fluid mass from dark brown to black color.

For obtaining weighted drilling fluids used Fluid-Loss-Control Additives. Clays, dispersants, and polymers such as starch are widely used as fluid-loss-control additives. Sodium montmorillonite (bentonite) is the primary fluid-loss-control additive in most waterbased drilling fluids. The colloidal-sized sodium-bentonite particles are very thin and sheetlike or platelike with a large surface area, and they form a compressible filter cake. Inhibitive mud systems inhibit the hydration of bentonite and greatly diminish its effectiveness. Therefore, bentonite should be prehydrated in fresh water before being added to these

systems. The larger and thicker particles of sodium montmorillonite do not exhibit the same fluid-loss-control characteristics. Polymers are used heavily in the oil industry for controlling the drilling fluid properties or for enhanced oil recovery applications to extract the heavy oil. Polymer flooding is a very important technique to extract the heavy oil from thin and heterogeneous reservoirs. Screening criteria and screening algorithms should be developed for enhanced oil recovery techniques. Artificial intelligence and data mining can be used to manage the reservoir for polymer flooding, especially in case of thin and heterogeneous heavy oil reservoirs [3–5].

Drilling high-pressure/high-temperature (HPHT) oil and gas wells is challenging because it requires a special fluid formulation that can control the high pressure and withstand the elevated down-hole temperatures. Weighting materials are added to the drilling fluid to attain the high density required to equalize formation pressure and control the well during drilling operations. There are many options for weighting materials that can be used with drilling fluids such as calcite, barite, hematite, manganese tetra oxide, ilmenite, and iron oxide. These materials are different in density and other properties; therefore, the final density of drilling fluid varies accordingly [5–7].

Determination of physical and chemical properties of drilling fluids

- **Determination of Mud Density.** The weight of the mud samples was determined using the Baroid mud balance. The cup was filled completely with mud after calibration. The expelled mud was washed and the balanced arm was replaced on the base with the knife edge resting on the fulcrum.
- **Determination of Mud Viscosity** The mud viscosity of the samples was determined using Fann V-G meter. The Fann VG meter was filled to the 350 cc mark and placed on the movable work table. The table was adjusted until the mud surface was at the scribed line on the rotor sleeve. The motor was started with a high speed position (600 rpm) and the reading was taken from a steady indicator dial value. The reading was also obtained at the low speed of 300 rpm.
- **Determination of pH.** The pH meter which consists of a glass electrode system, an electronic amplifier and a meter calibrated in pH units was used to test the pH of galena mud. The electrical connection with the mud was established through saturated KCl solution contained in a tube surrounding the calomel cell. The electrical potential generated in the glass – electrode system by the hydrogen ions in the drilling mud was amplified and operated the calibrated meter which indicated the pH. [8–9].
- **Determination of stability and sedimentation indicators.**
- **Stability** – the ability of a solution to its density over a period of time. The stability index S is a value determined by the difference in densities of the lower and upper parts of the drilling mud settled for a certain time. Sedimentation index $S, \%$, is the value determined by the amount of the dispersed phase, separated from a certain volume of the drilling fluid as a result of gravitational separation of its components for a certain time. The sedimentation rate indirectly characterizes the stability of the drilling fluid.
- **Determination of the stability index by the stability cylinder TS-2.**

Operating procedure:

- pour a thoroughly mixed sample of the solution into a cylinder with a volume of 720 cm³ to the edge;
- set the filled cylinder in a quiet place and leave it alone for a day;
- after 24 hours, open the cork, drain the upper part of the sample solution along with the settled water;
- thoroughly mix the drained solution and determine its density, ρ_1 ;

- closing the tap with a stopper, thoroughly mix the lower half of the solution remaining in the cylinder and determine its density, ρ_2 ;
- the stability index is calculated by the difference in densities;

$$C = \rho_1 - \rho_2, \text{ g/cm}^3$$

- **Determination of sedimentation rate.** To determine the sedimentation index, a glass cylinder with a capacity of 100 cm³ is used.

Operating procedure:

- a thoroughly mixed sample of the drilling fluid is poured into the cylinder up to 100 cm³;
- put the cylinder with the solution in a calm place and leave it alone for 24 hours;
- after 24 hours, the reference position of the solution interface level is determined on a cylinder scale.

The sedimentation rate is calculated by the formula:

$$S = 100 - V, \text{ cm}^3$$

where S is an indicator of sedimentation, %;

V is the position of the solution interface level, cm³ [10].

Results and discussion

Developed chemical reagents (MBR) and weighted drilling fluids for drilling in salt and chemical corrosive environments, as they are stable to cations of

polyvalent salts (Mg^{++} , Ca^{++} , Na^+ , K^+). Chemical reagent (MBR) is mainly about 60–65% gossypol resin and has a high lubricity due to the content in its composition of about 35–40% of polymerized fatty acids, pigment, glycerin and other components. These reagents as a surfactants serve to emulsify oil with water, increase drilling speed because of low coefficient of friction, play role as corrosion inhibitor.

There are formed water in oil emulsions. The emulsified phase is the calcium chloride brine and the continuous phase is the oil. It is characterized by its low electrical stabilities and high fluid loss values. Oil systems require additional gelling agents for viscosity. These types of systems have many advantages. They are not very reactive. They are also stable at high temperature and pressure, high contamination resistance and not corrosive, but also they have some drawbacks: they are expensive and harmful for environment.

Obtaining and modification of powder water soluble gossypol resin with mineral ingredients chemicals were investigated in the laboratory. Physical chemical properties of weighting materials also were investigated. Results of analyses were given in the (table 1).

Table 1.– Physical-chemical properties of weighting materials

Name of weightings	Physical chemical properties				
	Density, kg/m ³	Mohs hardness	Sieve residue, 0071, %	Humidity, %	pH
Clay	2550–2650	2–2.5	5	2	7.5
Marble flour	2600–2700	2.5–3.0	6	1.5	7–8
CPS	2700–2750	2.5–3.0	6	1.8	11–12
Dolomite	2800–2900	2.5–3.0	6,5	1.2	7–8
Barite (Uz)	3850–4100	3.0–3.5	10	1.9	7–7.5
Barite (Kz)	4100–4200	3.0–3.5	8	1.3	7
Barite (Ru)	4150–4250	3.0–3.5	7	1.1	7–8
Okalina	4800–4900	5–6	8	0.9	7–7.5
Hematite	5100–5300	5–7	9	0.8	7–7.5

As well as investigated physical and chemical properties drilling fluids based on composite chemical reagents and barite and hematite. Results of testing have been given on (figure 1).

Figure 1 presents, that with a weighting of the drilling fluid of hematite up to 70–72%, the density of the solution increases to 2.4–2.50 g/cm³, and the shear stress is in the range 55–60 mgf/cm².

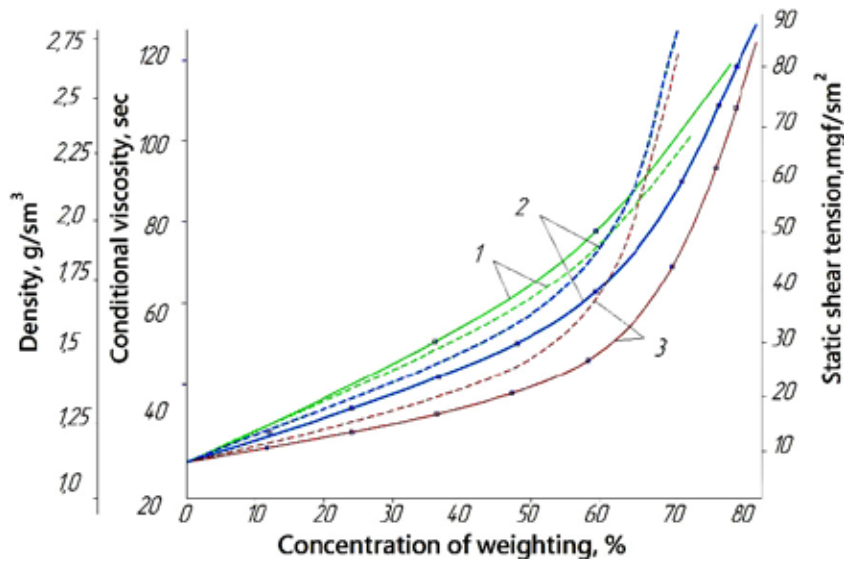


Figure 1. Dependence of Density (1), viscosity (2) and Shear stress (3) of drilling fluids basis MBR with barite and hematite contents

The water loss values hardly change and amount to 5–6 cm³/30 min, the hydrogen index is 11. When adding barite weighting agents in an amount of 60–65%, the density of the solution is 2.1–2.2 g/cm³, while the nominal viscosity of the drilling fluid is 100–110 s and the Shear stress of the solution is 62–64 mgf/cm² for 10 min. The fluid loss of the solution is 5–6 cm³/30 min, the hydrogen index is 10–11.

The Implementation of the research results shows that with an increase in the MBR concentration from 0.5 to 4%, the conditional viscosity of the T₅₀₀ increases from 40 to 82 s, the pH of the solution increases from 7 to 9, the water loss decreases from 14 to 3 cm³ in 30 minutes and the stability of the solution reaches up to 0.05 g/cm³. The speed of drilling have been increased by 10–15%.

Obtained weighted drilling based on composite chemical reagents type MBR have following advantages compare with existent drilling reagents:

- salt stable;
- thermal stable;
- long life time;
- multifunction;
- ecological safe

Conclusion. Research results of this work show that stabilization indexes of drilling fluids play main

role for drilling oil and gas wells without any accident. According to the doing this research have been concluded that mainly three factors impact to stabilization indexes of weighted drilling fluids:

- physical chemical properties of chemical reagents;
- type and dimension of weighting agents powder;
- geological conditions of the wells.

As well as have been found out effective composition of gossypol resin, minerals and carboxymethylcellulose for stabilization and obtaining weighted drilling fluids. It can be seen that obtained stable weighted drilling fluids based on composite chemical reagents have a multifunction. On the basis of this research result developed composite chemical reagents based on local and raw materials, production wastes as well as weighting agents have been proposed new compositions of weighted drilling fluids, as well as recommended for use in drilling of oil and gas wells with abnormally high reservoir pressure (AHRP). As well as by implementation of the results of the work will be solved some ecological problems of oil fat factories and metallurgical plants.

Conflicts of interest

The authors declare, that there is no conflict of interest regarding the publication of this article.

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Section 3. Physics

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DETERMINATION OF THE IMPACT OF THE URANIUM INDUSTRY ON THE ENVIRONMENT

Abstract. In this study, we investigated the changes in the specific activity of natural radionuclides potassium-40 (K40), thorium-232 (Th232), radium-226 (Ra226), and anthropogenic cesium-137 (Cs137) in the soil composition of the Samarkand and Navoi regions. The primary objective of this research was to evaluate the impact of uranium production enterprises on the variations in the levels of natural radionuclides ^{226}Ra , ^{232}Th , ^{40}K , and technogenic ^{137}Cs found in soil samples collected from the Navoi region. Additionally, we conducted a comparative analysis of the specific activity of radionuclides ^{226}Ra , ^{232}Th , ^{40}K , and ^{137}Cs in samples not influenced by uranium production.

Keywords: radioactivity, radionuclide, radiobiology, geophysics, migration, spectrometer, gamma, crystal, photoreceptor, background, energy, specific activity, uranium, technogenic, effective, identification.

Introduction

The radioactivity of environmental objects, such as soils, depends on the biological properties of the object, the geographical characteristics of the area, and the concentration of natural, cosmogenic, and man-made radionuclides in the rocks forming the soil, as well as the degree of anthropogenic impact [1]. These factors influence the distribution of natural radionuclides, including uranium, in different regions, particularly in areas with mineral deposits. Data on radionuclide concentrations, uranium deposits, uranium mining, radioactive environmental pollution, and the degree of exposure are of great practical importance in such areas. One significant

source of environmental radioactive pollution is the uranium industry, which mines, processes, enriches, and prepares uranium for nuclear fuel.

Throughout each stage of the uranium industry, there is potential for radioactive contamination of the environment. Natural uranium, consisting of ^{238}U (99.28%), ^{235}U (0.7%), and ^{234}U (0.006%), is mined, processed, and enriched to prepare ^{235}U nuclear fuel. Uranium, radium, and liquid waste generated at uranium processing plants are often stored nearby, potentially contaminating nearby ditches, lakes, and water sources with radioactivity. Accidents at these facilities can release significant quantities of enriched uranium, posing an ongoing risk of radio-

active radiation. Additionally, the production of fuel rods presents a high probability of minor environmental pollution.

This research paper investigates the specific activities of natural ^{226}Ra , ^{232}Th , ^{40}K , and technogenic ^{137}Cs in soil samples taken from the Samarkand (without the impact of the uranium industry) and Navoi (without the impact of the uranium industry) regions. The goal is to assess the degree of influence that uranium production enterprises have on the levels of natural radionuclides (^{226}Ra , ^{232}Th , ^{40}K) and technogenic ^{137}Cs detected in samples taken from the Navoi region. Furthermore, the study aims to compare the amounts of ^{226}Ra , ^{232}Th , ^{40}K , and ^{137}Cs radionuclides in samples taken from the Samarkand region, which were not affected by uranium production [3].

Measurement technique and methods

Soil samples were collected from two points in each selected area at layer depths of 0–5.0 cm and 0–10.0 cm. The samples were dried, cleaned of foreign rocks, crushed into a homogeneous state, and weighed. Gamma spectra of samples taken from the Navoi region were measured using a “Progress-Gamma” scintillation spectrometer. The measurement results were processed with the “Progress” computer program connected to the gamma spectrometer.

For soil samples collected from the Samarkand region, a 63×63 mm NaI(Tl) scintillation gamma spectrometer with an energy resolution of 10% was

used in the scientific laboratory at Samarkand State University’s Department of Nuclear Physics and Astronomy. Specific activities of natural ^{226}Ra , ^{232}Th , ^{40}K , and technogenic ^{137}Cs radionuclides identified in the spectra were determined using reference radioactive sources from the OMACH set. The measurement results were processed on a computer using the ASW program.

Results and their analysis

Some of the gamma spectra of the studied soil samples are illustrated in Figures 1 and 2. In the measured spectra, photopeaks of the following radionuclides are observed, which are distinct from the background ones:

- photopeaks of Pb^{214} with an energy of 295 keV ($n_\gamma = 19\%$), 351 keV ($n_\gamma = 36\%$) and of Bi^{214} with an energy of 609 keV ($n_\gamma = 47\%$), are produced by the radioactive decay of radium, which belongs to the decay chain of the natural radioactive family of uranium;

- photopeaks of Pb^{212} with an energy of 238 keV ($n_\gamma = 47\%$), of Ac^{228} with an energy of 911 keV ($n_\gamma = 25\%$), and Tl^{208} with an energy of 583 keV ($n_\gamma = 86\%$), belong to the decay chain of the natural radioactive family of thorium;

- in all spectra, the photopeaks of the natural radioactive isotope ^{40}K with an energy of 1460 keV ($n_\gamma = 11\%$) are clearly observed (n_γ – quantum yield of photopeak).

Table 1. – Specific activities of ^{226}Ra , ^{232}Th , ^{40}K , and ^{137}Cs radionuclides in soils taken from sown areas in various studied regions

№	Radioactive isotope							Sample mass (kg)
	Samples	^{226}Ra	^{232}Th	^{40}K	^{137}Cs	Ra_{eq}		
1	2	3	4	5	6	7	8	
Results of samples taken from Navoi industrial zone								
1 point	0–5 cm	39	38	686	3	152	1	
	5–10 cm	46	34	659	0	150	1	
2 point	0–5 cm	46	38	643	3	154	1	
	5–10 cm	45	30	627	3	142	1	
Results of samples taken from the residential area of Navoi region								
1 point	0–5 cm	50	35	642	< 1.59	155	1.12	
	5–10 cm	37	38	541	< 1.40	136	1.17	

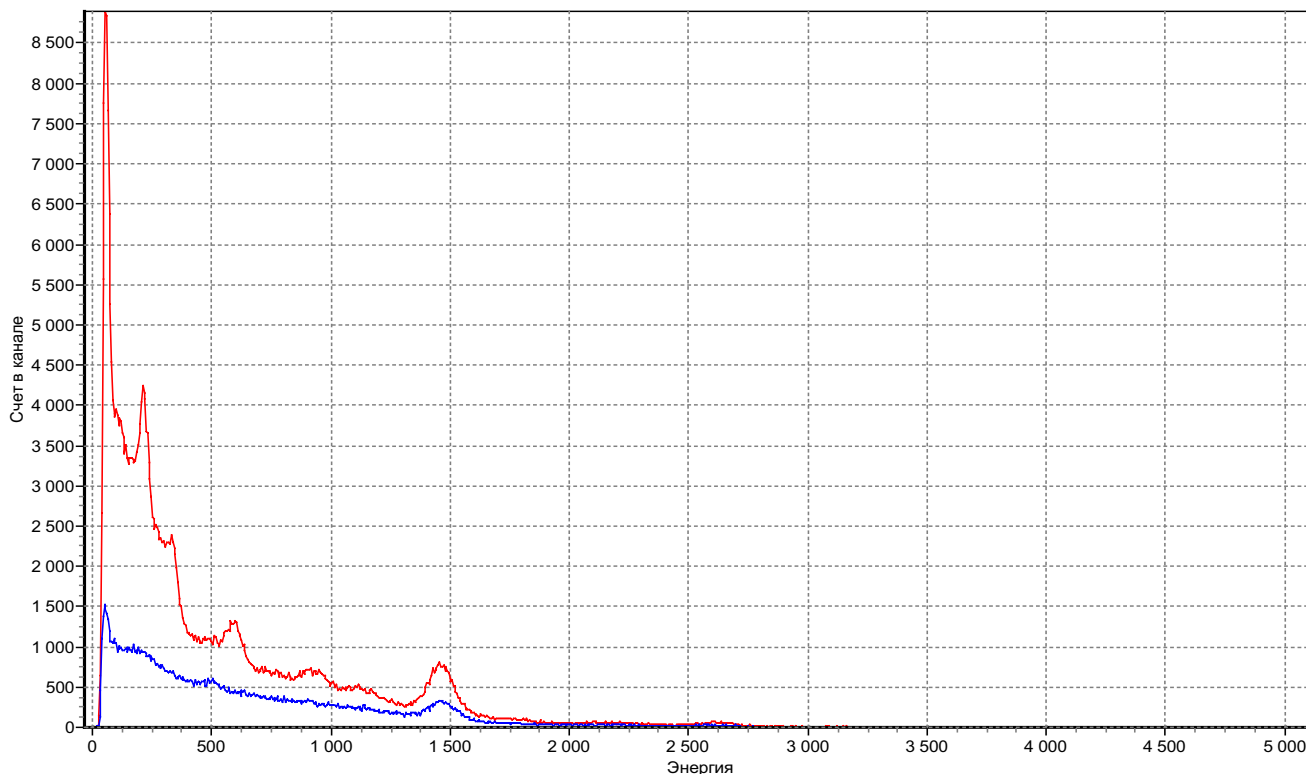


Figure 2. Gamma spectrum of soils of Samarkand region

Radionuclide	Activity, Bq	Uncertainty, %	Spec. activity Bq/kg	Absol. Uncer., Bq/kg	Relative Uncer., % (p=0.95)
Ra-226	35.482	0.1	33.954	5.6	16.5
Th-232	38.539	0.03	36.879	3.8	10.3
K-40	568.8	0.02	544.31	52	9.56
Cs-137	< 1.594	–	< 1.525	–	–

$$Ra_{eq} = 131 \pm 8.82 \text{ Bq/kg}$$

The difference between the effective activity of samples taken from the territory of the Navoi uranium industry and the effective activity of samples taken from the territory of residence of the population of the Navoi region is insignificant within the measurement error, on average within (150–167) Bq/kg. But the specific activity of the technogenic radionuclide Cs¹³⁷ is determined differently in different studied soils. The Cs¹³⁷ ratio is 1.8 times higher.

The difference between the effective activity of soils with a depth of 0–5 and 0–10 cm, taken from the Navoi industrial zone, is also insignificant: a=153 Bq/kg per 0–5 cm, A=146 Bq/kg per 10 cm, while in urban soils

A=181 Bq/kg per 0–5 cm, a=153 Bq/kg per 0–10 cm, in addition, 0–5 cm shows that the effective soil activity at a depth is ~ 1.2 times higher than soil activity up to 0–10 cm. It was noted that the effective activity of intra-urban soils of Navoi, although less than the effective activity of the industrial zone, is 1.12 times higher.

The effective soil activity at a depth of up to 0–5 cm, obtained from the Samarkand region, averages $Ra_{eq}=122 \text{ Bq/kg}$, and at 0–10 cm $Ra_{eq} = 118 \text{ Bq/kg}$.

The highest specific activity in the analyzed soils is accounted for by the isotope potassium-40, but this radionuclide has a different value in soils obtained from different regions and ranges from

456 Bq/kg to 742 Bq/kg. Such a difference may be due to factors such as the geographical location of soils, the degree of soil treatment with cultural fertilizers. The detection of potassium-40 in high concentrations compared to other natural radionuclides indicates its high concentration (2.4%) in the earth's crust [2].

The specific activity of natural Ra^{226} , Th^{232} , K^{40} and Cs^{137} radionuclides in soils depends on their physico-chemical properties, the degree of solubility in water, leaching from soils or entering the soil for various reasons, migration, half-life, geographical area of the location of soils, the degree of radionuclide distribution in the Earth's crust, soil type and soil treatment the dependence of irrigation water, atmospheric air on the radionuclide composition and other factors has been established by scientists.

Thus, the high value of the effective activity of the studied soils is detected in layers from the Earth's surface to a depth of 0–5 cm. From this it can be seen that a larger proportion of natural and technogenic radionuclides can accumulate in the upper layers of the Earth's surface to a depth of 0–5 cm.

Other authors have studied the migration of technogenic Cs^{137} in soils and have shown that its specific activity is determined at high values in the 0–5 cm layer of soils [5].

The effective activity of the studied soils of Navoi region was found to be 1.3 times higher than the effective activity of the soils of Samarkand region.

Conclusion

In conclusion, our study revealed that the difference in effective activity between soil samples from the Navoi uranium industry territory and those from residential areas in the Navoi region was insignificant within the measurement error, averaging (150–

–167) Bq/kg. However, the specific activity of the anthropogenic radionuclide Cs^{137} varied across different soil samples, with a 1.8 times higher ratio observed. The effective activity of intra-urban soils of Navoi was found to be 1.12 times higher than that of the industrial zone, despite being lower in value.

A comparison of soil samples from different depths (0–5 cm and 0–10 cm) in the Navoi industrial zone and urban areas revealed minimal differences in effective activity. The highest specific activity in the analyzed soils was attributed to the isotope potassium-40, with values ranging from 456 Bq/kg to 742 Bq/kg, depending on factors such as geographical location and soil treatment.

The specific activity of natural Ra^{226} , Th^{232} , K^{40} , and Cs^{137} radionuclides in soils was found to depend on various factors, including their physico-chemical properties, solubility, leaching, migration, half-life, geographical area, and soil type, among others. Our findings indicate that the upper layers of the Earth's surface (0–5 cm) tend to accumulate a larger proportion of natural and anthropogenic radionuclides. The effective activity of soils from the Navoi region was 1.3 times higher than that of soils from the Samarkand region.

This study contributes to the understanding of the distribution and behavior of radionuclides in soil samples from different regions and depths, providing valuable insights for assessing the potential environmental and health risks associated with exposure to these radionuclides. Future research should focus on monitoring radionuclide concentrations over time and evaluating the effectiveness of mitigation strategies to minimize their impact on human health and the environment.

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Section 4. Chemistry

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REGULATION OF POLLUTANTS IN WATER FACILITIES

Abstract. Pollution of water systems with various ecotoxicants and other pollutants, especially heavy metals, is one of the most difficult problems of environmental protection. Identification of the distribution of pollutants on the surface of the earth from sources of pollution, meteorological features of the region, in particular, from the direction of the wind, geochemical factors and landscape conditions, in general, is one of the tasks of analysts.

Keywords: heavy metals, lead, tin, ecotoxicants, colorimetric method, water pollution.

Information about the content of ecotoxicants in natural systems, their composition, features of territorial distribution, stability and the impact on physicochemical and physiological-biochemical properties in plant and animal organisms, as well as on biological activities, chemical composition and physical characteristics of waters is necessary and important a prerequisite for the development of modern analytical methods and a set of science-based measures to protect living organisms and optimize the conditions and parameters of nature management.

Of the elements known in nature, more than 20 metals are considered potentially hazardous to humans and animals, as well as the natural environment. The main sources of environmental pollution are mining sites (mines, quarries, etc.) and mining (smelting, metal-working, electroplating, and other enterprises), as well as various kinds of sedimenta-

tion ponds, tailings and concentrate storages, dumps and other materials.

As a result of human activity, there is a selective emission of various types of pollutants and ecotoxicants on an ever-growing scale over large areas. The main problem of controlling the composition of water is related to the complexity and temporal variability of the components of the analyzed objects. At first glance, natural and waste waters are solutions of mineral salts of various concentrations, but in reality they contain a wide variety of inorganic and organic compounds, including carcinogens. Therefore, micro- and trace analysis of natural and waste waters is a complex analytical task, the solution of which requires special and specific methodological and metrological approaches.

Heavy metals and their compounds can enter the human body through the lungs, mucous membranes, skin and gastrointestinal tract. The mechanisms and

speed of their penetration through various biological barriers and environments depend on the physico-chemical properties of these substances, the chemical composition and conditions of the internal environment of the body. As a result of mutual transformations between the metals or their compounds that enter the body and the chemicals of various tissues and organs, new metal compounds can be formed that have different properties and behave differently in the body. At the same time, in different organs, due to the peculiarities of metabolism, composition and environmental conditions, the ways of transformation of the initial metal compounds can be different. Individual metals can selectively accumulate in certain organs and stay in them for a long time. As a result, the accumulation of metal in a particular organ can be primary or secondary.

On the example of lead, let's consider the ways of their entry into the body through the gastrointestinal tract (GIT) with food (animal and plant origin), as well as toxic effects.

Lead, refers to p-elements and is one of the most common metal pollutants of the environment and, above all, air, unfortunately, in significant quantities can enter the human body by inhalation. Lead in the form of insoluble compounds (sulfides, sulfates, chromates) is poorly absorbed from the gastrointestinal tract. Soluble salts (nitrates, acetates) are absorbed in slightly larger quantities (up to 10%). With a deficiency of calcium and iron in the diet, the absorption of lead increases.

When analyzing wastewater, the samples under study may simultaneously contain copper, lead, zinc, nickel, and other elements, although, as is known, for many heavy metals, the dominant form of their presence in natural and wastewater is still not known, but, as a rule, toxicity and biological activity depend not so much on the concentration of the element, but on the specific physicochemical form of its presence. It is generally accepted that free (hydrated) ions of heavy metals, etc., have toxic properties, and their complexes are toxic to a lesser extent.

In connection with the foregoing, there is a need to develop sensitive, accurate and express methods for the determination of heavy metals, the MPC (Maximum Permissible Concentration) of which in environmental objects should be significantly higher than the sensitivity and lower limit of the determined concentrations of the components of the developed methods. One of the more promising options for solving this problem and achieving the stated goal is the colorimetric method, which can achieve fast detection with bare eyes without the need for complex instruments, and can also be applied to analytical applications in the field due to its portable function, since it itself the device is available and at the same time by this method it is possible to determine up to 5 elements in one aliquot of the analyzed sample.

In our country, "natural" water quality standards are taken as a basis (i.e., based on a biological assessment of the degree of harmfulness of a regulated substance, both in the development of sanitary and hygienic standards and fishery standards). This is a big step up from the "technical" regulations, the so-called "standards". In recent years, biological standards "criteria" have also appeared, but they are not mandatory. Technical standards are determined by the capabilities of existing methods for assessing wastewater, and they are more practical. Biological standards, in turn, make it possible to assess the real state of aquatic ecosystems and apply more effective methods for eliminating pollution.

Pollution of water bodies is any negative effect (violation or deterioration of water use conditions) caused by the entry or appearance in a water body of substances directly or indirectly related to human activity. There are three types of pollution:

- primary pollution – caused by the intake of pollutants and the processes of their direct transformation. Secondary and downstream pollutants may appear in the primary pollution cycle;
- secondary pollution – develops as a consequence of primary pollution and represents a new cycle of pollution;

- re-contamination – caused by the repeated removal of pollutants due to primary pollution. For example, the removal of oil products that have settled to the bottom or frozen into ice during floods or ice melting.

Sources of pollution of water bodies can be organized, with a localized place of entry and devices for discharge (household effluents, industrial wastewater); unorganized, not having a localized place of discharge and devices or devices for discharge (timber rafting, washings of fertilizers from fields, drifts of pesticides during aerial processing); semi-organized, having one of the two listed conditions (drilling rigs, washouts from the territories of warehouses, transport enterprises, etc.).

According to the time of action, pollution of water bodies can be constant (incoming during the entire growing season), periodic (the water body does not have time to restore its properties in the intervals between the intake of pollutants) and one-time (the water body has time to recover).

The intensity of the direct action of pollutants is estimated by the following parameters:

- acute lethal concentrations that cause the death of living organisms within a few hours up to 10 days;
- chronic lethal concentrations that cause the death of living organisms in longer periods;
- sublethal concentrations (depressing), violating the basic vital functions – growth, reproduction, metabolism;
- stimulating concentrations;
- inactive concentrations.

The nature of the impact of pollutants on water bodies and aquatic organisms is divided into three main groups, which are commonly called limiting hazard indicators (LIH).

1. General health LIH. It includes a change in the trophy of water bodies, a decrease in the concentration of dissolved oxygen, a change in salinity and temperature of the environment, mechanical pollution with solid and liquid substances.

2. Toxicological LIH. Reflects the direct toxic effect of substances on aquatic organisms.

3. Economic (fishery) LIH. Shows damage to the commercial quality of commercial aquatic organisms.

There are two groups of standards for pollutants entering the aquatic environment.

1. Standards for the intake of pollutants, at which the properties of water bodies and their population protected by this standard are preserved – the maximum allowable discharge (MAD).

2. Content standards, under which the protected properties of the reservoir are not violated – the maximum permissible concentration (MPC).

MPC is set according to the lowest threshold concentration, taking into account the following aspects of action: the stability of harmful substances in water, their impact on the sanitary regime (self-cleaning ability) of water bodies, the impact on the organoleptic properties of water, the impact on the health of the population using water. These indicators refer to MPC and are considered sanitary and hygienic. There is another type of MPC, which reflects not only sanitary and hygienic requirements for water quality, but also environmental – MPC (fishery reservoirs).

The fishery MPC is such a maximum concentration of a pollutant, with the constant presence of which, in a reservoir, there are no negative consequences for the fishery use of the reservoir. It should be borne in mind that pollutants in water bodies are not always constantly present. In this case, the values of the maximum permissible single concentrations (MASC) are used. This is the maximum initially created in the water body concentration of a substance that enters there once, at which it and the harmful products of its decay do not cause negative consequences for the fishery use of the water body.

Fishery regulation includes the following aspects – assessment of the effect of a substance on the hydrochemical regime of a reservoir (the concentration of oxygen dissolved in water, oxidizability according to

Kubel, BOD₅ and BOD_{20'}, changes in the content of three forms of nitrogen – ammonium ions, nitrites and nitrates), on the food base of fish (algae, zooplankton and benthos), on microorganisms, on the growth and development of fish (roe, juveniles and adults), its commercial qualities, as well as an assessment of the rate of destruction of the pollutant.

According to the degree of hazard of pollutants for MPC F.R. subdivided:

- especially dangerous (maximum concentration limit with the content of pollutants less than 0.0001 mg/l), providing for the absence of a harmful substance in the water;
- dangerous (toxic, but stable), limited by MPC;
- toxic (stable and non-accumulative);
- environmental, limited by general sanitary LGS.

The second standardized indicator used to protect the aquatic environment from pollution is the maximum allowable discharge (MAD). In accor-

dance with interstate standard (IS), the maximum allowable discharge of substances into a water body is understood as the mass of a substance in wastewater, the maximum allowable for discharge with the established regime at a given point of a water body per unit of time in order to ensure water quality standards at the control point.

MAD is set taking into account the MPC of substances in places of water use, the assimilative capacity of a water body and the optimal distribution of the mass of discharged substances between water users discharging wastewater. When discharging substances with the same MPC, the MPC is set so that, taking into account impurities that enter the reservoir or drain from upstream outlets, the sum of the ratios of the concentrations of each substance in the water body to the corresponding MPC does not exceed one. MAD values are valid only for a specified period of time, after which they are subject to revision.

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TITRATION OF THE ZINC ION WITH A SOLUTION OF 2-PHENYL-HYDRAZIDE PHENYLAZOTHIOMIC ACID

Abstract. Sensitive and selective reactions of sulfur-containing reagents to metal ions in non-aqueous (acetic acid and n-propanol) media were the basis for establishing the possibility and developing voltammetric procedures for titration of zinc ion with a solution of phenylazothioformic acid 2-phenylhydrazide in dimethylformamide and dimethylsulfoxide. The article presents the results of experiments on the voltammetric determination of the zinc ion by phenylazothioformic acid 2-phenylhydrazide in medicinal zinc-containing preparations.

Key words: diphenylthiocarbazone, zinc, tying, electrodes, sulfur-containing reagents.

The literature presents the possibility of using amperometric indication of the end point of titration of ions of some heavy metals with solutions of phenylazothioformic acid 2-phenylhydrazide (according to their emerging anodic current using two platinum indicator electrodes in an amphiprotic solvent – n-propanol. It was of interest to check the possibility of similar titrations with solutions of the same titrants in protophilic media, the acid-base properties of which are very different from amphoteric ones – dimethylformamide and dimethylsulfoxide [HCON(CH₃)] and (CH₃)₂SO.

We found that the reagent phenylazothioformic acid 2-phenylhydrazide, oxidized on a platinum disc microanode in protophilic media on the backgrounds of potassium acetate, lithium nitrate and perchlorate, gave quite clearly pronounced anodic waves with half-wave potentials equal to 0.49 V, 0.58 V and 0.70 V respectively.

It was shown that in dimethylformamide and dimethylsulfoxide on backgrounds of different acid-base properties, of all the studied cations, zinc (II) is best titrated with solutions of the above reagents,

while the position of i.e., as a rule, is always proportional to its taken amounts, which predetermines the possibility of obtaining correct and reproducible results in the voltammetric determination of zinc(II) based on the stoichiometric reaction of complex formation in the ratio Me: Reagent= 1:2 (Zn - differential current protection).

Influence of external voltage. From the current-voltage curves of differential current protection oxidation, it can be concluded that amperometric titration of Zn(II) is possible based on the cathodic reduction current of both the titrated ion and the emerging anodic current of the reagent. Zn (II), as has already been shown, form very strong dithizonates that do not decompose even in fairly acidic and basic media. Therefore, it could be expected that the formation of zinc dithizonate complexes in dimethylformamide and dimethylsulfoxide would also proceed quantitatively, especially in the presence of potassium acetate and lithium perchlorate. Zinc dithizonate is a zinc metal chelate compound with the formula $Zn(C_{13}H_{11}N_4S)_2$. Under normal conditions, it is purple-red crystals.

Comparing the voltammograms of zinc cations, titrating reagents, their complexes (dithizonates) and oxygen, obtained in dimethylformamide and dimethylsulfoxide, we can conclude that already at a voltage of about 0.4–0.5 V, the current at the first stage of acid-base titration should arise due to the reduction of titratable zinc cations at the cathode and the oxidation of their respective metal complexes (zinc dithizonate) at the anode. After acid-base titration, the current should again arise, but this time due to the reduction of oxygen and the oxidation of the reagent at the anode. The experiments carried out confirmed our assumptions; when titrating zinc ions with differential current protection solutions, curves of sufficiently clear shape, correct and reproducible acid-base titration results were obtained in the range of voltages applied to the indicator electrodes that did not exceed the optimal values (0.4–0.8 V). Experiments have shown that the formation of complexes of Zn (II) with differential current protection occurs quite quickly and the measured indicator current becomes constant at any stage of the titration after 5–10 s. after each addition of titrant. Very clear voltammetric determination curves, which make it quite easy and accurate to find acid-base titration, are observed on the backgrounds of potassium acetate and lithium perchlorate at an electrode voltage of 0.4–0.8 V.

Influence of the nature and concentration of the supporting electrolyte. During the voltammetric determination of Zn (II) with a differential current protection solution in dimethylformamide and dimethylsulfoxide, it was found that the concentration of supporting electrolytes (potassium and sodium acetates, lithium chloride, nitrate and perchlorate) has a significant effect on the clarity of titration curves, and at their low content (less than 0.025 M) even on the correctness of the results.

The experiments showed that potassium acetate and lithium perchlorate turned out to be the best of all the studied backgrounds. On other backgrounds, it is difficult to accurately find the end point of the titration of the zinc ion.

It was found that the optimal concentrations of background electrolytes in the voltammetric determination of a zinc ion with a differential current protection solution are: for potassium acetate – 0.10–0.30 M, lithium nitrate – 0.05–0.20 M, and lithium perchlorate – 0.05–0.25M.

Evaluation of the correctness and reproducibility of the developed methods. To assess the degree of accuracy of the proposed method for the voltammetric determination of zinc(II) with a solution of differential current protection in dimethylformamide and dimethylsulfoxide, as well as their mixtures with various inert solvents, voltammetric determinations of various amounts of zinc ion were carried out with 3–5-fold repetition of titration of each amount. The results of the voltammetric determination of 5–1000 mg of zinc ion in 10 ml of the test solution indicate the correctness and reproducibility of the data obtained (relative standard deviation is not more than 0.045), and the average value found, compared with the introduction, does not go beyond the confidence interval.

The obtained experimental data show that the developed procedures for the voltammetric determination of zinc(II) by a solution of diphenylthiocarbazone in dimethylformamide and dimethylsulfoxide, as well as in their mixtures with inert solvents, are quite selective.

Summing up the results of the studies on the positive zinc ion with differential current protection solution in protolytic media (acetic acid, n-propanol, dimethylformamide and dimethylsulfoxide) and their mixtures with some inert solvents, we can conclude that the most favorable medium for such titrations is acetic acid and its mixtures with chloroform and carbon tetrachloride, then n-propanol and its mixtures with benzene and chloroform, and finally dimethylformamide and dimethylsulfoxide and their mixtures with chloroform and hexane.

Of all the above solvents, anhydrous acetic acid and its mixtures with inert solvents are the most versatile in terms of titration of 2–4 cations in one aliquot

in the presence of a large number of interfering metal ions, because in such media high selectivity can be achieved quite well and quickly by increasing the acidity of the titratable solutions by adding nitric, perchloric or other strong acids. Under such conditions, zinc (II) can be determined very accurately in the presence of large amounts of heavy metal ions without the use of special masking agents or other compounds.

With regard to the rapidity of performing the voltammetric determination of metal ions in one analyzed sample, other things being equal, of all the studied media, dimethylformamide and its mixtures with inert solvents are better, since the time for titration of one aliquot of the analyzed sample does not exceed 2–3 min.

The determination of zinc (II) in artificial mixtures was carried out both by the current of zinc reduction on a platinum indicator electrode by the current of differential current protection oxidation.

The results of the analyzes performed show that the developed methods for determining the zinc (II) ion with a differential current protection solution are quite correct and selective with a relative standard deviation not exceeding 0.05. the time of the analysis of one mixture is no more than 10–15 minutes. The developed procedures for the voltammetric determination of the zinc ion are characterized by fairly good selectivity in protophilic media with relative accuracy, rapidity, and a low detection limit.

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DEVELOPMENT OF TECHNOLOGY FOR OBTAINING NEW TYPES OF MICROELEMENT-CONTAINING FERTILIZERS BASED ON GLAUCONITES AND BENTONITES OF KARAKALPAKSTAN

Abstract. The climatic and geographical features of Uzbekistan, including the Republic of Karakalpakstan and the special zone of the Aral Sea region, its unique ecosystems with rare species of flora and fauna, which are of great importance for the entire global ecosystem of the planet, have led to the inclusion of tasks to ensure environmental sustainability among the national priorities. One of the alternative ways to restore soil fertility is the use of organic-mineral fertilizers. The results of the existing experience in the use of organic-mineral fertilizers in agriculture show that they have the property of restoring soil fertility due to the content of various microelements in them. Along with this, the water-retaining property of organic fertilizers based on manure, among other things, allows for a more rational use of water.

Keywords: Republic of Karakalpakstan, bentonites, glauconites, organic, organomineral, ammonium nitrate.

In order to prevent dehydration of the soil cover, soil, mobilize soil phosphates, and protect the environment, by eliminating waste from the production preserve and even increase the humus content in the

of mineral resources, two types of microelement-containing fertilizers have been created based on local mineral raw materials and plant waste of Karakalpakstan.

The climatic and geographical features of Uzbekistan, including the Republic of Karakalpakstan and the special zone of the Aral Sea region, its unique ecosystems with rare species of flora and fauna, which are of great importance for the entire global ecosystem of the planet, have led to the inclusion of tasks to ensure environmental sustainability among the national priorities. Given the high rates of economic growth over recent years, Uzbekistan recognizes the need to balance measures aimed at ensuring further economic growth with actions to protect the environment, including the rational use of natural resources and their preservation for future generations.

Insufficient application of organic fertilizers led to a sharp decrease in the amount of humus in the soil. Scientific research data show that intensive chemicalization of agricultural production with the use of mineral fertilizers leads to an increase in emissions of carbon dioxide, methane and nitrogen into the atmosphere, which are formed as a result of the destruction of soil humus. Research scientists show that the formation of carbon dioxide leads to climate change. It has been established that 20–25% of the total accumulated carbon dioxide in the atmosphere is the result of the destruction of soil humus due to the use of mineral fertilizers.

Studies show that more than 95% of the irrigated lands of the Republic of Karakalpakstan (the total area of irrigated lands is 500 thousand hectares) are saline. Practice shows that even weak salinization of soils leads to the loss of at least 15% of the yield of cotton and other crops. Currently, soil desalination is carried out by washing. The scarcity of fresh water complicates the application of this method.

One of the alternative ways to restore soil fertility is the use of organic-mineral fertilizers. The results of the existing experience in the use of organic-mineral fertilizers in agriculture show that they have the

property of restoring soil fertility due to the content of various microelements in them. Along with this, the water-retaining property of organic fertilizers based on manure, among other things, allows for a more rational use of water.

Regular monitoring of the state of the soil in the Aral Sea zone shows that from year to year the soils are subject to degradation processes: dehumification, desiccation, salinization, deterioration of water-physical properties, and more. The predominance of the removal of nutrients over their return, more intense mineralization of organic matter in comparison with humus formation is the main reason for the decline in fertility and an increase in the rate of regression of agro-ecosystems.

Therefore, along with the need to develop effective measures for desalinization and improvement of soils, a promising direction is the creation of agro-ore-containing fertilizers based on animal and poultry waste (30–40 t/he or more per year) with complex-forming, ion-exchange and sorption properties that would help plants grow on saline soils. Such properties are possessed by complex fertilizers obtained on the basis of agricultural ores of Karakalpakstan.

It should be emphasized that it is the decrease in the content of organic matter in the soil that is the root cause of its salinization, which, in turn, leads to a complete loss of structure and further to deflation and erosion.

The problem of soil degradation poses urgent challenges for the entire world community. In this regard, the FAO expert panel report *The State of the World's Soil Resources* identifies 10 major threats to soils: erosion, loss of soil organic carbon, nutrient imbalances, soil acidification, pollution, waterlogging, soil compaction, soil sealing, salinization and loss soil biodiversity. There are four priority measures to combat degradation (UN General Assembly resolution 64/201): 1) minimizing further degradation and restoring the productivity of soils that have already degraded in regions where the population is

most vulnerable; 2) stabilization of global stocks of organic matter in soils, such as organic carbon and soil organisms; 3) stabilization or reduction of global fertilizer use in regions where there is a shortage of nutrients; 4) improving knowledge about the state of soils and the main trends in this area.

The soil cover of the arid zones of Uzbekistan (including Karakalpakstan) is also subject to degradation and desertification processes, which leads to a reduction in the area of agriculturally suitable land. Taking into account the above priority measures to combat the degradation of arid soils, the Institute of General and Inorganic Chemistry of the Academy of Sciences of the Republic of Uzbekistan is developing new types of fertilizers that would optimize the nutrient regime of soils, increase the efficiency of nitrogen and phosphorus fertilizers through modification and giving them new properties.

So, thanks to the addition of local minerals – bentonites in an amount of 15–20% to the melt of nitrogen and phosphorus fertilizers, modified fertilizer granules acquire new qualities: slowly soluble properties, the ability to swell and water retention, to change the physical and chemical properties of soils due to the stabilization of soil aggregates and, as a result, the optimization of biological processes.

Three-year vegetation studies of the Laboratory of Agrochemistry of the Institute of General Chemistry of the Academy of Sciences of the Republic of Uzbekistan and the Laboratory of Chemistry of Mineral Fertilizers of the Karakalpak Research Institute of Natural Sciences made it possible to deeply study the properties of new bentonite-modified nitrogen and phosphorus fertilizers of prolonged action, intended for irrigation conditions on typical gray soil. A complex of physicochemical, agrochemical and microbiological studies was carried out, which made it possible to: 1) assess the degree and rate of release of nutrients from granules of bentonite-containing fertilizers; 2) to study the change in the physicochemical and agrochemical properties of the soil under the influence of slow-acting fertilizers;

3) evaluate the effectiveness of their influence on the growth, development and productivity of cotton plants; 4) identify patterns of microbial activity in the soil, including the dynamics of the number of microorganisms involved in the transformation of nitrogen and phosphorus and the level of activity of soil transformation of nitrogen phosphorus and the level of activity of soil enzymes.

The material briefly presents the results of studying the physicochemical and agrochemical properties of fertilizers and their agrochemical effectiveness on cotton crops. The composition of the studied fertilizers: bentoammonium nitrate (BAN) in%: bentonite – 15; N – 28.9; CaO – 0.6; Al_2O_3 – 1.9; SiO_2 – 6.5; SO_3 – 0.19; K_2O – 0.3, granule strength – 4.77 MPa; bentoammophos BAM in%: bentonite – 20; N – 8.65; P – 38.5; CaO – 0.5; Al_2O_3 – 1.4; SiO_2 – 5.6; SO_3 – 0.12; K_2O – 0.23, granule strength – 7.50 MPa. The experiment was carried out on a typical gray soil (Calciol, WRB, 2006) with the following characteristics: C – 0.5%; N_{total} – 0.09%; P_{total} – 0.14%; pH 7.2.

A model laboratory experiment with soil columns found that the presence of bentonite in the composition of fertilizers, prolonged BAN and BAM, and the ability to adsorb and retain moisture can increase soil moisture capacity (by 0.42–0.65%), reduce the dissolution rate of fertilizer granules by 1.1–2.5 times (in the first days of the experiment up to 4–10 times), reduce the intensity of leaching of NH_3^+ , $N-NO_3^-$ and P_2O_5 – ions by irrigation water.

Laboratory and vegetative experiments showed that BAN and BAM showed a positive effect on the phenological and biometric characteristics of the development of cotton plants, stimulating both the energy of seed germination (by 2.4–28.1%) and the growth of plant organs (the main stem by 1.7–4.7%); leaves by 2.3–4.1%; sympodial branches 2.5–12.7%; buds and fruit elements 2.1–12.9%) with an increase in yield by 9.4–15.2%. It should be especially noted that the number of immature fruit elements in the

variants with BAN and BAM was 2.3–1.6 times less than in the control.

The study of the agrochemical characteristics of a typical serozem under the influence of prolonged BAS and BAM fertilizers recorded a small but stable change in indicators (by the end of the third year of research): an increase in the amount of humus by 3.2–4.4% (compared to control), an increase in ammonium nitrogen under exposure to BAS (1.12–3.7 times), with a decrease in the content of the nitrate form (by 1.9–47%) and an increase in mobile phosphorus by 20.5–32.5% in the soil due to a more gradual and uniform release nutrients.

The involvement in the production of fertilizers of new types of agrochemical raw materials (local minerals and agro-ores, in particular bentonites) is one of the reserves for increasing the yield of irrigated crops and the quality of agricultural products, maintaining and increasing soil fertility in conditions of moisture deficiency or drought on degraded soils.

It should be noted that in recent years microelements containing fertilizers are practically not used on the sown areas of the republic, although it is known that microelements are part of enzymes, vitamins, hormones and other physiologically active compounds that play an extremely important role in the processes that occur in living organisms. Therefore, along with the need to develop effective measures for soil desalinization, a promising direction is the creation of microelement-containing fertilizers with complex-forming, ion-exchange and sorption properties. Such properties, in our opinion, can be possessed by complex fertilizers obtained from glauconites of Karakalpakstan. In this regard, we used glauconites as additives in order to obtain new nitrogen fertilizers.

Ammonium nitrate is a universal nitrogen fertilizer. The main disadvantages of ammonium nitrate are its caking and thermal instability, to eliminate which various additives are introduced into it. The best effect is achieved when using caustic magnesite. It is known that pure ammonium nitrate is a strong

oxidizing agent capable of sustaining combustion and detonation when subjected to a strong impact load or when initiated by explosives. An important task at present is to reduce the level of potential hazard of ammonium nitrate. For this, research is underway on the selection of highly effective additives that improve the strength of the granules, increase the thermal stability of the fertilizer [1–3].

We used glauconite sand of the Karakalpakstan deposit as an additive. Glauconite is a clay mineral of variable composition with a high content of bi- and trivalent iron, calcium, magnesium, potassium, and also containing a whole complex of microelements. The beneficial effect of glauconite on increasing plant productivity is manifested in various ways. It improves soil structure by increasing its permeability, which is especially important on heavy soils. In addition, the introduction of glauconite into ammonium nitrate makes it possible to reduce its flammable and explosive properties and expand the sales market.

One of the promising deposits is the Khodjakul glauconite deposit, the promising reserve of which is about 10 million tons.

It seems possible to identify those properties of glauconite that can be classified as unique, since they are the determining factors in the manifestation and development of the process of self-organization of the mineral, and among which the high physical and chemical activity of glauconite occupies a special place.

Along with the need to develop effective measures for soil desalinization, a promising direction is the creation of fertilizers with complexing, ion-exchange and sorption properties that will help plants grow on saline soils, as well as solve the problem of the explosive nature of ammonium nitrate.

The results of the research showed that the introduction of glauconite ammonium nitrate into the melt leads to a significant increase in the quality indicators of the resulting fertilizer. Based on the results obtained, for the first time, a technology was developed for obtaining a microelement-containing fertilizer based on the melt of ammonium nitrate

and glauconite, the introduction of which in order to solve the problem of its explosiveness leads to the production of thermostable ammonium nitrate. In this regard, samples of a new fertilizer were obtained at the experimental facility under laboratory conditions, its chemical, physico-chemical, physico-mechanical, and mineralogical compositions were determined.

The objects of research in the work were ammonium nitrate, glauconite of the Khodjakul deposit and the obtained fertilizer.

Since agriculture imposes strict requirements on the quality of fertilizers: all granular fertilizers should not be caked, 100% friability should be maintained for 6 months from the date of their manufacture: the static compressive strength of the granules should be at least 1.2–1.8 MPa. In this regard, we have determined some quality indicators (caking, the rate of dissolution of the granules of the resulting glauconite-containing ammonium nitrate in water).

The caking of ammonium nitrate with the addition of glauconite was determined by the express method, according to which the change in the degree of caking of ammonium nitrate was checked when glauconites were added to its melt in the ratio of ammonium nitrate: glauconite, equal to 100: (3–30). The test results of AS with the addition of glauconite show that with a decrease in its amount, the caking capacity of ammonium nitrate increases from 1.94 to 2.61 kg/cm². With the ratio AC: glauconite equal to 100:30, the caking of the product is 1.94 kg/cm², which is 2.4 times less than the caking of pure ammonium nitrate with the addition of magnesite produced by Maksim-Chirchik JSC (the caking of which is 4.64 kg/cm²).

The values of the hygroscopic points of the studied fertilizer with granule sizes of 2–3 mm are equal, in%; for AS-62.2; for fertilizer (AC: glauconite=100:3)-61.2, for fertilizer (AC: glauconite=100:20)-60.44 and for fertilizer (AC: glauconite=100:30)-58.5. According to the hygroscopicity scale, all samples are classified as hygroscopic sub-

stances. When studying the sorption moisture capacity, it was noted that ammonium nitrate at a moisture content of 3.5% strongly caking and loses friability, and samples of glauconite-containing fertilizers up to 5.0–6.0% moisture content retain the ability to sieving.

The rate of dissolution of fertilizer granules determines the caking of fertilizers during storage, therefore it has been experimentally revealed that when glauconite is introduced into the melt of ammonium nitrate, the rate of dissolution of fertilizer granules decreases compared to pure ammonium nitrate. With an increase in the mass fraction of glauconite in fertilizer samples (from 5 to 50), the time for complete dissolution of the granules increases from 48.8 to 96.2 sec. The time of complete dissolution of pure saltpeter granules is 46.8 sec. The data obtained indicate that the leaching of the studied fertilizer from the soil will occur much more slowly than the leaching of pure ammonium nitrate.

Studies on the strength of granules have shown that the more additive is introduced into the composition of the ammonium nitrate melt, the higher the strength of the granules. It was found that already at the Ac: Gl ratio of 100:5, the strength of the granules is up to 1.66 MPa, with the strength of the granules of pure ammonium nitrate – 1.6 MPa, and at the ratio of Ac: Gl equal to 100:13, the strength of the granules already reaches 2.0 MPa.

All the data obtained from the studies also indicate a decrease in the propensity of the obtained nitrogen fertilizer to detonation, which is explained by a decrease in the size of the crystals, which ensure their denser packing and the presence of calcium in the mixture, which interrupts the uniformity of the properties of ammonium nitrate and the detonation wave propagation zone.

Practice has shown that organic and organomineral, glauconite-bentonite-containing fertilizers have high agrochemical efficiency and mobilizing properties in relation to indigestible phosphates and have growth-active substances in their composition, create

a loose structure, increase the total surface area of the volume of finished products, promote adsorption and retention of moisture, and also nutrients – nitrogen, phosphorus, potassium, calcium, trace elements.

For organic and inorganic substances used as fertilizers, in terms of increasing their functional efficiency, their physical and mechanical state is of great importance, so the first and main effect will be achieved due to their loose structure, and this will affect several indicators [4–9]:

- time of transition to the active functional phase (decomposition phase). The fact is that as a result of oxidative processes in the production of fertilizers or in soil conditions, humification and transformation of organic matter occur and loose, developed structures with a large volume surface are formed;
- looser structures (compounds), when they decompose, and they decompose faster, are in the phase of free radicals, which in itself increases the functional activity of the compounds, as a result of which the rapid penetration of nutrients into soil solutions and plants is ensured;
- to increase the productivity of the process, the development of the contact surface is of great importance, which leads to an increase in the efficiency of the entire process. Due to the development of the contact surface and loose structure, the time of interaction of the reacting substances is reduced, which makes it possible to simplify the technology and improve the quality of the resulting fertilizers;
- loose structures are hydrophilic structures, they promote the adsorption and binding of soil moisture and prevent many of the processes that cause weathering and soil erosion. These are “preservatives” of soils while improving their structure and fertility;
- organic and organomineral fertilizers are capable of adsorbing and retaining nutrients by increasing the total volume surface, and their high ability to adsorb moisture (up to 50% abs.) prevents and eliminates the possibility

of washing out nutrients (nitrogen, phosphorus, potassium, calcium, and others) in subsurface horizons. All this makes it possible to significantly (by 25–50%) reduce the rate of application of nutrients to the soil. The use of such fertilizers will reduce and eventually remove salinization and increase soil fertility, as well as save the growing season of plants that require irrigation;

- loose and porous structures of organic and organomineral fertilizers allow to increase the possibility of covering soil horizons and improve their interaction with phosphates, soil and plant root system.

The economic component of the production and use of organic, organomineral fertilizers based on organomineral raw materials always has a real and reliable positive value due to:

- simplicity of technological solutions for their production (no high temperatures, pressures, expensive equipment, washing, roasting and other operations);
- the maximum utilization rate of raw materials (conducting the process using non-waste technologies or technologies involving the involvement of waste as additional raw materials);
- a significant reduction in the volume of acidic reagents (by 4 or more times) and energy costs;
- reduction of chemical aggression on the environment and the biosphere (lack of fixation and leaching of nutrients into subsoil horizons and loss of nitrogen into the atmosphere in the form of oxides);
- increasing the efficiency of the nutrient elements of finished products and reducing the hectare norm of fertilizers by 2 or more times;
- optimization of physico-chemical, physical, soil, microbiological processes and other factors;
- improving the quality of grown products (no nitrates, increasing shelf life, increasing the content of vitamin C, protein, starch, gluten, carbohydrates, organic acids, etc.).

Maintaining and increasing the level of soil fertility is becoming a critical issue due to the increasing population density in the world, and the need to increase the yield of food crops. Therefore, the development of effective technologies for the production of organic and organomineral fertilizers and their implementation will allow to comprehensively solve the issues of raw materials, water and soil, animal and plant resources, environmental protection and ensure an increase in the volume and quality of agricultural products.

The lack of mineral fertilizers in the Republic of Kazakhstan is associated with remoteness from the place of their production, high cost. They do not contain trace elements. Standard fertilizers do not heal the saline soils of Karakalpakstan, have little effect on soil moisture retention, do not improve soil structure, do not contribute to the formation of humus in the soil, and increase the content of harmful salts in the soil. The efficiency of standard fertilizers

is not high enough. For example, the efficiency of phosphate fertilizers (ammophos, superphosphate) is 15–20%. Standard fertilizers quickly dissolve in the soil solution and a significant part of the beneficial components are washed out. In this regard, plants do not receive enough nutrients necessary for growth and development.

Establishing the production of fertilizers locally, using cheap local agricultural ores, can change the situation for the better. The composition of enriched agro-ores contains from 15 to 20 micro- and macroelements necessary for the growth of crops. As a result of our research, it was found that new fertilizers based on local raw materials heal the soil, namely, in the process of interaction with the soil solution, redox reactions occur, which lead to a decrease in soil salinity, help retain moisture in the soil, and increase the humus content in the soil, soil structure formation improves, which leads to an increase in crop yields.

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LEARNING ABOUT THE METHOD OF CONNECTING THE ELECTRONIC MICROSCOPE OF COMPLEXATION OF Co (II) SALT WITH OXADIAZOLE DERIVATIVE

Abstract. The oxadiazole derivative 5-(4-pyridyl)-1,3,4-oxadiazolin-2-thione (Hpot) was used as a ligand in reactions to form complexes of Co(II) ions. The composition and structure of the selected ligand were studied by means of elemental, thermal and X-ray phase analysis, IR spectroscopy, and absorption electronic microscope analysis. Based on the research, it was found that the ligand has individuality, characteristic composition and cyclic structure. According to the data of IR spectroscopy, it was found that the ligand exists in tautomeric forms in the solid state and in solution.

Keywords: oxadiazole, cyanoactive electronic microscope, electronic light, cobalt ions.

Currently, a powerful technique is used in the analysis of material – the scanning electron microscope (SEM). In this case, a modern cell phone is passed through a thin electronic circuit board. The resulting electron is bombarded and leads to the release of a secondary electron, the collision of a double electron with a low energy, and the formation of a pentogen nucleus opposite to the element itself. The SEM detector only collects low-energy secondary electrons from the thin nanometer surface of the sample. This eca paints very good peaks with a perfect color version.

A portable electronic microscope has many advantages over other devices. For example: when attached to the tip of a conventional optical microscope, the optical microscope is characterized by high accuracy and high reproducibility, as well as the clarity of the image obtained and the speed of analysis.

The percent concentration of Co, C, N, O, and S elements in the composition of the complex based on $\text{Co}(\text{Cl})_2$ is Co-13.2%, C-37.4%, N-9.5%, O-21, 5% and S-14.6%. This results in a formula with the composition $\text{CoC}_{14}\text{N}_6\text{N}_{18}\text{O}_6\text{S}_2$. According to the

given formula, the composition of the complex can be represented by the formula $[\text{Co}_2(\text{H}_2\text{O})_4]^*2\text{H}_2\text{O}$.

The results of the thermal analysis were analyzed in order to determine the thermal stability of the complex bipicalap of the Co (II) salt with 5-(4-pyridyl)-1,3,4 oxadiazol-2-thione and the presence of a new molecule.

The thermal analysis is carried out in a thermal analytical device – deviator, and simultaneously the rate of reduction of the mass of the sample, the mass of the complex and the thermal stability are determined. As a result of the thermal analysis, the folding and folding of the complex, the coordination quality and coordination of the ligand, and the complex product are determined.

Dehydration is assumed to occur at significantly lower temperatures when dehydrating. Because the Van-Der-Vals circuit requires a low-energy capacitor when it closes to a coordination bond break. The separation of the water in the crystallhydrate and the internal shpere is in a very wide range of temperature, so it is not possible to determine the temperature of the beginning of the water in practice. For the

studied complex, the peak of the coagulation curve appears at 120–134 °C, which is due to the crystallizing water molecule in the complex.

The thermal analysis of the synthesized complex compounds can be summarized as follows: complex compounds is decomposed in an oven at an temperature of 50–700 °C. For the studied complex, the observation of the endothermic effect at the temperature of 120–134 °C is caused by the dissociation of the water molecule in the complex. This is explained by the fact that the complex compounds has a crystallization curve.

In order to determine the nature of the ligand and the electronic transitions of the synthesized complex compounds, as well as the degree of oxidation of Co (II) ions and the spatial structure of the complex compounds, the electronic spectrum of the powder complexes was studied.

It is known from the literature that the Rak-B parameter, which describes the inter-electron repulsion and is related to the size of the metal and the effective charge of its nucleus, provides information on the degree of covalency of the metal-ligand bond; in this case, the greater the covalency of the bond (the greater the polarizability of the ligand and the polarizing effect of the cation, the greater the effective charge of the cation nucleus and the level of covalency of the bond) Rak parameter B. Dq parameter is a metal ion with a complex increase in the metal charge and the strength of the ligand field, and depending on the nature of the ligand. The Rak parameter tends to increase with an increase in the number of electrons in the d-shell due to the increase in interelectron repulsion B.

Thus, as a result of the analysis of the electronic spectrum of the diffusion reduction of Co (II) nitrate complex in the form of powder, it can be said that the absorption lines of the ligands, determined in the strong field, shift to the side of high frequencies. Accordingly, the degree of compression of the coordination polyhedron in the direction of the planar structure corresponds to the skewed octahedral structure of the Co (II) complex.

In the calculation analysis of the obtained results, it should be noted that the calculated values of the Rak B parameters increase with an increase in the number of d-electrons in the 2+ charged ions of Co (II) complexes, which means a decrease in the level of covalency of the M–L bond with the return of electrons and a change in the nature of the metal.

A selected ligand has multiple donor competing atoms to coordinate into a complex structure. To determine the approximate coordination centers in the heterocyclic ligand, we carried out a chemical calculation of the reactivity of the donor centers in the polyfunctional ligand by the quantum chemical DFT method. The analysis of the calculated data showed that the most probable centers of coordination in (Hpot) ligand molecules are nitrogen atoms of oxadiazole and pyridyl rings. The data of physicochemical analysis of some intermediate metal complexes obtained confirmed the results of quantum chemical calculation of the selected ligand molecule. Methods of synthesis of 8 new complex compounds with Co (II), Ni (II) chlorides, nitrates and acetates based on (Hpot) ligand were developed and mastered.

The composition of the synthesized complex compounds was studied by the methods of elemental, X-ray phase and thermal analysis, IR spectroscopy, scanning electron microscope, diffusion reduction electron spectrum analysis methods. According to the results of thermal analysis, it was found that the synthesized complex compounds contain water of crystallization and coordination.

According to the results of IR spectroscopy, the coordination centers of the metal ions of the ligand were determined, the heterocyclic ligand (Hpot) can be monodentate and bidentate, it was shown that the molecule is bound by the donor atom when the quantum chemical theory of the ligand is calculated. It was found that, depending on the reaction conditions, complexes can have M : L = 1:2 or 1 : 4 composition.

For all complex compounds formed from metal chlorides and 5–4-pyridyl-1,3,4-oxadiazol-2-thione/thiol in C₂H₅OH, a two-state octahedral struc-

ture in the coordination compound was proposed on the basis of physicochemical analysis. The polygons are covered by monodentately coordinated molecules with the nitrogen atom of the pyridyl ring, the ligand, and the four bound water molecules.

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ELEMENTAL COMPOSITION IN THE SOIL LAYERS OF THE DRIED BOTTOM OF THE ARAL SEA AND BALANCE THEIR AMOUNTS ON THE BASIS OF EQUIVALENT RATIOS

Abstract. Every year, up to one hundred million tons of toxic salt and dust mixture is carried by the winds from the dried bottom of the Aral Sea. Most of it settles in the nearest territories, but millions of tons are carried away thousands of kilometers away. The results of the analyzes show that the migration of toxicants infects the environment and pollutes plant products. Based on the results of the research, approaches have been developed to balance the ions in a layer of 0–20 cm to create the development of plants according to biological properties.

Keywords: Aral Sea, soil, heavy metals, calcium, then magnesium, sodium, B, Cu, Zn and Mn, dried bottom.

Introduction

The Aral region attracts great attention of scientists as an object that is experiencing drastic changes in the natural environment and caused the deterioration of the ecological situation.

The dried bottom of the Aral Sea is a global threat to the environment. From this, one can imagine what a global difficult task faces scientists who are looking for possible ways to lay a dried-up seabed and help the natural process to fix sandy areas containing toxicants and devoid of vegetation [1–3]. A toxic salt-dust mixture is carried by the winds around the Aral Sea and its adjacent territory [2–4].

Heavy metals are inhibitors of many physiological processes as toxic substances [5; 6]. Therefore, at present, the problem of protecting the environ-

ment from pollutants, which is closely related to the need to obtain a large number of environmentally friendly agricultural products through the use of intensive technologies, is very relevant. The literature contains rather contradictory information about the migratory ability of the most dangerous toxicants, about the quantitative parameters of their accumulation in the natural environment, as well as about the factors influencing this process [5–13].

Our research work is related to the study of toxicants in the salt-sand layers of the dried seabed and the attempt to neutralize where resistant species/varieties or seed materials are planted.

Objects and methods

To study toxicants and their migration, the southeastern latitudes of the Aral Sea from the Muynok re-

gion were chosen as the object of study. The selected territory of the Aral Sea is located from the 80th kilometer from Muynak. Although this territory belongs to the drylands of the 60 s, 70 s and 80 s, samples of soil layers and plant products grown in areas and areas adjacent to the territory of the island were taken for analysis.

Soil samples and plant products were taken in an amount of 200 mg on an analytical balance (FA220 4N) to prepare for elemental analysis. A mineralization device (MILESTONE Ethos Easy, Italy) was used to mineralize the sample. To do this, in a test tube with a device. The whole mixture was then mineralized at 180 °C for 40 min.

After completion of the mineralization process, the mixture in the test tube is diluted with distilled

water (BIOSAN, Latvia) to 25 ml in a separate conical volumetric flask and placed in test tubes of the MILESTONE Ethos Easy microwave instrument hopper. Samples were prepared for analysis in a microwave device after a specified time interval.

The prepared sample was analyzed on an Avio200 ISP–OES optical emission spectrometer with inductively coupled plasma (Perkin Elmer, USA). The level of accuracy of the device is high and allows you to measure the elements contained in the solution, with an accuracy of up to 10⁻⁹g.

Results and discussion

It has been established that the composition of soil samples taken from the layers of the dry bottom of the island consists mainly of mineralized sandy layers (Table 1).

Table 1. – Mineral composition of soil layers of the dried bottom of the Aral Sea

Electrical conductivity (mS/sm)	Normal amount mg/100 g	0–20 sm	20–40 sm	40–60 sm	60–90 sm
1	2	3	4	5	6
	0–0.6	1.48	1.134	2.309	1.589
pH	6–7.5	7.87	7.59	7.05	7.35
NO ₃ ⁻ -N mg/l	3.1–4.0	0.314	0.439	0.41	0.603
NH ₄ ⁺ -N mg/100 g	4.6–6.0	0.394	0.733	0.362	0.319
P (mg/100 g)	4.6–6.0	0.476	0.385	0.33	0.506
K (mg/100 g)	30.1–40.0	34.6	23.0	34.59	32.95
S (mg/100 g)	20.5–40.0	2.79	2.96	8.16	5.605
Cl ⁻ (mg/100 g)	28.4–54.8	569	352	254	341
Ba (mg/100 g)	0.7–8.7	0.039	0.069	0.088	0.026
Co (mg/100 g)	2.0–3.0	0.03	0.03	0.029	0.031
Sr (mg/100 g)	0.2–7.0	1.592	1.268	8.634	0.567
B (mg/100 g)	0.06–0.10	0.217	0.087	0.138	0.178
Zn (mg/100 g)	0.23–0.41	0	0	0	0
Fe (mg/100 g)	7.4–11.0	0.04	0.04	0.041	0.045
Cu (mg/100 g)	0.47–1.28	0.042	0.042	0.039	0.043
Mn (mg/100 g)	0.6–10.0	0.03	0.032	0.032	0.032
Cr (mg/100 g)	1.5–7.0	0.037	0.037	0.037	0.037
Ca (mg/100 g)	100–200	88.93	91.27	351.74	68.76
Li (mg/100 g)	0.7–20	0.075	0.036	0.077	0.065
Hg (mg/100 g)	0.003–0.01	0.02	0.019	0.018	0.019
Mo (mg/100 g)	0.03–0.05	0.057	0.039	0.043	0.044
Sn (mg/100 g)	0.001–0.22	0.014	0.012	0	0.014
Ag (mg/100 g)	0.001–0.1	0	0	0	0

1	2	3	4	5	6
Pb (mg/100g)	0.001–0.1	0.047	0.048	0.045	0.049
Na (mg/100 g)	59	262.4	172.13	324.3	304.82
Cd (mg/100 g)	0.001–0.1	0.032	0.031	0.031	0.031
Sb (mg/100 g)	0.02–0.03	0.010	0.008	0.014	0.017
Mg (mg/100 g)	65.0	82.22	42.8	74.7	75.35

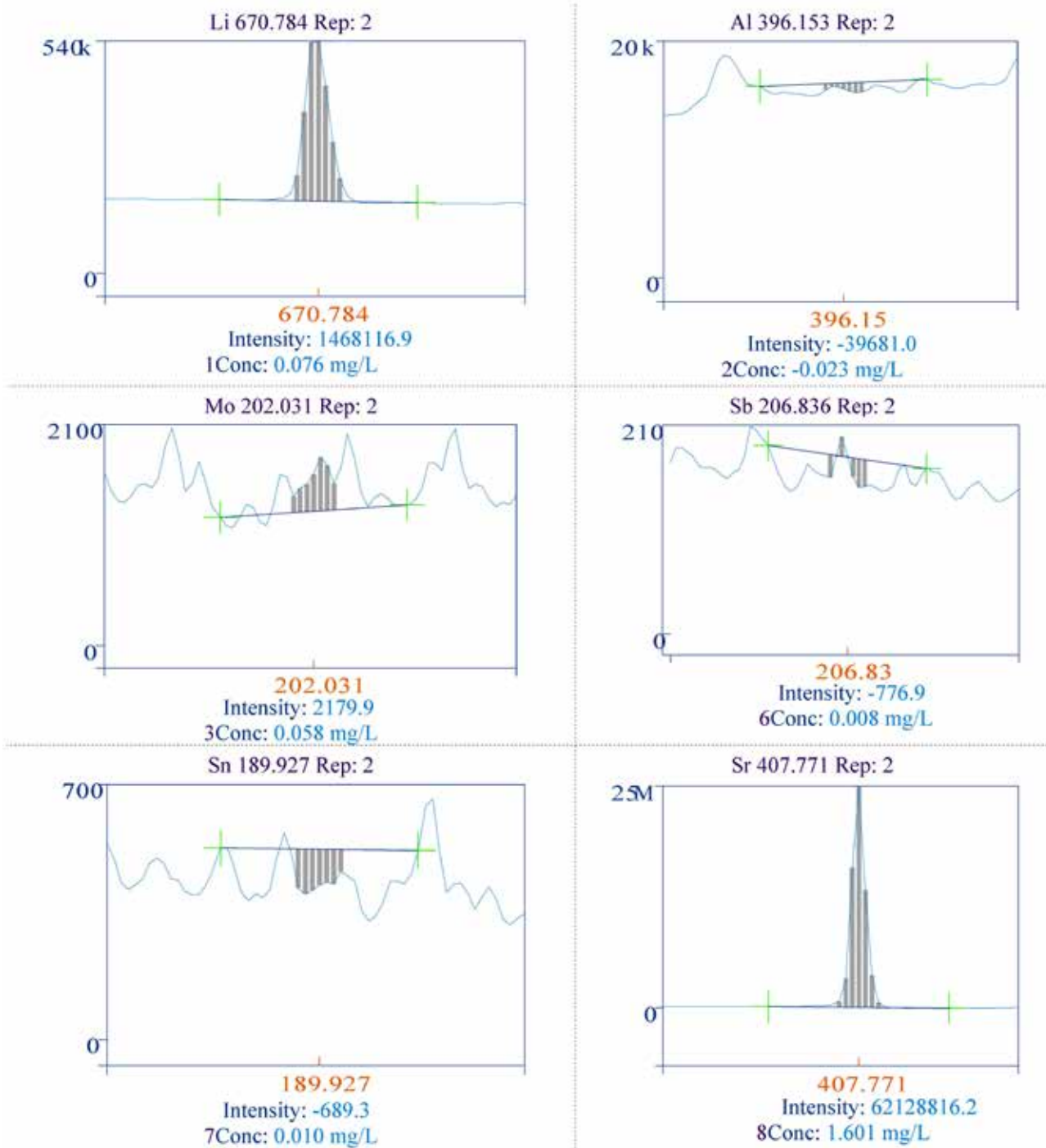


Figure 1. Results of analyzes of metals in the composition on an Avio 200 ICP-OES optical emission spectrometer with inductively coupled plasma (Perkin Elmer, USA)

Salt content in the upper layer ranges from 15–20%, including chlorine 10–15%, sulfates 5–10%. The sharp excess of chlorine content over sulfate ions is explained by the accumulation of salts in soils under conditions of stagnant highly mineralized chloride-type groundwater. So in a layer of 20–40 cm, the salt content in the paid residue decreases by 10–20%. In these horizons, the content of chlorine is 5–8% and sulfates – 2–3%. The value of dense remains from 40 cm to a depth of 90 cm varies mainly within 5–6%. The type of chemistry up to 60 cm is sulfate-sodium chloride alternating with sodium chloride. The increased moistening of the deep layers of the soil is a distinctive feature of saline.

The absorption capacity of clay saline soil under crust up to 60 cm is characterized by low and varies in examples 0–20 cm per 100 g of soil. The composition of the base in the soil layer up to 60 cm is dominated by calcium, then magnesium, sodium. The presence of sodium in the soil-absorbing complex indicates a sign of alkalinity, however, this phenomenon is not significant, since it is closely related to the content of silt particles on the profile of sections up to 90 cm, which content or varies between 2–12%. A pronounced saline feature in the soil is manifested when the content of silt particles in the composition of 50 cm is more than a percent.

Also soil in the layers of metals Sb, Cd, Pb, Sn, Mo, Hg, B and other trace elements and toxic heavy metals are above the specified norm and not at the level of quantitative and equivalent norms. This has a negative effect on the absorption of appropriate nutrients by plants and on their growth and development.

Accordingly, in order to regulate the amount of elements in the soil in an equivalent ratio to the growth and development of plants, we tried to balance the composition of the soil of the seedling and seed planting site with nutrients in the plant development stage.

We calculated the number of elements in an equivalent ratio for adding per 100 g of soil: ammonium nitrate 171 mg/100 g; Ammophos 206 mg/100g; potassium sulfate 140 mg/100g; Cobalt sulfate 5.5 mg/100g; Boric acid 39 mg/100 g; Zinc sulfate 7.8 mg/100g; Ferrous sulfate 242 mg/100 g; Copper sulfate 15.6 mg/100g; Manganese sulfate 163 mg/100 g; Calcium sulfate 2700 mg/100g.

$\text{Ca}(\text{NO}_3)_2$ was used to improve the ratio of Ca and Na ions in the soil. The initial ratio of elements Ca and Na is 4.5 : 9.

After applying calcium fertilizers, the equivalent ratio of Ca and Na ions is 36 : 9.

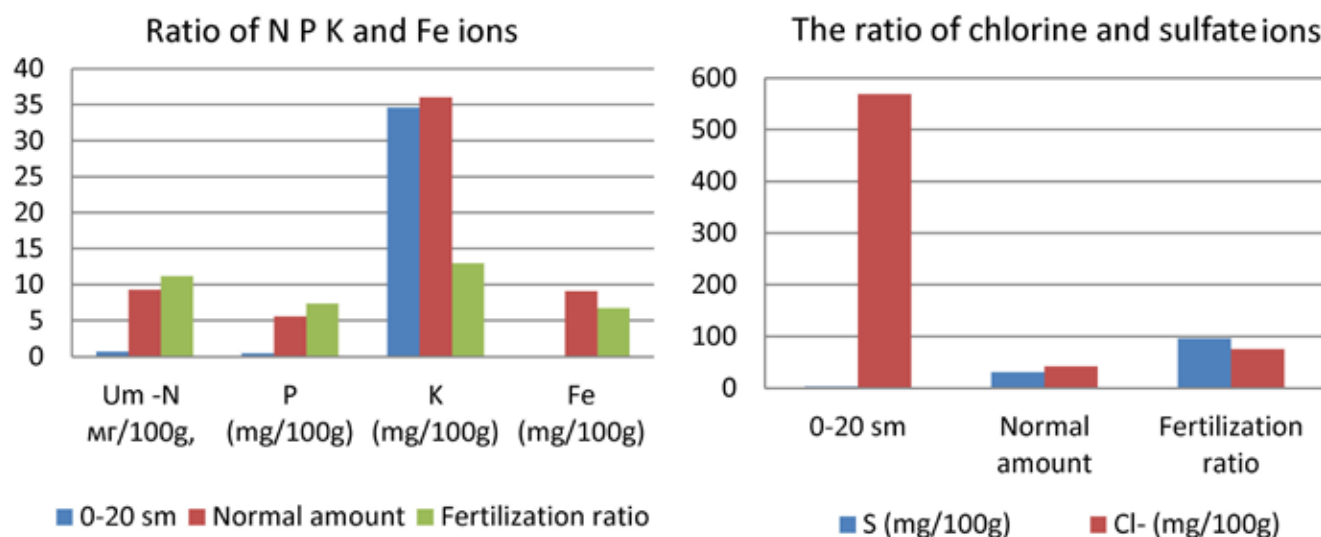


Figure 2. The results of the balance ions of NPK and Fe (A), Cl and SO_4 in the 0–20 cm layer of the dried bottom of the Aral Sea based on equivalent ratios

Since monovalent elements destroy the soil structure, as a result of the introduction of additives, the concentration of Na^+ and Cl^- ions decreases

Due to the relatively low nitrogen content in the soil, 171 mg of ammonium nitrate, 206 mg of ammonium phosphate fertilizer due to lack of phosphorus, 140 mg of potassium sulfate to equalize the amount of potassium, 242 mg of Fe_2SO_4 salt to normalize the amount of

iron ions were applied to the soil. This amount of added salts is calculated to improve the condition of 100 g of soil compared to the Na ion in the soil.

According to the analysis of samples, it was found that the proportions of chlorine and sulfate ions differ from the norm. To equalize the quantitative ratios of these ions, sulfate salts of Ca and trace elements, which are absent in some soils, were used.

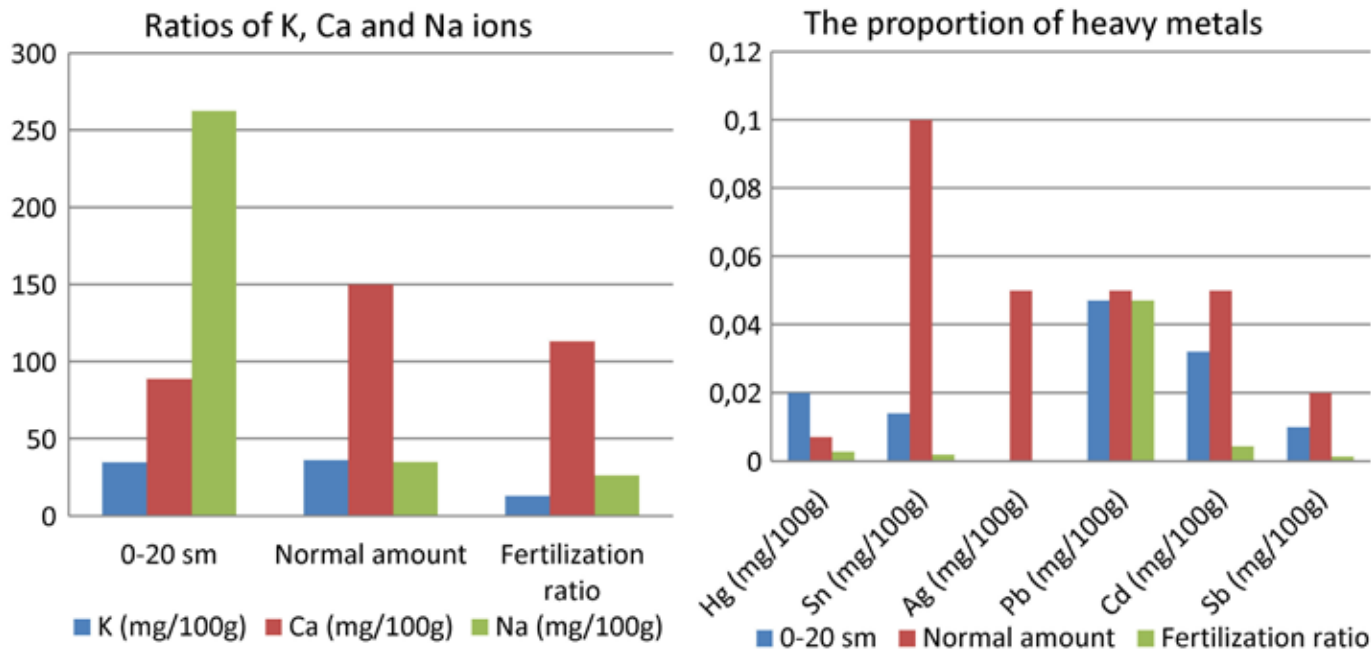


Figure 3. The results of the balance ions of K, Ca, Na (A) and heavy metals (B) in the 0–20 cm layer of the dried bottom of the Aral Sea based on equivalent ratios

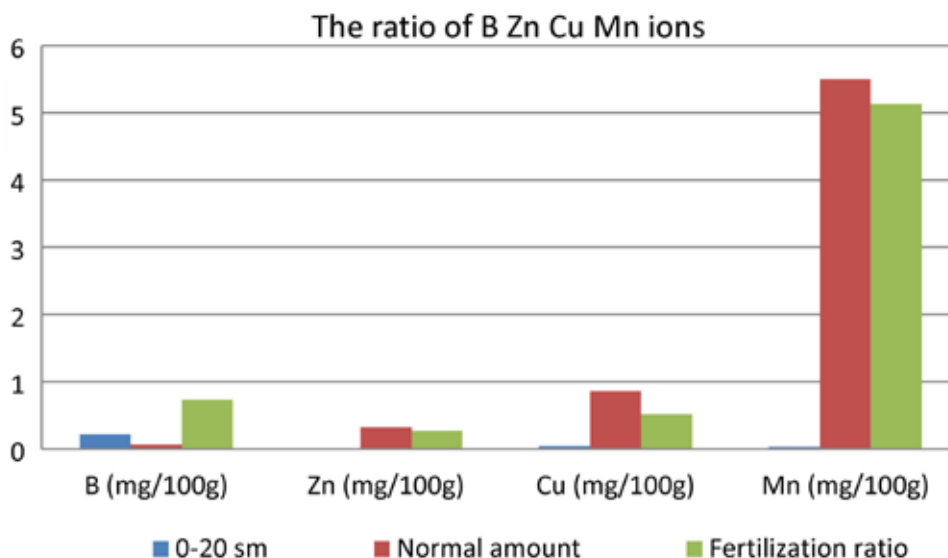


Figure 4. The results of the balance of B, Cu, Zn and Mn ions in the 0–20 cm layer of the dried bottom of the Aral Sea based on equivalent ratios

As a result of the analysis of mobile ions of potassium, calcium and sodium, it was found that sodium ions are 7–8 times higher than the norm. Accordingly, as a result of the addition of Ca and K salts, the quantitative ratios of cations were equalized. That is, calcium sulfate (2700 mg) and potassium (140 mg) salts were used.

The elements boron, zinc, copper and manganese are known to be vital trace elements. According to the results of the analysis, it was found that these elements are a little out of the norm. Therefore, to enrich the amount of boron, boric acid (39 mg) was added, and to enrich zinc (7.8 mg) and copper (15.6 mg) and manganese (163 mg), sulfate salts of these elements were added.

Based on the biological properties of plant species, the salts of the necessary elements, calculated by equivalent ratios, were gradually added to the soil composition. This served as an important basis for

ensuring their growth and development based on the absorption of nutrients from the soil.

Conclusions

Analysis of the soil layers on the dried bottom of the Aral Sea showed that the salt content in the upper layer ranges from 15–20%. To correct the amount of elements in the soil in the equivalent ratio of plant growth and development, we tried to balance the soil composition of the seedling planting site and seeds with nutrients at the stage of plant development.

Calculated the number of elements in an equivalent ratio for adding per 100 g of soil: ammonium nitrate 171 mg/100 g; $(\text{NH}_4)_3\text{PO}_4$ 206 mg/100g; K_2SO_4 140 mg/100g; CoSO_4 5,5 mg/100g; H_3BO_3 39 mg/100 g; ZnSO_4 7,8 mg/100g; FeSO_4 242 mg/100 g; CuSO_4 15,6 mg/100g; MnSO_4 163 mg/100 g; CaSO_4 2700 mg/100g to create nutrition for plants in developmental stages.

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IR-SPECTROSCOPIC METHOD TO HELP IN CHEMICAL-TOXICOLOGICAL INVESTIGATION OF AMLODIPINE

Abstract. Diseases of the cardiovascular system are very common among the population today. According to statistics, 17 million people live in the world every year. One of the main reasons for this is acute heart rhythm disturbances, problems with high blood pressure. In particular, ventricular tachycardia and fibrillation of cardiac arrhythmias are very life-threatening. Therefore, in connection with life-threatening severe rhythm changes, such as tachycardia and irreversible ventricular fibrillation, the development of suitable antiarrhythmic drugs that can be fast and highly effective even in severe arrhythmias remains one of the urgent tasks of today. Based on this, the relevance of our work is the development of methods for separating amlodipine from a biological object, improvement of methods for analyzing the drug amlodipine, enalapril and metoprolol which is widely used in the treatment of hypertensive diseases.

Keywords: hypertension, biological object, substance, tablet, drug, blood, urine, methods of analysis, solvent system.

Actuality of theme. Diseases of the cardiovascular system are very common among the population today. According to statistics, 17 million people live in the world every year (Oshchepkova E. V., 2007). One of the main reasons for this is acute heart rhythm disturbances, problems with high blood pressure. In particular, ventricular tachycardia and fibrillation of cardiac arrhythmias are very life-threatening (Wathen M. S., 2004; Anthony R., 2008; Knecht S., 2009; Juan J. S.M., 2010). Therefore, in connection with life-threatening severe rhythm changes, such as tachycardia and irreversible ventricular fibrillation, the development of suitable antiarrhythmic drugs that can be fast and highly effective even in severe arrhythmias remains one of the urgent tasks of today. Based on this, the relevance of our work is the

development of methods for separating amlodipine from a biological object, improvement of methods for analyzing the drug amlodipine, enalapril and metoprolol which is widely used in the treatment of hypertensive diseases.

Communication of dissertation work with research plans. Practise an assay method that separates the drug from the biological object, causing hypersensitivity reactions to the drug amlodipine, which lowers blood pressure and normalizes heart function in hypertensive patients.

The purpose of the study.

1. Development of hypersensitive chemical reactions to antihypertensive drugs;
2. To determine the sensitivity of the reaction to antihypertensive drugs;

3. Improvement of methods of quantitative analysis of antihypertensive drugs;

4. Development of a method for separating antihypertensive drugs from biological fluids and biological objects.

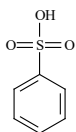
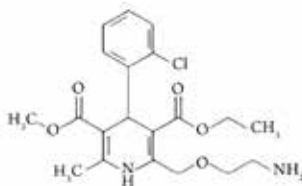
Object and subject of research. Antihypertensive drugs that lower blood pressure.

Research methods: during the analysis, the use of chemical reactions, the creation of qualitative reactions to the preparations obtained for the analysis, the use of thin layer chromatography, spectrophotometric and high-efficiency liquid chromatography methods, as well as the use of infrared spectroscopic spectroscopy methods.

Scientific, theoretical and practical significance of the research results. Implementation of the developed methods of analysis in the Republican laboratories of forensic chemistry.

Introduction

Amlodipine is a derivative of dihydropyridine and has antianginal and hypotensive effects. At the same time, it causes a number of unpleasant reactions, and in some cases cases of poisoning have also been observed. As a result of excessive vasodilatation, there is a sharp drop in arterial pressure and tachycardia.



$C_{20}H_{25}ClN_2O_5 \cdot C_6H_6O_3S$ $n_D^{20} = 1.5671$
(RS)-2-(2-aminoethoxymethyl)-6-methyl 4-(2-chlorophenyl)-1,4-dihydropyridine - benzene-sulfonate of 3,5-dicarboxylic acid.

Amlodipine is widely used in medical practice as a hypotensive agent. In some cases, acute poisoning occurs when it is taken in excess of the norm. In such cases, the patient's urine and blood are analyzed and a conclusion is drawn. Determination of the authenticity of the substance was carried out by the method of thin layer chromatography. When amlodipine is isolated from biological liquid urine and determined

by TLC method, 2 g of ammonium sulfate is added to 15 ml of urine containing 10 mg of the substance, extracted 3 times (5 ml) with chloroform, 1 g of anhydrous sulfate is filtered through a filter containing sodium sulfate, and washed with 2 ml of chloroform. The chloroform was evaporated to a dry residue. The residue was dissolved in 2 ml of alcohol, then the solution was dripped onto the starting line of a silufol UV-254 plate with a diameter of 3 mm using a capillary and dried. Then 1 mol was chromatographed in a chromatographic chamber saturated with acetic acid vapor. When the plate was dried from the chamber and exposed to iodine vapor, a blue spot with $R_f = 0.87$ was observed. At the same time, an IR spectroscopic method for determining the authenticity and quantity of the substance extracted from the biological fluid by the method described above was developed.

Basic phrases. Amlodipine, thin layer chromatography, silufol - UV-254, IR -spectroscopy, valence and deformation vibrations, intensity of absorption path, validation.

The purpose of the study. Chemical-toxicological studies of amlodipine are of great importance, allowing quick and accurate investigation of cases of poisoning. We aimed to develop an infrared spectroscopic method for the extraction and analysis of amlodipine from biological fluids.

Practical part. From the IR spectrum of amlodipine isolated from biological fluid, the following classification absorption pathways were determined: n_{max} : cm^{-1} , 3301 primary NH_2 group, 3190 (pyridine ring N-H valence vibrations amino group valence vibrations), 2981 (C-H valence vibrations in ethyl and methyl groups); 2948 (valence vibrations of C-H bonds in aromatic ring and pyridine ring) 1698, 1675 (valence vibrations of carbonyl bonds in carboxyl group), 1615 (valence vibrations of aromatic ring - C=C bonds), 1493 (valence vibrations of C=C bonds in the pyridine ring), 1445, 1432 (deformation vibrations of methyl groups), 1384, 1365 (deformation vibrations of C-H groups in the aromatic ring and pyridine ring), 1303, 1265 (out-of-surface defor-

mation vibrations of C-H groups), 1202, 1125 (plane deformation vibrations of C=C bonds to aromatics), 1095, 1034, 1049 (carboxyl and oxyethiamine and categories C-O-), (1,2, Plane strain vibrations of 4,5-substituted pyridine C=C bonds, 869, 838, 791 (C-H bonds of 1, 2, 3 substituted aromatic rings), 735, 615 cm⁻¹ (C-H valence vibrations).

Quantitative analysis. Infrared spectra of a 1 mg (exact draw) amlodipine working standard sample and samples isolated from a biological object were obtained in the form of pressed KBr tablets, and the areas of carboethoxyl groups were measured as characteristic absorption pathways.

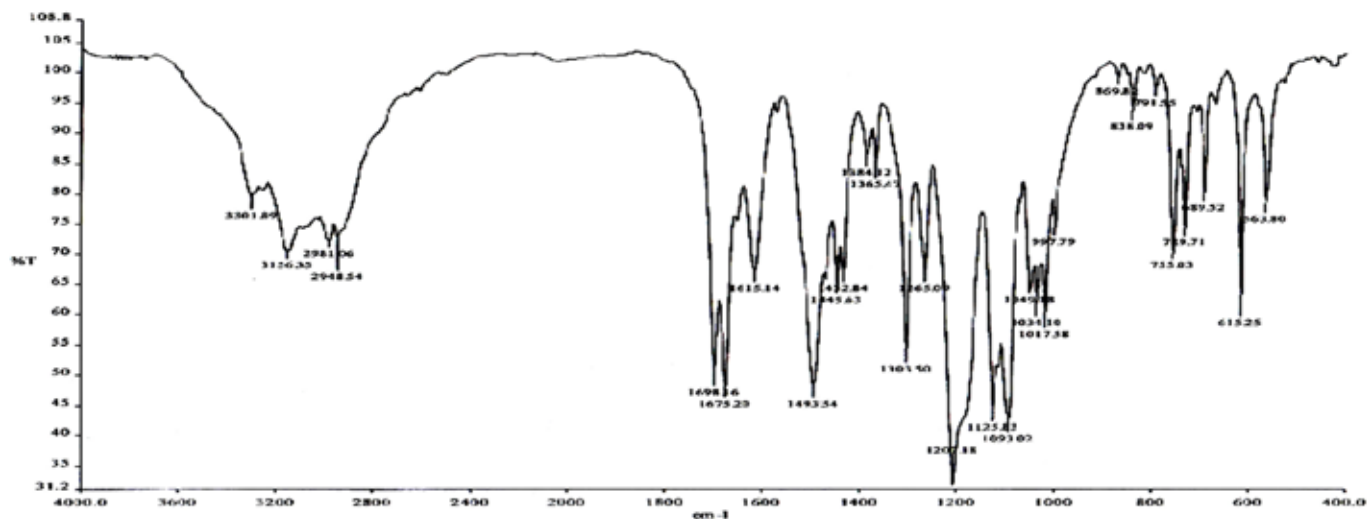


Figure 1. – IR spectrum of amlodipine isolated from biological fluid

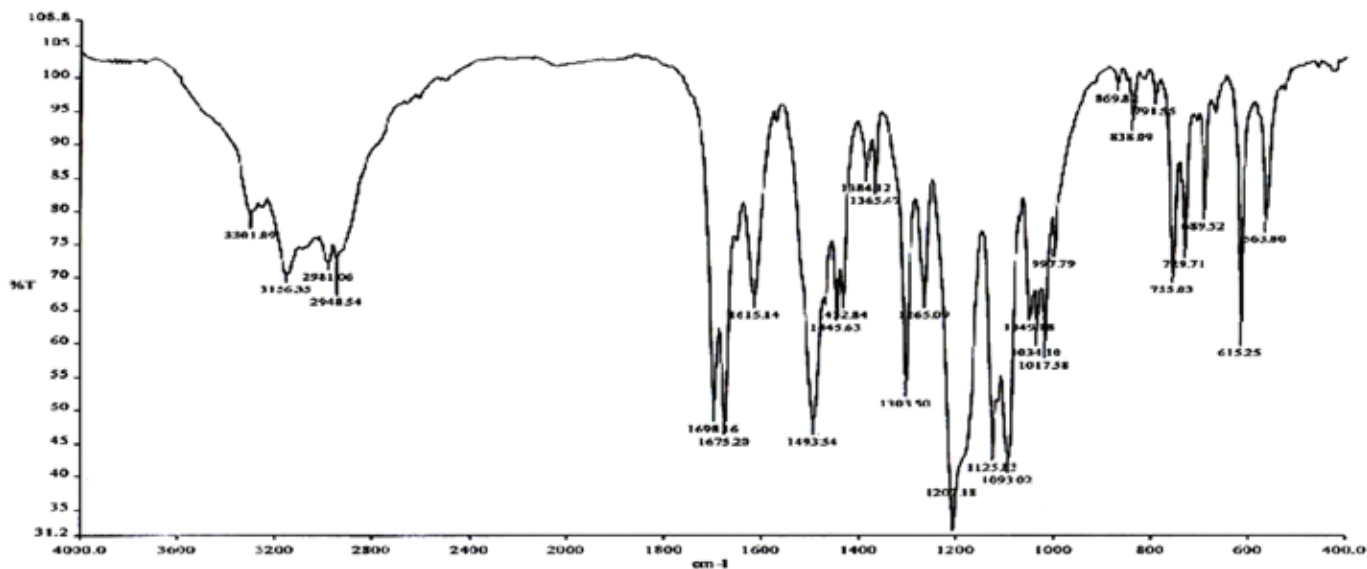


Figure 2. IR-spectrum of a working standard sample of amlodipine

The percentage of amlodipine extracted from the biological object was determined using the following calculation formula.

$$X = \frac{S \cdot m_0 \cdot P \cdot 100}{S_0 \cdot m \cdot 100}$$

in the formula: S – the area of absorption paths of carbonyl groups in the IR spectrum of the standard sample;

S_0 – amlodipine working standard sample IR – area of absorption paths of carbonyl groups in the spectrum;

m – Drawer of amlodipine isolated from a biological object;

m_0 – drawer of the working standard sample of amlodipine;

P – amlodipine is the percentage of amlodipine in the working standard sample.

Metrological description and validation of the analytical method

Table 1.

Nº	m	m_0	X	\bar{X}	S^2	S	Δx	$\Delta \bar{X}$	$E\%$	$\bar{E} \%$	$RSD\%$	$V\%$
1	0.00090	0.00010	98.4									
2	0.00095		98.7									
3	0.00098		99.2	99.2	0.32	0.57	1.57	0.7	1.71	0.76	0.6	0.32
4	0.00103		99.6									
5	0.00107		100.2									

Specificity of the method. When the spectra obtained at different concentrations and with different equipment are compared, the intensity and classification values of the absorption lines in them are the same, and the absorption lines of the carbonyl groups in the spectra were observed at 1698, 1675 cm^{-1} .

Linearity of the method. The linear relationship was determined in the dimensions of the relationship between the draw and the characteristic absorp-

tion path for obtaining an IR-spectrum, the correlation coefficient was 0.9992 nm, and the graph of the linear relationship was found to be $y = 3.5833 \times x - 0.0167$.

IR-spectrometric quantitative analysis method of amlodipine linearity of the relationship between the amount of substance and the area of the absorption path

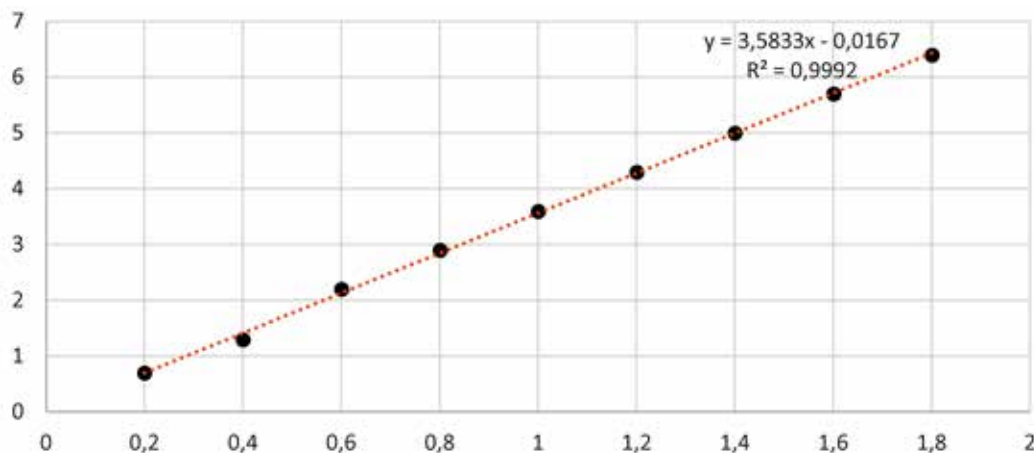


Figure 3.

The precision of the method was determined in six re-analyses and was determined by studying the metrological description of the results.

Table 3.

X_g	$X\%$	$\bar{X} - X_i$	d_2	Metrological description	
1	2	3	4	5	
0.00090	98.4	1.2	1.44	$S^2 = 0.75$	$\Delta X = 0.69$
0.00095	98.7	0.5	0.25	$S = 0.27$	$\Delta \bar{X} = 0.28$

1	2	3	4	5	
0.00098	99.2	0	0	$S_{\bar{x}} = 0.11$	$E = 0.27$
0.00104	99.6	0.4	0.16	$\bar{E} = 0.12$	$V = 0.75$
0.00108	100.2	1.0	1.0	RSD=0.8%	

The reproducibility of the method was carried out by analyzing the samples extracted from the biological fluid six times on the basis of triplicate experiments, and processing the obtained values with the method of mathematical statistics.

Table 4.

Return № number	Percentage of Amlodipine		
	Experiment 1	Experiment 2	Experiment 3
1	98.4	98.1	98.2
2	98.7	98.8	98.6
3	99.2	99.4	99.8
4	99.6	99.7	100.2
5	100.2	100.5	100.8
6	100.5	101.4	101.8
RSD	0.8	2.1	1.8

The accuracy of the developed method was determined by comparing the results of experiments repeated 9 times in three series in samples with 10%: 20%: 30% more than the nominal value

Table 5. – Determining the accuracy of the equipment

Amlodipine drawer, g	Amount added, g	Total amount, g	Determined amount, g	Determined amount, %
0.001	0.0001	0.0011	0.0009	82 } 88
0.001	0.0001	0.0011	0.0009	
0.001	0.0001	0.0011	0.0009	
0.001	0.0002	0.0012	0.0011	92 } 92.6
0.001	0.0002	0.0012	0.0010	
0.001	0.0002	0.0012	0.0012	
0.001	0.0003	0.0013	0.0011	85 } 94.5
0.001	0.0003	0.0013	0.00128	
0.001	0.0003	0.0013	0.0013	

Average value 91.7%; The range of values is 88–94.5%

Conclusion

1. A moderate method of extracting amlodipine from biological fluid was developed. The most suitable extractant was found to be chloroform;

2. The isolated amlodipine was identified using chromatographic and physical methods;

3. The absorption pathways of the IR-spectrum of amlodipine were determined;

4. IR-spectroscopic method of quantitative analysis for amlodipine was developed;

5. The method was validated according to parameters such as precision, accuracy, reproducibility, linearity.

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ON THE MODIFICATION OF CELLULOSE ACETATE WITH PIPERIDINE

Abstract. In this article, the process of modifying cellulose acetate with piperidine in an organic solvent medium (acetone, dimethylformamide) at a temperature of 20–50 °C was studied. The structure and thermal properties of the modified sample were studied by infrared spectroscopy and thermogravimetry.

Keywords: cellulose acetate, cellulose diacetate, piperidine, modification, thermogravimetry.

Introduction

Synthetic membranes acting as a selective barrier are widely used in seawater desalination, separation of dispersed systems and chemicals, for the isolation of rare earth elements, in blood hemodialysis and other areas. The current ideas about the mechanism of transport of molecules and ions through diffusion membranes make it possible in some cases to predict which chemical structure and supramolecular structure of the polymer will be optimal for solving the problems posed. Achieving the required characteristics of membranes is possible by modifying them or synthesizing new polymers. However, it should be taken into account that the synthesis of new polymers is a laborious and expensive process. The modification is used to increase the selectivity and permeability of membranes, or to impart specific properties to them [1–2].

Cellulose acetate is one of the most important cellulose ethers. Depending on the processing method, cellulose acetate can be used for various syntheses (for example, for films, membranes, or fibers) [3]. The review analyzes the methods of chemical modification of cellulose acetates and the prospects

for creating composite materials based on the modified polymer [4].

Cellulose acetate is widely used in the production of filtration membranes, especially in the food, pharmaceutical and medical industries [5]. The most commonly used membrane polymer is secondary cellulose acetate, cellulose diacetate (DAC). Its macromolecules consist of very rigid and dimensionally stable supramolecules.

The purpose of this work is to study the modification of cellulose acetate with a heterocyclic compound – piperidine, to determine the structure and properties of the synthesized products.

Experimental part

Acetylcellulose – white amorphous mass; density 1300 kg/m³. At 230 °C it starts to decompose. Let's dissolve in organic solvents dimethylformamide and acetone. Acetone (dimethyl ketone) is a colorless volatile liquid with a characteristic odor, mixes well with water, density – 792 kg / m³; melting point – 94 °C, boiling point 56.2 °C. N, N-dimethylformamide colorless liquid. Boiling point 153 °C; dissolves well in alcohol. Piperidine (hexahydropyridine), C₅H₁₁N – colorless liquid with a pungent

odor, purified by distillation before use; molar mass 85.15 g/mol, density 0.862 g/cm³; dynamic viscosity 1.573 Pa*s; melting point 8 °C; boiling point 106.17 °C, mixed in any ratio with water, alcohol, ether [6–7].

Method for modifying cellulose acetate with piperidine. The required amount of acetylcellulose was placed in a conical flask and dimethylformamide was poured, and the conical flask was placed on a magnetic stirrer. After dissolution of cellulose acetate, piperidine was added in portions to the conical flask. The reaction proceeds at a temperature of 40–50 °C for 4 hours. The films were synthesized by known methods from polymer solutions [8]. For this purpose, polymeric dimethylformamide solutions were

prepared in advance in various percentages. Dimethylformamide was used to dissolve cellulose acetate. The completeness of its dissolution was determined by the absence of swollen polymer particles on the glass walls.

Obtained results and their analysis

The modification process of cellulose acetate (AC) with piperidine (Pp) was carried out at a temperature of 50 °C in an organic solvent medium. The chemical composition and structure of the resulting polymers were confirmed by elemental analysis, IR spectroscopy, thermogravimetric (TGA) and differential thermogravimetric analysis (DTA).

The IR spectra of polymers based on AS and PP are shown in (Figs. 1.2).

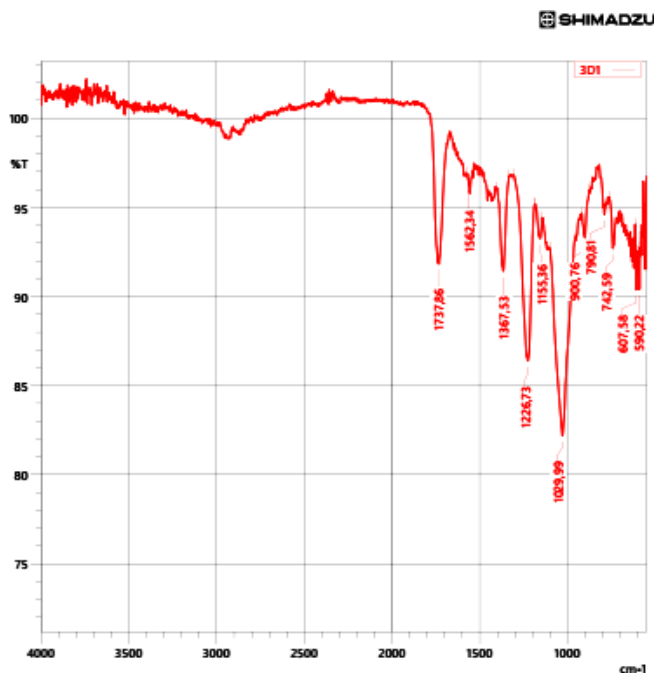


Figure 1. IR spectrum of AC films obtained on the basis of AC and PP

The results of IR spectra show that in the region of 1562.34 cm⁻¹ there is a line of symmetric stretching vibrations of piperidine [8–9].

Based on the experiment and from the results and IR spectroscopic analysis, the reaction between cellulose acetate and piperidine can be expressed as follows:

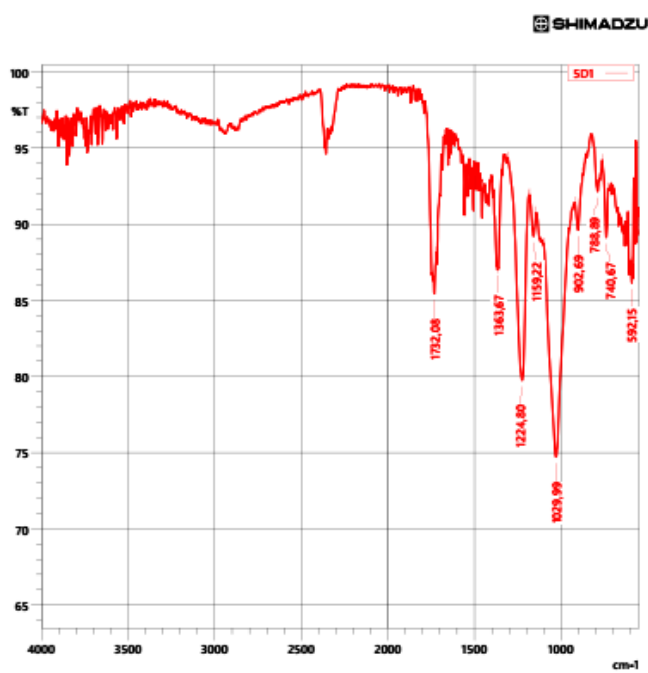


Figure 2. IR spectrum of films

A thermogravimetric study of piperidine with modified samples of cellulose acetate was also carried out (Fig. 3). The results of the analysis of samples were studied on the basis of thermogravimetric derivatogram (TGA) and differential thermogravimetric analysis (DTA). In this case, three endothermic effects were revealed at temperatures of 25.54 °C and 601.34 °C.

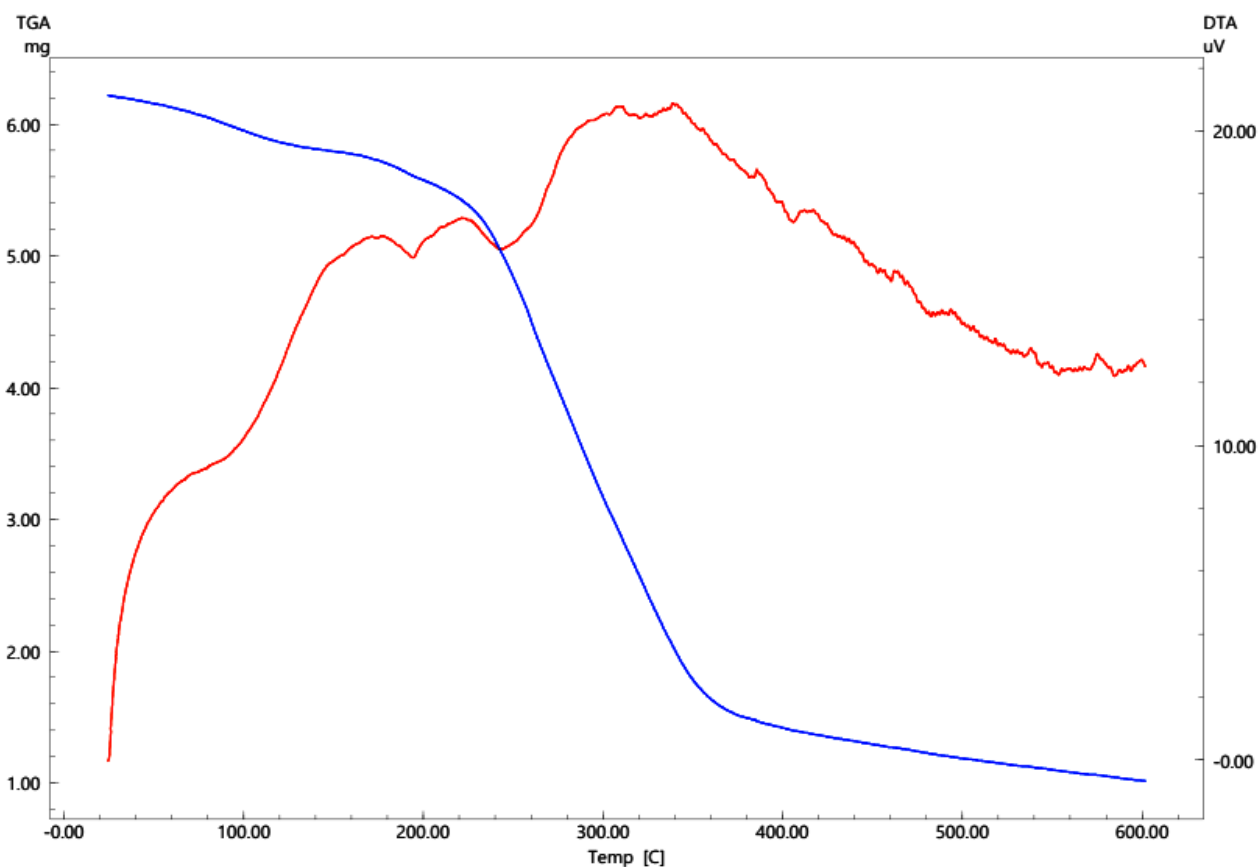
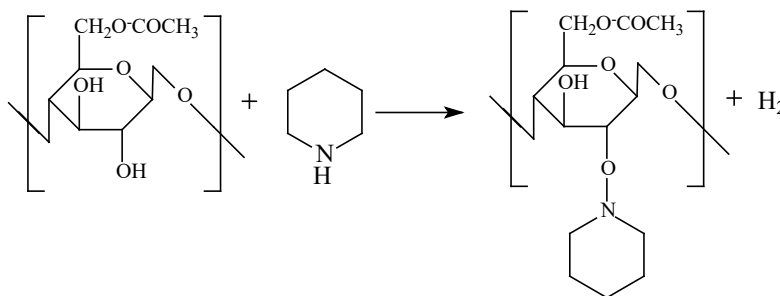


Figure 3. Thermogravimetric derivatogram (TGA) and differential thermogravimetric analysis (DTA) of films based on cellulose acetate and piperidine

A sample weighing 6.217 mg was poured into an open aluminum crucible with a fire resistance of 600 °C, and starting at 20 °C, the temperature was gradually increased to the final one. Analysis of the curve showed that the TGA curve in was formed as a result of intense weight loss within the temperature range: 1-interval of weight loss corresponds to 25.54–162.68 °C, 2-interval of weight loss corresponds to 162.68–378.51 °C, 3-interval of weight loss corresponds to 378.51–601.34 °C. The analysis shows that in the 1st interval the weight loss is

0.451 mg or 7.254%, in the 2nd interval the weight loss is 4.270 mg or 68.683%, and in the 3rd interval the weight loss is 0.483 mg or 7.769% where an intensive decomposition process takes place. The results of the analysis showed that at temperatures of 162.68–378.51 °C, the weight loss is 4.270 mg, or 68.683%. Analysis of the results of thermal decomposition of the substance at different temperatures is given in (Table 1).

Table 1. – Analysis of the results of TGA and DTA curves of modified cellulose acetate

Temperature °C	Lost mass (mg) (relative to 6.217mg)	Lost mass (%)	The amount of energy expended ($\mu V \times s/mg$)	Elapsed time (min)	dw (mg)	dw/dt (mg/min)
50 °C	0.063375	1.02	1.277	3.22	6.153	0.0197
100 °C	0.269324	4.332	1.718	8.42	5.947	0.032
200 °C	0.644124	10.36	2.956	18.55	5.573	0.0347
300 °C	3.050525	49.067	6.475	28.62	3.166	0.106
400 °C	4.803924	77.27	12.52	38.8	1.413	0.124
500 °C	5.033423	80.96	11.7	49	1.183	0.103
600 °C	5.203622	83.7	12.575	59.25	1.013	0.878

Thus, the structure of cellulose acetate modified with piperidine was determined by IR spectroscopy and thermal parameters by thermogravimetry.

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