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The collection includes scientific articles of participants of the International University Science Forum, the purpose of which is to present significant results of scientific research in the field of humanities, natural and technical sciences; the formation of a modern level of scientific knowledge, experience in transformation of theoretical science into the sphere of practical application of innovations; generalization of research and practical experience. The forum is a tool for establishing sustainable ties, as well as the exchange of experience between teachers and researchers of universities and research organizations.

Le recueil comprend des articles scientifiques des participants du Forum Scientifique International des Universités, dont l'objectif est la présentation des résultats significatifs de la recherche dans le domaine des sciences humaines, de la nature et de l'ingénieur; la formation du niveau contemporain des connaissances scientifiques, de l'expérience de la transformation de la science théorique au champ de l'application pratique des innovations; la synthèse de l'expérience des recherches scientifiques et pratiques. Le forum est un instrument permettant d'établir des liens durables et d'échanger des données d'expérience entre les enseignants et les chercheurs des universités et les organisations scientifiques.

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COMPETITIVENESS AND COOPERATION OF STATE AND BUSINESS IN THE SPHERE OF SOCIAL SERVICES: THEORY, METHODOLOGY, LEGISLATION, PRACTICE (ON THE EXAMPLE OF THE REPUBLIC OF KOMI)

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The article considers approaches to determining competitiveness and cooperation in the social sphere. On the basis of the all-Russian classifier of types of economic activity and in accordance with the standard for the development of competition in the constituent entities of the Russian Federation, a list of socially significant regional markets is indicated. An Action Plan ("road map") to promote competition in the Komi Republic is presented. As an indicator of the region's competitiveness, it analyzes the monitoring of population satisfaction with the quality of social services for the population, over the course of three years (2015–2018). It is determined that the set target indicators of the private market of goods, works, services have been achieved. The level of development of competition for this type of economic activity is defined as "satisfactory".

Keywords: competitiveness; cooperation, social sphere; non-governmental institutions; social services for the population.

Introduction

Competition is subject to legal regulation. Actively promoting competition in the Russian Federation is a priority for the President of the Russian Federation, the Federal Assembly of the Russian Federation, the Government of the Russian Federation, the Central Bank of the Russian Federation, federal executive bodies, legislative (representative) and executive bodies of state power of the constituent entities of the Russian Federation, as well as local government bodies. The Decree of the President

of the Russian Federation "On the main directions of state policy on the development of competition" defined the goals of improving state policy: *increasing customer satisfaction by expanding the range of goods, works, services, improving their quality and lowering prices*; increasing economic efficiency and *competitiveness* of business entities; stable growth and development of a multistructure economy, reduction of social tension in society, ensuring national security [1].

Such a transformation of the economic system implies the progressive development of production relations between competing entities and the state, as well as a change in the goals of the structure of the entire system of the economy. At the XIX World Festival of Youth and Students in Sochi, President V.V. Putin called for a change of rivalry to cooperation and partnership [2]. In this regard, it seems appropriate and overdue to rethink the correlation of the categories of “competitiveness” and “cooperation”, acting as set social strategic goals aimed at equality and social friendliness.

The methodological basis of the study

A peculiarity of the social sphere is its territorial and regional character of action. In this regard, the traditional conceptual apparatus, methods and approaches to assessing the competitiveness of a region need to be expanded and supplemented. There is a need to consider the research methodology from the point of view of both objective indicators based on the theory and concept of regional development, the results of fundamental and applied studies of domestic and foreign experts on the problems of assessing and improving the competitiveness of regions, systemic and statistical analysis, and subjective, to which the results relate analytical studies and surveys of business entities, monitoring of administrative barriers and assessing the state of the competitive environment by business entities, as well as monitoring consumer satisfaction with the quality of goods and services on product markets.

Purpose of the study is to analyze the competitive environment in the social services market of the Komi Republic.

Objectives of the study:

— analyze the content of the concepts of "competitiveness" and "cooperation";

— study the development of a competitive environment in the market of social services for three years (2015–2018);

— analyze the monitoring: administrative barriers and assessing the state of the competitive environment by business entities; customer satisfaction with the quality of goods and services in the regional commodity markets and the state of price competition; satisfaction of business entities

and consumers of goods and services with the quality (level of accessibility, understandability, ease of obtaining and sufficiency) of official information on the state of the competitive environment in the markets for goods and services in the region and activities to promote competition in the region;

— assess the established and achieved target indicators of the competitive environment in the market of social services in the Komi Republic.

Object of the study is the market of social services for the population of the Komi Republic in dynamics over three years (2015–2018).

Subject — consumers of the social services market.

Scientific novelty:

— methods and approaches to assessing the competitiveness of a region are indicated;

— monitoring of the state of the competitive environment in the market of goods, works and social services of the region's population is analyzed in terms of both objective and subjective indicators;

— conclusions and suggestions are made that allow achieving the regional competitiveness targets.

The materials of this article can be used by government and legal authorities in the development of budgetary policies to promote competition in the Komi Republic, specialists from ministries and departments, students and researchers.

Sources of information

To analyze the competitive environment in the markets of goods, works and services of the Republic of Komi we used the following data: Territorial authority of the Federal State Statistics Service for the Republic of Komi; Territorial fund of obligatory medical insurance in the Komi Republic; Ministry of Labor, Employment and Social Protection of the Komi Republic; Ministry of Economy of the Komi Republic; Monitoring data on the state and development of the competitive environment in the Komi Republic for 2015-2018 carried out in accordance with Section VI of the Competition Development Standard. The regulatory framework of this work was constituted by Federal laws, Decrees of the President of the Russian Federation, decrees and orders of the Government of the Russian Federation, regulatory legal acts of the Republic of Komi.

The study of the content of the concepts of "competitiveness" and "cooperation". We will consider the analysis of the content of the categories "competitiveness" and "cooperation" from the perspective of an economic and sociological approach, within the framework of which interactions between competing agents [3] and the state in the development of the social sphere are subject to review. The concepts of "com-

petitiveness" and "cooperation" are interpreted differently by foreign and domestic researchers.

Increasing the competitiveness of the company in modern conditions M. Porter has reduced to an extremely meaningful wording: "To be different", i.e. find an alternative solution to the problem that distinguishes this economic entity from other similar entities in the market and thereby reduce the level of competition [4].

In his theory, he was echoed by researchers J. Robinson and E. Chamberlin, who believed that competitiveness was the ability to circumvent the struggle, developing new markets for differentiated products. [5].

In the works of J. Schumpeter and P. Romer, the competitiveness of an enterprise is also "determined by the ability to create new technologies, new markets and ideas." [6].

All of the above interpretations in their essence note the most important innovative role of competitiveness, based on intellectual leadership and excluding struggle.

In Russia, the concept of "competitiveness" is being studied relatively recently. Economists identify the main features that reveal the essence of the category of "competitiveness":

– competitiveness is manifested in the market (goods, works, services) [7];
– applies to both the object and the subject of market relations [7];
– has a certain competitive environment (quantitative assessment of economic objects, with which the level of competitiveness is determined) [8];
– the basis for determining competitiveness are identical key indicators of a competitor that determine the social effect (the ability to satisfy human needs) [9];
– has a common legislative, legal, regulatory, scientific and methodological base and information space [10];

Today, fundamentally new forms of business interaction are becoming an important factor in their competitiveness, and human resources are being successfully realized for the most part as a result of joint cooperation. Cooperation acts as a mechanism for regulating market relations, contributes to the development of not only production, but also human capital, the level and quality of life of the population, and in this sense is an important factor in increasing competitiveness [11].

Abroad, the theory of cooperation between competing entities was proposed by F. Hayek [12]. He saw that competing entities are in the common information space created by all economic entities. I. Kirtsner, L. Miseson, F. Knighton, P. Drucker also focus on the informational nature of competitiveness [13].

Cooperation as a form of market relations between subjects was proposed in the concept of O. Williamson. He called them “hybrid structures” aimed at “joint creation of additional values” [14].

In Russia, cooperation is carried out to a greater extent in the interaction of the state and business. However, the content, forms and methods of effective application of such interaction have not been sufficiently studied. The following basic forms of cooperation are distinguished in the scientific literature:

– conclusion of contracts (implemented on the basis of concession relations);

– holding contests;

– interaction of public and private capital, carried out by forming clusters;

– *cooperation between the state and business in the development of the social sphere,* which we will consider in this study.

The fundamental principle of state policy is to reduce the share of business entities controlled by the state in the total number of business entities operating in the markets for goods and services. The National Competition Development Plan for the Russian Federation for 2018-2020 has been approved. Its activities are aimed at achieving key indicators, one of which is to increase the share of purchases by 2020, the participants of which are socially oriented non-profit organizations engaged in activities aimed at solving social problems, the development of civil society in the Russian Federation in the field of state and municipal procurement no less than doubled compared to 2017. [15].

At present, the social sphere is legally interpreted in accordance with the “Standard for the Development of Competition in the Subjects of the Russian Federation” where the social significance of the branches of the social sphere is determined taking into account the list of priority and socially significant regional markets aimed at improving the living standards of the population [16].

In accordance with the Federal Law "On the Basics of Social Services for Citizens in the Russian Federation" dated December 28, 2013 N 442-FL (latest revision), the social services system is managed by federal authorities, executive bodies of the constituent entities of the Russian Federation, and also includes non-state (commercial and non-profit) social service organizations [17]. As market relations develop, the state strives to minimize its presence in the social services market, while retaining a regulatory role. Combining the resources of state and non-state structures is an innovative approach to the development of the social services

market, opening up new opportunities and access to budget financing for socially oriented non-state providers of these services in a competitive market environment. In this regard, there is a need to assess their competitiveness. In the field of social services, the concept of "market of social services" is considered as the relationship between entities (providers) that help citizens (consumers) to get out of a difficult life situation in accordance with individual programs and terms of contracts concluded with recipients of social services or their legal representatives, Based on the requirements of the Federal Law.

Development of a competitive environment in the field of social services for the population of the Komi Republic.

In the Regulation on the executive authorities of the Komi Republic, the development of competition is also defined as one of the main priorities of activity [18]. By order of the Government of the Republic of Komi, the authorized body to promote competition is the Ministry of Economy [19]. A list of priority and socially significant markets has been approved to promote the development of competition in the region with the rationale for their choice [20]. It includes socially significant markets to promote competition in the Komi Republic: market for pre-school education, children's recreation and rest services, additional education services for children, *the market for medical services,* psychological and pedagogical support for children with disabilities, cultural services, *housing and communal services,* retail, ground transportation services, informatization services and communications and *the market for social services*. Priority markets have been identified: the market for tourism services and the market for the production of building materials.

An important characteristic of the competitive environment in the markets for goods and services is the share of non-state (non-municipal) ownership. The development of competition in these markets will increase the share of non-governmental organizations and market participants, which is provided for in the framework of the Federal Standard for the Development of Competition prepared by the Ministry of Economic Development of the Russian Federation and the Agency for Strategic Initiatives. As of January 1, 2019, in the Komi Republic, the share of private ownership organizations amounted to 79.4% of the total number of organizations, the share of state and municipal ownership organizations - 12.1%; mixed - 1.7%. From 2012 to 2018, the number of state and municipal organizations in the region decreased by 613 units, or by 21.9%. Taking into account the requirements for the system for assessing the competitiveness of the region, the Decree of the Head of the Komi Republic identifies 34

key indicators of the development of competition in the Komi Republic for the period up to 2022 [21].

In this work, as an indicator of the region's competitiveness, we consider the dynamics of the *social services market* for four years (2015–2018).

As part of the implementation of the Competition Development Standard in the constituent entities of the Russian Federation, the following is envisaged:

- monitoring of administrative barriers and assessing the state of the competitive environment by business entities;
- monitoring of customer satisfaction with the quality of goods and services in the regional commodity markets and the state of price competition;
- monitoring the satisfaction of business entities and consumers of goods and services with the quality (level of accessibility, understandability, ease of obtaining and sufficiency) of official information on the state of the competitive environment in the markets for goods and services in the region and activities to promote competition in the region.

These monitoring were carried out in the Komi Republic. The sample of respondents was carried out in accordance with the recommendations of the Analytical Center under the Government of the Russian Federation. A survey of business entities in a sectoral context was carried out by local authorities. Calculation of quotas for a survey of entrepreneurs was carried out separately for each municipality based on data on registered business entities as of 01.01.2018 (according to the State Statistics Service of the Komi Republic). The total required number of respondents (2500 business entities) was distributed among municipalities proportionally, including in accordance with the type of economic activity. Similarly, population quotas were calculated. As a result, 2644 business entities of the Komi Republic and 11277 people in consumer services markets participated in the survey.

The market for social services. As an indicator of the region's competitiveness, we consider the market for services in the field of social services for the population, the key indicator of which should be at least 10% in the period 2018–2021 [22]. The responsible executor of this market is the Ministry of Labor, Employment and Social Protection of the Komi Republic. It approved a list of types of priority social services, the provision of which can be carried out on the territory of the Komi Republic by socially oriented non-profit organizations [23]. For non-profit organizations, the procedure for including a non-governmental organization in the register of suppliers is applied in order to obtain further compensation for the cost

of providing services from the budget at approved tariffs. In particular, the provider should provide information on the forms of social services, the list of social services provided, tariffs and their work experience. Each region has the right to clarify or expand the list of information provided.

The state has taken a number of measures to help businesses get involved in social services. For this, amendments were made to part two of the Tax Code, the essence of which was to create a favorable tax regime for organizations providing social services. In particular, this is the zeroing of the tax rate on income tax and exemption from VAT on the services provided by private companies. Also, to compensate for construction costs, a subsidized rate on the loan, which is taken by a non-governmental organization for the construction of a social service institution, is provided. The subsidy is provided in the amount of the entire key rate of the Central Bank of the Russian Federation. The sanitary and epidemiological requirements for the buildings of social service organizations have been significantly simplified [24]. Unnecessary requirements for the placement, design, construction and operation of newly constructed and reconstructed objects have been removed. The provisions on the availability of a sanitary-epidemiological conclusion on compliance with the sanitary rules of a land plot for construction are excluded. Granted the right to place organizations in the premises built into residential buildings, in the built-in and attached premises. A register of social service providers of the Ministry of Labor, Employment and Social Protection of the Komi Republic has been compiled, which contains information on 76 social service providers, including 15 non-governmental organizations.

According to the implementation of the Law of the Komi Republic "On some issues related to care and assistance to elderly citizens and people with disabilities in the territory of the Komi Republic" [25], it was possible to provide elderly people and people with disabilities home care and assistance, 330 treaties were in effect and assistance for disabled citizens. On behalf of the President of the Russian Federation to ensure access of socially oriented non-profit organizations to budgetary funds, a number of measures were taken to transfer social services to the non-state sector. Since 2017, social services at home have been fully transferred to the private sector and are provided by 11 autonomous non-profit organizations. About 8.9 thousand elderly and disabled people received care in the usual conditions at the place of their permanent residence, taking into account the new requirements of federal legislation on social services. The share of citizens provided with social services at home, in the total number of applicants for such services, has been maintained at 100 percent.

Improving the quality of social services is directly related to the development of competition and the creation of an independent assessment system of the quality of work of social institutions [26]. In order to determine the level of development of competition in the region, we consider the results of monitoring in dynamics over the past three years (2015–2018). Distribution of respondents by type of economic activity of a business that represented social services of 14 organizations out of 15 or 0.5% of all interviewed entrepreneurs.

Monitoring administrative barriers and assessing the state of the competitive environment by business entities of social services.

In the Komi Republic, the main negative barriers to the development of competition in the provision of social services in 2018 were: high taxes (28.6%); instability of Russian legislation regulating entrepreneurial activity (23.3%); privileges for individual business entities (14.3%); the need to establish partnerships with authorities (14.3%); the difficulty of gaining access to land and industrial or other premises (12.9%); duration of the procedure for obtaining licenses (7.8%); quotas for jobs (7.1%); corruption (3.4%). There are no barriers, according to 35.7% of this business.

Over the past three years, it has become easier for business to overcome administrative barriers than 7.1% think before, the level and number of administrative barriers have not changed, 21.4% noted.

Assessment of the state of competition and the competitive environment by business entities of social services in the Komi Republic.

To calculate the indicator characterizing the average number of competitors by type of economic activity, the answer option “a large number of competitors” was assigned a score of “4”, “4 or more competitors” - “3”, “from 1 to 3 competitors” - “2”, “no competitors ”-“ 1 ”. Manufacturers of social services (50%) believe that they have “1 to 3 competitors” (2.21), in 2015 this indicator was higher (2.44) by 0.23 points. To the question “How has the competitive environment changed over the past year?” (2018) ”replies were received:“ has not changed ”- 78.6%; “Improved” - 14.3%; “Worsened” - 7.1%.

Representatives providing social services (85.7%) believe that over the past three years the state of the competitive environment has not changed. Respondents' satisfaction with the state of competition was equally divided between “rather satisfactory” (21.4%) and “satisfactory” (21.4%).

Consumer satisfaction with the quality of goods, services and price competition in the social services market of the Komi Republic. During the survey, respondents were asked to evaluate how widely represented organizations are in the field of social services of the district (city) in which

they live. Most of the respondents described the number of these organizations as sufficient (74.3%). The number of respondents who noted the growth of social services organizations increased (28.5%).

To the question “How, in your opinion, has the *number of organizations* providing services in the field of social services for the population changed over the past three years?” - 42.7% of respondents answered “has not changed”, 1.3% - “decreased” and 33.5% - “increased”. The *quality* of these *services* “satisfied” - 89.1% of respondents. Satisfaction with the *level of prices* was noted - 41.1%, 28.2% - “rather satisfied”, “rather not satisfied” - 11.9% and “unsatisfied” - 7.1%. Most respondents were satisfied with the *choice of services* in the field of social services (78.5%).

The above data indicate that the established target indicators of the private market of services in the field of social services of the population of at least 10 percent are reached and amount to 19.7% (in 2017 - 15.7%).

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THE NEED FOR STRESS TESTING FOR FINANCIAL ORGANIZATIONS

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The article discusses the need to use an effective predictive tool in the field of risk management, which allows forecasting financial losses during stable and highly volatile periods of economic development, as well as assessing the stability of organizations when they are exposed to stressful, but quite realistic risk factors. The use of the stress testing procedure is proposed as such a tool. The article analyzes stress testing from the point of view of various applied aspects, also identifies the problems that are often encountered during this procedure, suggests ways to solve these problems. In addition, the key characteristic of the stress testing procedure is described, in the absence of which the target task will not be solved to conduct a preventive risk assessment in the worsening economic situation or in the event of a financial crisis. In addition, regulatory requirements for stress testing are provided, advantages and disadvantages of current legislation are highlighted, and examples of the use of stress testing by the government are provided.

Keywords: stress testing, stress scenarios, risk factors, crisis, coronavirus.

Since the beginning of the 2000s, global shocks in the Russian economy have already been observed several times: the economic crisis of 2008, the currency turbulence of 2014. 2020 also portends the beginning of a new crisis, but this time the epidemiological reason became the prerequisites for this shock: the spread of coronavirus infection worldwide. In such an extremely unstable economic situation, it is extremely important to have tools that can proactively identify risks, especially in financial institutions that are the basis of any economy.

At the beginning of 2019, the rating agency "Expert RA" made an assumption about the default of 46 banks in the period from April 1, 2019 to 01.04.2020 [20]. Given the current situation in which the majority of orga-

nizations located on the territory of the Russian Federation have not been operating since the beginning of April 2020, it is difficult to imagine how devastating the results of a long downtime will be, the end of which has not yet been determined. But it is now clear that the economy will suffer significant damage, and the number of banks that declare their default in 2020 will be greater than the previously predicted value.

One of the tools that allows you to assess the vulnerability of financial institutions to shock, but quite realistic events, is the stress testing procedure. Recently, this tool has been increasingly used not only at the level of a separate financial organization, but is also being introduced into supervisory activities at the state level when assessing systemic risks by the Russian regulator. Significant support in the development of stress testing is played by Central banks, including in the Russian jurisdiction. The need for stress testing as one of the elements of risk management is legally established for most financial institutions in the Russian Federation. This approach allows us to assess the economic stability in the country and take corrective measures if necessary.

Foreign regulation in terms of a detailed description of the stress testing procedure with the scenarios used and the prerequisites used in the calculation of risk metrics has moved much further than Russian practice, in which the requirements for the stress testing procedure are not formally detailed at the regulatory level. This, in turn, can adversely affect risk assessments in stressful situations for financial institutions with different specifics of activity, as well as during stress testing at the macro level.

The active popularization of stress testing in recent years is due to the large number of advantages of this tool. Firstly, the stress testing procedure allows us to predict the amount of damages and losses that a financial institution will incur as a result of the implementation of shock factors. Secondly, thanks to the results of the stress testing, the initial array of existing risks can be ranked by the amount of potential damage. And besides, stress testing, which is especially important in the current volatile conditions, can also be used as a crisis management tool, since in an extremely unstable economic situation stress testing allows you to model hypothetically possible outcomes in a short time and take appropriate preventive actions.

The implementation of stress testing in practical execution is the calculation of various kinds of financial and non-financial risks with a predetermined scenario or the basic formation of a financially unstable state of the organization and finding macroeconomic parameters that lead the organization to such a financial situation. At the same time, it is necessary

to use such parameters of the initial scenarios and financial indicators that are economically justified and quite realistic.

Stress testing models are often a complex mathematical apparatus, which makes it possible with sufficient accuracy to make a forecast regarding the susceptibility of a financial organization to extraordinary but probabilistic events. Prediction of the future effectiveness of the functioning of a financial organization under the influence of stress factors allows us to draw conclusions not only about the current situation, but also to use the results of stress testing to form measures that are part of a plan to restore the financial stability of a financial organization.

To minimize subjectivity and take into account a large number of individual characteristics of a financial organization, a large number of different indicators are included in the stress testing models. And as a result, the stress testing procedure becomes laborious and difficult to conduct. In addition, a model that takes into account many different risk factors can give distorted results due to the error of even one of the indicators used.

When conducting stress testing, attention should also be paid to the correspondence of the mathematical apparatus used to the task, since the model for calculations may not take into account the features of the simulated process or the specifics of the data being analyzed. Also, when conducting complex stress testing at the level of a group of companies, as a rule, they face the problem of balancing the final quantitative result of losses or probabilistic damage, as the additive model when taking into account several types of risk is not optimal due to the correlation relationships between different types of risks. Another significant drawback in the stress testing procedure is the underestimation of various kinds of factors, as well as their combination and impact force.

The solution to the above problems may be

- validation of the models used, revision of the applied stress factors and argumentation of their validity on an ongoing basis;

- continuous monitoring of the activities of a financial organization in order to identify and study new stress factors, including in the field of non-financial risks, for example, reputational risks, which are extremely difficult to quantify.

In addition, the use of international experience and best practices in terms of conducting stress testing can also help to eliminate these shortcomings. At the same time, it is worth noting the positive effect in the creation and active use of methods for assessing the quality of stress testing, its accuracy in forecasting and adaptive ability to quickly transform into new needs.

Improving the applied aspects of stress testing is important, however, the key characteristic of stress testing, which is dominant when using this

tool, is the applicability of the results obtained in the activities of a financial organization. If the stress testing procedure is formal, the results are not informative and are not implemented in the organization's risk procedures, then the target task is to conduct a preventive risk assessment in the worsening economic situation or in the event of a financial crisis.

In addition, as already noted earlier, at the moment there are no regulatory requirements for methodological approaches to stress testing. On the one hand, the absence of normatively established recommendations for the development of models and algorithms for stress testing gives financial institutions more freedom with regard to the choice of tools used. On the other hand, unlimited possibilities can lead to a model risk of the algorithms laid down in the stress testing procedure, which in turn can affect management decisions that will be made taking into account inaccurate information.

Nevertheless, despite the existing shortcomings of the practical application of stress testing and its regulation, the Russian government actively uses it in assessing the hypothetical consequences of measures taken and in the supervision of financial institutions. An example of this use is the use of stress tests for systemically important companies according to the scenario of the spread of coronavirus, quarantine and lower oil prices.

In conclusion, it can be noted that the costs of restoring financial stability for developed and developing countries after a series of crises at the beginning of the XXI century were significant. Considering the previous experience, it is necessary now on the threshold of another crisis to think about the active use of effective risk identification tools. It is to such demanded tools that stress testing belongs, which allows you to evaluate hypothetical losses, as well as choose mitigation methods. In order to ensure financial stability, stress testing can also be used as a way to find the most vulnerable business areas of a financial institution. All of the above actions should be part of measures aimed at protecting the organization from default.

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QUANTITATIVE AND QUALITATIVE ASSESSMENT OF THE FINANCIAL STABILITY OF COMMERCIAL BANKS

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In the article, the authors consider the problems of developing a toolkit of qualitative methods for concretizing the concept and assessing the financial stability of a commercial bank. The relevance of such a study is due to the extremely unstable financial and economic state of commercial banks at the federal and regional levels and the entire banking system as a whole. The authors have proposed a list of key banking risks and methods for calculating them, based on methods approved by international financial organizations and the Central Bank.

Keywords: banking system, commercial bank, bank portfolio, financial stability, sustainability indicators, Basel III standards.

Introduction

The banking system is the most important institution of a market economy, designed to ensure the regulation and transformation of financial flows based on the activities of credit institutions, which differ in capital volumes, portfolio sizes, profitability and risk indicators, and other factors that determine their role at the regional and federal levels. Based on this, the strategic goal of banks, like other commercial organizations, is to achieve systemic criteria for the effectiveness of core activities, such as profitability, liquidity and stability. These indicators are formed both at the stage of passive operations related to the attraction of financial resources, and at the stage of active, carried out in accordance with the policy of allocation of financial resources.

To maintain stability in order to reduce potential financial risks, a commercial bank needs the correct assessment, monitoring and regulation of financial stability [1, 2]. However, most of the currently known methods for assessing this indicator do not solve the problems of bankruptcy, reorganization or license revocation, since they do not fully reflect the realities of the practical activities of commercial banks. One of the reasons is the

incorrect determination of financial stability and the bank's internal risks characterizing it.

The purpose of the study is to determine the main financial risks, the diagnosis of which will allow to correctly identify the financial stability of a commercial bank.

The subject of the study is the quantitative and qualitative assessment of the financial stability of commercial banks.

Research results and discussion

The use of certain methods of assessing the financial stability of a banking organization is dictated by the chosen conceptual apparatus. Several theoretical approaches to determining sustainability are known, the main of which are functionally-targeted and risk-oriented.

The first involves the use of the ability to fulfill its functional responsibilities and achieve the goals of owners and creditors in a changing external environment in assessing the financial stability of a bank. For example, S.L. Ermakov [4] characterizes the financial stability of the bank as the ability to maintain equilibrium under the influence of internal and external forces.

Some proponents of this approach especially highlight the function of the bank fulfilling its obligations. So, I.S. Ilyasov [5] argues that the financial stability of a bank is the ability under dynamic market conditions to clearly and efficiently perform its functions, to ensure the reliability of deposits of legal entities and individuals and its obligations to serve customers. I.I. Mozhanova and O.A. Antonyuk [2] believe that financial steadiness is determined by stability, the progressive development of an economic entity, ensuring maximum achievement of its goals in a changing environment.

The time aspect is becoming an equally important criterion in determining financial stability. According to L.V. Tatarinova [3], the financial stability of a commercial bank is a qualitative characteristic of its activities, which allows it to adapt in a timely manner to changes in the macroeconomic environment, operate efficiently in the banking services market, and fulfill obligations to customers and shareholders regardless of external and internal factors and ensure the potential growth and development of all structural divisions in the medium and long term.

We emphasize that the categories of “sustainability” and “reliability” are not identical. This position is held, for example, by prof. M.A. Khalikov and his students [1,6,7]. According to the dictionary I.S. Ozhegova [8], “reliable” - trustworthy, meeting its purpose; “Stable” - not subject to fluctuations, persistent, solid. Thus, the fulfillment by the bank of its obliga-

tions to customers or participants is the determining criterion of reliability. Stability, first of all, is the ability to withstand the influence of exogenous and endogenous factors [9].

The second approach to determination is focused on internal sources of instability, acting in the form of risks. Following E.S. Rosengren, “risk transformation" occurs due to the accumulation of funds of investors and directing them to more risky long-term investment projects [10]. So, financial stability is determined by the effectiveness of risk assessment and how to level it, taking into account the likelihood of occurrence. S.V. Kadomtseva, a proponent of this approach, also notes the need to take into account the achievement of the optimal combination of gain and risk [11].

It is also worth noting that the Central Bank of Russia directly establishes methods for assessing financial stability and treats it as a condition in which the bank continues to fulfill its functionality, avoiding violations of control parameters [12].

Given the above approaches, we offer the following definition of financial stability of a commercial bank, focused on use as part of a risk analysis: **financial stability - the state of financial resources in which a commercial bank, transforming financial risks, is able to quickly perform its functions and maintain the basic parameters of economic activity (capital, profit) in case of changes in the macroeconomic environment.**

Further, proceeding to the procedure for assessing the financial stability of a commercial bank, we will proceed from the procedures established by regulatory acts of the Central Bank and internal standards to establish the degree of compliance of the stability of a commercial bank with the requirements of the subjects of assessment [12, 13,14]

An integrated approach to determining the financial stability of a bank includes:

- analysis of balance sheets, quality of customer base and market conditions [11];
- identification of risks of credit investment and operational activities of the bank;
- compliance with regulatory standards;
- control over the conduct of financial accounting;
- monitoring the effectiveness of active and passive operations.

Since the conclusion about the stability of the bank is made on the basis of assessing the level of risks and the quality of their management, it is necessary to identify these risks.

A single list of risks for commercial banks in the Russian Federation has not been established, and each credit institution chooses its own method of assessing financial stability. In its review of the banking sector, the Bank of Russia determined the following indicators of financial stability (in%) [13, 14]:

- capital adequacy;
- credit risk;
- liquidity risk;
- market risk;
- profitability risk.

The capital adequacy ratio (N1) regulates the bank's insolvency risk and determines the requirements for the minimum amount of the bank's own funds. Since financial stability is determined by the ability to maintain the basic parameters of economic activity, this indicator covers the possible market, credit and operational risks of a commercial bank. The capital adequacy ratio is calculated as the ratio of bank capital to the amount of liabilities to customers at the last reporting date of the quarter [12]:

$$C_{N1} = \frac{C_0}{O}. \quad (1)$$

Basel III experts have proposed an alternative way to determine the level of capital adequacy in assessing financial stability based on the basic (stable) part of capital and assets weighted by the amount of risk [15]:

$$C_{av.cap.} \frac{C_{bas.}}{A_{t.risk}}. \quad (2)$$

The higher the ratio, the more stable the estimated bank is considered.

Credit risk is most important in assessing the long-term sustainability of a bank. It characterizes the probability of loss of financial assets as a result of a borrower's failure to fulfill its obligations to pay interest and principal in accordance with the agreement. In a broad sense, the Bank of Russia associates credit risk with the allocation of funds in various assets, with the conduct of forward transactions, with the presence of contingent credit commitments [14]. According to form 0409115, credit risk is calculated as a formed reserve for possible losses on loans in% in the amount of loans issued:

$$Ccred. = \frac{R_{loans'}}{C}. \quad (3)$$

Thus, the stability of the financial position of a commercial bank and the ability to conduct continuous economic activity in the event of external risks depend on the level of the reserve base.

The banking system of the Russian Federation uses the experience of revoking licenses in connection with problems with cash liquidity. Meth-

ods for assessing the liquidity risk of credit institutions are based on the ratio between the volume of assets and related liabilities. So, the liquidity risk is characterized by a decrease in cash on correspondent accounts, delays in making cashless payments [14]. The bank needs to evaluate the amount of potential losses that may occur while maintaining liquidity in order to correctly allocate available resources. Thus, the liquidity risk indicates the state of financial resources, which characterizes the bank's ability to fulfill its obligations and maintain financial stability.

Banking efficiency is characterized by the current liquidity ratio (N3), which assesses the risk of liquidity loss and determines the minimum value of the ratio of the amount of the bank's liquid assets to the amount of liabilities on demand accounts and with the term of fulfillment of obligations in the next 30 calendar days, adjusted for the minimum total balance of funds on accounts of individuals and legal entities on demand and with a deadline for fulfillment of obligations in the next 30 calendar days. The current liquidity ratio of the bank (N3) is calculated by the formula:

$$C_L = \frac{A_{LQ.}}{O_{dm} - O_{dm*}} * 100\%, \quad (4)$$

where, O_{dm} - liabilities on demand accounts, on which a depositor and (or) creditor may be required to immediately repay them, and bank liabilities to creditors (depositors) with a maturity of obligations in the next 30 calendar days;

O_{dm^*} – the value of the minimum total balance of funds on accounts of individuals and legal entities on demand and with a deadline for fulfillment of obligations in the next 30 calendar days.

Market risk arises as a result of losses due to adverse changes in macroeconomic indicators of the financial system (interest rate curves, exchange rates, value of financial instruments). In all forms of market risk (interest, currency, stock, commodity), exogenous indicators are used, which makes it difficult to assess financial stability [7].

The coefficient of net stable financing proposed by Basel III is able to determine the bank's ability to withstand external market shocks, taking into account the totality of urgent deposit attractments to the total volume of risky assets. However, in Art. 837, Cl. 2 of the Civil Code there is a norm guaranteeing the return of the deposit to an individual at his first request [9].

Thus, for an objective assessment of financial stability, urgent deposit funds should be considered without taking into account the deposits of citizens. This will allow to determine the share of funds covering risky assets, which will not be claimed in the event of "non-shock" market events:

$$Cmar. = \frac{D_{av.} - D_{F.L.}}{A_{risk}}. \quad (5)$$

Profitability risk is also an indicator of the endogenous form of financial stability of the bank, since a low rate of return may be associated with a conservative investment policy or high operating costs. The effective activity of the bank can be determined by the rates of income from assets, which also indicates the correctness of the disposal of financial resources and maintaining the profitability of shareholders when the market situation changes. In Russian banking practice, indicators of financial stability include such indicators as return on assets, return on equity. S.V. Kadomtseva suggests considering an alternative way to assess the risk of profitability [11]. The author gives examples of bankruptcies of banks whose liabilities were formed due to borrowed securities.

The higher the bank's dependence on wholesale financing, the greater the risk of loss of profit.

For example, loans in the real economy of the Russian Federation in the late 90s amounted to less than a third of the assets, but 33.4% of the assets were invested in securities. So banks sought to stay farther from the real sector of the economy in order to get a larger percentage of profits, while not always reckoning with risks, which led to losses due to a default in 1998.

In this regard, it is proposed to consider the ratio of the amounts invested by the bank for the acquisition of shares of other legal entities to capital (standard N12) [13]:

$$\text{Cprof.} = \frac{I_{as.}}{C} \quad (6)$$

The next risk - operational - is inherent in all banking products and is closely associated with other risks. The Basel Committee recommended that it be included in the sustainability assessment of commercial banks. The Central Bank characterizes operational risk as the probability of losses as a result of non-compliance with the nature and scope of the credit institution and (or) the requirements of the current legislation, their violation by employees of the credit institution, lack of functionality, and also as a result of external events [16]. Control of operational risk is the basis for the stable functioning of the bank.

In December 2017, a new methodology was adopted for a standardized assessment of operational risk, which consists in determining the minimum capital [14]:

$$\text{Cdet.} = \text{BIC} * \text{ILM}, \quad (7)$$

where BIC – business indicator reflecting averaged industry operational risk;

ILM – internal loss multiplier.

$$ILM = LN\left(\exp(1) - 1 + \left(\frac{LC}{BIC}\right)^{0,8}\right), \quad (8)$$

where, LC - component of losses (Loss Component), taking into account the specifics of the operational risk of a particular bank according to the statistics of its internal losses in recent years (at least 10 years).

If LC is bigger than BIC, then ILM is bigger than one: a bank with high losses compared to its BIC should have higher capital due to accounting for internal losses.

Conclusion

Financial analysis is the most important way to determine the financial condition and choose the direction of increasing the efficiency of banking activities. The aggregate assessment of the financial stability of a Russian commercial bank, according to the authors, should be based on the following risk indicators:

- capital adequacy risk;
- credit;
- liquidity risk;
- market;
- profitability risk;
- operating.

The main problems of the banking system of Russia are associated with its lack of stability and high dependence on geopolitical and economic factors. The most significant risks for the banking system are a decrease in the liquidity of credit institutions and the vulnerability of depositors' funds. It is necessary to take into account the low degree of diversification of bank assets and deficiencies in their insurance system. Commercial banks should use unified and proprietary financial sustainability criteria and track deviations from their acceptable values.

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LANGUAGE LEARNING GAMIFICATION IN HIGHER EDUCATION

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The article discusses the features of the gaming technology in the foreign language teaching. The specificity of the game activity in student's personal development is highlighted. The author presents the targets of language learning gamification in higher education. The article offers the review of different types of games according to their didactic tasks. The author shows the example of a role-playing game on the topic of "Humanitarian Law". The transition from reproductive to productive and creative strategies of the development of game cognitive activity is shown as the necessary condition of game introduction in higher education. The author states that the inclusion of game situations, business games, and role-playing games in the language-learning process helps the professional orientation in educational activity of students.

Keywords: gamification, language learning, gaming technology, didactic games, higher education, game cognitive activity.

One of the pedagogical technologies that implements the tasks of refining education is gaming technology, which is a system of applying various didactic games in education. They form the ability to solve problems based on the component choice of alternative options. The use of the game in the learning process is based on its great potential. The game activity plays a great role in student's personal development. This is due to the fact that playing a game helps to remove the barriers that many students have in the context of traditional education, as there is no teacher's strict control, there are no marks for each incorrect statement.

The target orientations of gaming technology include:

Didactic target: It leads to broadening students' horizons, development

of their cognitive activity; the formation of certain skills needed in practice; development of general educational skills; development of labor skills.

Educational target: Gamification of educational process develops student's independence and will. It helps to improve the communication skills as well as the skills of cooperation, and sociability. It serves to form moral and aesthetic worldview.

Developing target: The implementation of gaming technology in the educational process leads to the development of attention, memory, speech, thinking, imaginations, fantasies, creative abilities, empathy and reflection. Gaming technologies improve students' abilities to find optimal solutions; to compare, contrast and find analogies. They develop the motivation for educational activities. [5]

Each game has an element of competition. In competitions the learner's activity and the will to win arises. The element of competition increases the emotional intensity, self-control of students, activates their actions.

The choice of each game is determined by its potential, correlated with the features of the didactic task. According to the Bespalko's ideas there is a goal displayed in the structure of the didactic task. The achievement of the goal is determined by the situation (conditions) and contains the information necessary for the activity. The technology includes the unity of three components: organizational form, didactic process and teacher qualifications. [2]

In modern pedagogical and psychological literature there are many types of games. The nature of the pedagogical process makes it possible to distinguish the following groups of games:

- training, controlling and generalizing;
- cognitive, educational, developing;
- reproductive, productive, creative;
- communicative, diagnostic, career orientated , psychotechnical, etc.

According to the didactic tasks of the game, it should be divided into educational, controlling and generalizing. It should be noted that the goals of didactic games are as follows: broadening one's horizons, cognitive activity; the formation of certain skills that are necessary in practice; development of general educational and labor skills.

Educational games are games in which students acquire some new knowledge and skills. The potential of games in the process of the assimilation of new knowledge is significantly inferior to more traditional forms of learning, so educational games are used relatively rarely.

Controlling games are games used to check up. Their didactic goal is

to repeat, consolidate and verify previously acquired knowledge.

Generalizing games are interesting in their content and form. They require the integration of knowledge. They are used to reveal the inner connections in the sphere of knowledge. Generalizing games teach students to act in various situations.

Various modifications of business games: simulation, operational, role-playing, business games can be widely used in higher school. [4]

Let us consider the essence of the above mentioned games.

Simulation games

The students imitate the activity of any organization or enterprise. Some events, the specific activities of employees and the conditions of work can be imitated. The script of the simulation game, in addition to the plot of the event, contains a description of the structure and purpose of the simulated processes and objects.

There are five components of a simulation game: players, experts, game organizers, the educational material, experimental situation.

We can distinguish the following stages of a simulation game:

Preparatory – students study the material and the instructions.

Gaming – it consists of separate periods.

Final - it includes an intergroup discussion, the project presentation or making some sort of resolution of the problem.

It should be noted that in the context of higher education simulation games can be preferred from the existing range of games for university education. They increase interest to the material being studied, allow the student to see its significance in solving specific practical problems and tasks, and make it possible to practice professional activity.

Operational games

These games help students to practice specific operations. In operational games the corresponding workflow is modeled. Games of this type are held in conditions that simulate real ones.

Role-playing games

A role-playing game is a way to expand the participants' experience by involving them into an unexpected situation in which it is suggested to take the position of one of the participants and then develop a way to bring this situation to a worthy conclusion.

In these games tactics of behavior, actions, fulfillment of the functions and duties of a particular person are worked out. To conduct games with the performance of a role, a model-play of the situation is developed. roles with “mandatory content” are distributed among students.

This type of games in the context of university education is useful when

a teacher organizes profession-oriented training.

An example of organizing a role-playing game on the topic of "Humanitarian Law" given below shows its advantages in the developing the communicative competence of students:

TV Presenter:

«And finally, we come up to the last and the most essential part of our interactive lecture. The milestone of human life, which represents personal freedom, is respect for human rights. About a century ago in 1948 the Universal declaration of human rights was proclaimed as a common standard for all nations.

The right to nationality, right to life, liberty and security of a person are the examples of human fundamental rights.

Nowadays there are even more cases when these rights are easily neglected. We can clearly observe the demolition of human rights in the situation with refugees.

Let's act out a briefing on the topic the violation of refugees' rights. Choose a role and prepare to introduce yourself and present your point of view (Table 1).

Table 1. Role card

Role A	***A European union representative.*** *You think the population of European countries are worried about the lavish of migrants in Europe. Tell the others that they anticipate the economic meltdown, terrorists' attacks, deviant behavior, the rise of crime rates. You are sure that the European government will face the lack of experience in migration policy.*
Role B	***UN military observer****. You think it's necessary to find a good balance. Tell the others that human rights are the greatest human achievement but European authorities have to stick to 'zero-tolerance' policy towards immigrants to prevent refugees from entering European countries illegally.*
Role C	***Syrian refugees' committee representative****. You think the situation with refugees is close to collapse. They suffer from weather, lack of supplies, food and fresh water, exhaustion. Tell the others which is the worst of these things and why – moral exhaustion, homesickness, outbreaks of diseases.*

- So, we are in our studio. I am presenter and we are going to have a very important talk about refugees' human rights.

Could you introduce yourselves?»

Mr A: *-I am a European union representative*

Mr B: *-I am a UN military observer*

Mr C: *-I am a Syrian refugees' committee representative.*

TV Presenter:

-Let's start with the refugees' committee representative as a real witness of this situation.

Syrian refugees' committee representative presents his/her point of view.

TV Presenter listens to the opinion, asks questions, summarizes the results of the speech:

-You are right, European migration crisis is regarded to be the largest in Europe since the Second World War. However, we have to take into consideration the point of view of some European countries' population. Let's listen to a European union representative.

European Union representative presents his/her point of view.

TV Presenter listens to the opinion, asks questions, summarizes the results of the speech: «*Although this is true, some European citizens show support to refugees. According to The Guardian, thousands of Icelandic citizens demanded from their government to increase the number of refugees who will be granted an asylum in their country.*

Let's listen to UN military observer a member of UN Commission on human rights».

UN military observer presents his/her point of view.

TV Presenter listens to the opinion, asks questions, summarizes the results of the speech:

«Horrors of war, poor economic conditions force people to flee from their lands seeking for asylum that leads to serious problems in the recipient countries.

Thank you for expressing your opinions.

Conclusion. *Our briefing reveals all the importance of human rights respect:*

- first of all, noone should be deprived of his nationality;

- people should have social, political and economic freedom to which all community members are entitled;

- we are to have affordable housing, medicine, education and pension insurance.

According to Maslow's pyramid, the basic level which is required is live safety and personal security».

Thus the sequential inclusion of game situations, business games, and role-playing games of a professional orientation in educational activity raises the quality of education. The necessary condition is the transition from reproductive to productive and creative strategies of the development of game cognitive activity.

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INTENSIFICATION OF EDUCATIONAL AND COGNITIVE ACTIVITIES OF INTERNS IN THE PROCESS OF TRAINING

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Ensuring the effective socio-economic development of any society and the high level of medical care necessitates the professional training of specialists in a fundamentally new formation. An important stage of preparation in medical business is postgraduate training - internship. The main task of the interns' professional training is the activation of their educational and cognitive activities, the development of clinical thinking, the motivation for the need to master practical skills.

Keywords: educational and cognitive activities, interns, specialty "neurology", interactive teaching methods, problem-based training, case-study method, interdisciplinary seminar.

Success in implementing the reforms that the healthcare system have now embraced can be achieved only if there are a sufficient number of highly qualified personnel, which requires new approaches to training a doctor at the postgraduate stage [1, 10, 11]. The main objectives of postgraduate education of doctors is to improve the quality of training, the widespread introduction of methods of enhancing educational and cognitive activity, independent work, distance education and the training of interns with the requirements of continuous professional development throughout their professional lives [2, 6].

New approaches to the organization of training provide for significant adjustments to traditional relations in the system of "teacher-intern". In the modern educational process, the intern is not an ordinary consumer of information, but a creative seeker of knowledge and skills. In this case, the teacher's task is not only to transfer information in a ready-made form, but to encourage the intern to independent cognitive activity, to form his skills of independence in mastering knowledge [3, 8].

In order to enhance learning, the teacher must implement a multifactorial comprehensive approach to all types of cognitive activities based on the use of various teaching methods and techniques, the use of educational resources and organization of time, as well as positive motivation for the intern. In this situation, the teacher is the leader who organizes the educational activities of the entire audience, motivates and encourages each intern to develop creative abilities and independent cognitive activity, the ability to work in a team, with patients, and to identify a creative approach to solving problems [12, 13, 7].

In the educational process, it is necessary to create conditions providing motivation for learning, conscious activity of the intern, transformation and construction of the content of the material, reflection of the experience gained in solving practical problems. This will allow you to build your own active system of knowledge, the formation of experience and the choice of intern activity, since a high level of professional training is expressed in medical skills and practical skills, which is important in working with patients. In this case, the analytical and synthetic activity is fully implemented, generalization is carried out, the use of knowledge in practical activities is ensured [5, 9, 4].

We conducted a study on the basis of the Kharkiv National Medical University in order to verify the effectiveness of methods and means of enhancing the educational and cognitive activity of interns in the process of their professional training. Doctors-interns of 2 years of study in the specialty "Neurology" (total number - 20 people) were involved in the study.

Theoretical preparation of interns was carried out during lectures, seminars and independent work on the study of individual topics. During the lectures, we widely used the methods of "informational communication": audio-visual presentations, videos, graphics, integrated circuits of pathogenesis and topical diagnosis of various levels of damage to the nervous system, video and multimedia presentations demonstrating studies of the neurological status of patients with various pathologies.

The assimilation of theoretical material at seminars and workshops was carried out using interactive techniques: simulation business games,

various types of discussions, training seminars, case method (active problem-situational analysis) - the solution of specific tasks-situations. We have developed a package of case studies for interns on relevant topics of general and special neurology, as well as applied situational tasks of computer control, solving a block of tasks in neurology using the "ELEX" program.

Also during the experiment, such a form of training as an interdisciplinary seminar was used. An interdisciplinary seminar as an interactive teaching method provides the conditions for deepening and consolidating knowledge by interns, makes it possible to activate them for independent study of scientific and methodological literature, forms self-education skills, provides mastery of the methods of analysis of facts, phenomena, problems that are considered; contributes to the formation of skills for the implementation of various types of future professional activities; Encourages a collective creative discussion of the most complex issues, helps develop future specialists' skills in applying optimally acquired knowledge in practice.

The plan of the standard program also provides for practical medical activity for the assimilation of professional techniques and research methods of sensitivity, motor function and coordination of movements, autonomic nervous system, cranial nerves, pathological reflexes, and functions of higher nervous activity; establishing a topical diagnosis with subsequent clinical diagnosis, prescribing treatment and prevention of neurological pathology at the prehospital stage of patient management.

First of all, we attach importance to mastering the skills of neurological examination of patients, methods for examining the reflex sphere, shell symptoms, coordination tests, methods of examining all types of sensitivity, determining the emergency condition and providing the patient with adequate emergency measures and sending him to the hospital. Test control of the current topic, work with patients is preceded by practical mastery of the skills to identify individual symptoms, the study of the reflex sphere on mannequins in an interdepartmental gym.

The introduction of modern teaching methods on the “Neurology” cycle for interns has significantly improved the assimilation of special skills and abilities and the acquisition of theoretical and practical knowledge in the diagnosis, treatment, prevention, and the provision of adequate assistance in emergency situations in people with pathology of the nervous system.

The effectiveness of these activities was noted during the final exam. So, the percentage of “excellent” answers on emergency neurology has significantly increased - up to 50% against 27% with traditional approaches to training.

The technique of the correct performance by interns of special methods for examining neurological patients has doubled.

The majority (83%) of interns-doctors correctly determined the tactics of conducting neurological patients at the outpatient stage, as well as indications of their referral to a specialist.

The exam results prove the effectiveness of the selected methods and means of enhancing the educational and cognitive activity of interns, contribute to the achievement of the goal - the formation of a competency system, a system of knowledge, skills and abilities, readiness for professional activity, clinical thinking, responsibility and creative activity.

Thus, the introduction of the latest technologies for managing the educational and cognitive activities of the intern-doctor provides for the following:

- widespread use of forms and methods of active learning, contributes to the intensification of educational, cognitive, intellectual and practical activities of the intern;
- implementation of a personality-oriented approach to learning based on the interests, inclinations and abilities of a person;
- modeling the professional activities of the future doctor.

Innovative, interactive, problematic methods increase the efficiency and effectiveness of training when they are used at the stages of the educational process, and various means of approaches to diagnosis and treatment, emergency care and rehabilitation of patients, solution of problematic case situations provide a more effective preparation for the doctor's practical activities in the field neurology.

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REFLECTION OF THE LANGUAGE CONSCIOUSNESS OF NATIONAL CULTURE IN THE ASSOCIATIVE FIELD OF EXTERNAL ADVERTISING

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The article analyzes the associative field of an advertising banner in the multi-ethnic city of Ufa, which is the capital of the Republic of Bashkortostan, which is part of the Russian Federation. This work was written on the basis of a free associative experiment, in which 34 residents of Ufa took part. The resulting associative field was compared with the verbal part of the banner and its accompanying image and analyzed for the reflection of the linguistic consciousness of the carriers of the Bashkir culture in the city text of Ufa. It also analyzed the influence on the formation of associations in subjects of such methods of creolization of the advertising text as font, color and background image.

Keywords: associative experiment, associative field, creolized advertising text

Studies of associations and associative relations are of great importance in psycholinguistics, which has been actively studied since the end of the last century by such Russian scientists as A.A. Leontiev, Yu.N. Karaulov, E.F. Tarasov, Yu.A. Sorokin, A.A. Zalevskaya, N.V. Ufimtseva, etc.

One of the most popular methods for the study of associative relations is a free associative experiment, which "can serve as a valuable source of information when trying to explore the psychological equivalents of "semantic fields" and reveal the semantic connections of words objectively existing in the psyche of a native speaker" [Leontyev 1977: 7]. This experiment reveals the reactions of the subjects, which are the same for the entire language collective, despite their individual characteristics. The obtained associative fields for one or another word, which plays the role of a stimulus in the experiment, "make it possible to identify the systematic nature of the content of the image of consciousness behind the word in

a particular culture, as well as the systematic linguistic consciousness of carriers of a particular culture as a whole and show uniqueness and the soleness of the world image of every culture" [Ufimtseva 2003: 103]. A striking illustration of the originality of the linguistic picture of the world of a particular culture is the outdoor advertising of such a multi-ethnic city as Ufa. Being the capital of one of the national entities that are part of the Russian Federation, the Republic of Bashkortostan, Ufa is the place of residence for representatives of various nationalities. More than 100 ethnic groups live in it: Russians, Bashkirs, Tatars, Chuvash, Mari, Ukrainians, Belarusians, Mordovians, Udmurts, etc. A distinctive feature of Ufa is the fact that it has two state languages - Russian and Bashkir, which refers to the Turkic languages Kypchak group, Volga-Kypchak subgroup. All this affects the Ufa city text, which contains elements of the Bashkir culture.

In order to clearly demonstrate how the features of urbotekst affect the formation of the associative field in the linguistic consciousness of the residents of the Bashkir capital, a free associative experiment was conducted, in which the creolized advertising text was placed on the streets of Ufa and contained elements of the Bashkir culture. Outdoor advertising was chosen insofar as it, along with other areas included in the concept of the city as a territory, plays an "essential role in the life of the city, influencing the inner world and the behavior patterns of the urban population, since the" objectified space "is directly related to the existence of qualitatively heterogeneous urban living environments and cultural areas" [Yakovleva: 2019: 420].

The banner selected for the experiment contained an advertisement for the dairy products of one of the republic's dairy plants under the brand name "Kurai Land" (Fig. 1). The experiment was attended by 34 residents of Ufa aged 18 to 24 years, among whom were representatives of Russian, Bashkir and Tatar nationalities. The subjects were asked to carefully read the verbal part of the advertising text and the accompanying image, after which, without wasting time thinking, write from 5 to 10 associations that first came to mind.

The associative field obtained after the experiment is as follows: *Village 15, good 11, taste 11, Bashkortostan 9, milk 9, nature 9, freshness 8, health 7, cow 7, grandmother 4, sour 4, house 4, naturall 3, green 3, grass 2, food 2, kefir 2, product 2, breakfast 2, life 2, native 2, stop 2, easy 2, drink 2, milk 2, meadow 2, bright 2, dairy products 2, greens 2, cheap 2, trust 2, delicious, sun, sky, earth, thick, sweet, farm, sour cream, coolness, plastic, naturalness, proximity, design, childhood, dainty, pancakes, fresh air, cats, summer, purchase, porridge, koumiss, cottage cheese, child, for-*

est, fields, hunger, cereals, pattern, animals, smell, co ova, protein, milk powder, cream, homeland, plant, calcium, dietary supplement, snack, comfort, snow-white, love, beauty, vitamins, different, air, freedom, native land, republic's milk brand, mother, heat, diet, lips, mustache. Thus, a total of 190 reactions were obtained, of which 86 different and 55 single, no failures were recorded.

Fig. 1. Advertising of the “Kurai Land” trademark

The analysis of the obtained associative field showed that it not only reflects the features of the Bashkir culture in the urban text of Ufa, but also directly depends on the colors, font and symbols used in advertising.

The banner depicts three dairy products (kefir, yogurt and milk), which are buried in lush grass, and above them is the inscription "dairy products from the protected land", imitated under a wooden plaque suspended on a twine. This inscription, together with the name of the brand “Kurai's Land”, forms the verbal part of the banner, which is directly associated with the image of the Republic of *Bashkortostan*. It was recorded that 9 of

34 subjects wrote the word Bashkortostan, and it is included in the core of the associative field along with the words *village, good, milk, nature, taste*. Reactions such as *native* (2 people) and singular *koumiss, homeland, native land, and the republic's dairy brand also apply to the republic*. A similar reaction of the subjects is explained by the fact that the name of the trademark "Kurai Land" allegorically means the Republic of Bashkortostan. This is due to the fact that kurai is a "Bashkir musical instrument, a longitudinal open flute" [Big Russian Encyclopedia 2010: 373.], which is made from the stalk of the Ural rebrood, popularly called kurai. This tool is a symbol of Bashkir culture, it is represented on the flag and coat of arms of Bashkortostan. Playing kurai is often accompanied by throat singing, its sound is poetic and sublime. Kurai is mainly associated with the endless steppes of the Trans-Urals, mirror lakes, transparent rivers and clean air, i.e. with the "reserved land". All this is enhanced by the use of a font, as if taken from a book of fairy tales, and a wooden plaque with twine. All three components (color, font, wood with string) emphasize the naturalness of the advertised products and the "preservation" of the kurai land. They generate the following reactions: *village, benefits, nature, freshness, health, natural, life, sun, sky, earth, farm, naturalness, proximity, fresh air, forest, fields, love, beauty, air, freedom, native land.* The advertised milk, yogurt and kefir also sparked associations: *milk, taste, food, kefir, product, breakfast, light, drink, milk, dairy products, tasty, sweet, sour cream, dainty, pancakes, porridge, koumiss, cottage cheese, hunger, cows, protein, milk powder, cream, calcium, dietary supplement, snack, vitamins, republic's dairy brand, mom, heat, diet.*

The background to the entire creolized advertising text is the image of thick and juicy grass, the use of which is explained by the cult of the plant as a symbol of life not only in world culture, but also in Bashkir, because "in the world-thinking mind of the Bashkir all vegetation was perceived from ancient times as a symbol of life, growth, rebirth" [Akkuzhina 2013: 10]. It is known that the Bashkirs collected spring and medicinal herbs, performing various rituals such as "sorrel feast", "sour feast", etc. The grass creates a feeling of usefulness of the product, its naturalness and environmental friendliness. The colors used in the banner also contribute to this - the color of the grass itself and white. In addition to the fact that green color "is associated with health, tranquility, nature and harmony, helps to achieve balance and relaxation" [Bogatyreva 2018: 21], it is also the color of Islam, the traditional religion of the Bashkirs. White color means "all good, joy, purity, health, multiplication of offspring, peace, harmony" [Grigoryeva 2011: 1478]. In addition, it is the color of milk, natural

yogurt and kefir and is directly associated with the advertised product. The creolization of the text with the image of grass, green and white flowers caused the following reactions of the subjects: *village, benefit, Bashkortostan, nature, freshness, health, natural, green, grass, life, meadow, bright, greens, sun, sky, earth, farm, coolness, naturalness, childhood, fresh air, summer, forest, fields, homeland, plant, snow-white, love, beauty, air, freedom, native land.*

Thus, summing up all of the above, it should be concluded that the urban text is able to form various associative connections with the linguistic consciousness of the carriers of the region's national culture through symbols that are significant for the ethnic group. It should also be noted that such methods of creolization of advertising text as font, color and background image can control associations that pop up in the minds of advertisers.

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TYPES D'ANTONYMES DANS LA LANGUE IAKOUTE

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Cet article est consacré à l'analyse des types d'antonymes dans la langue iakoute. Les possibilités sémantiques des antonymes considérés sont analysées, en fonction du type logique-sémantique du contraire.

Mots-clés: linguistique, antonyme, langue iakoute, synonymie, dictionnaire.

L'un des moyens de connaître la réalité environnante est la juxtaposition. *Le bien-mal, l'amour-la haine, la guerre-la paix, la naissance-la mort* sont les termes de l'être. Nous ne saurions pas ce qui est bon si nous ne nous sentions pas ce qui est mal, nous ne pourrions pas distinguer les intelligents s'il n'y avait pas des «fous» parmi nous.

Les antonymes de la langue iakoute n'ont pas encore fait l'objet d'une étude linguistique.

Dans les manuels de la langue iakoute, il y a des paragraphes qui donnent de brèves informations sur les antonymes comme l'une des couches du vocabulaire de la langue iakoute [3, 4, 8]. En linguistique iakoute, Allakhskii a donné pour la première fois l'explication authentique sur les opposés par rapport à la valeur des mots – antonymes, qui est l'auteur du seul dictionnaire des antonymes iakoute, publié en 1957 et 1976. Le tutoriel Antonova possède un paragraphe d'antonymes iakoutes dans son livre «La langue iakoute moderne», qui a paru en 1967. L'auteur du manuel note que les antonymes servent de moyen stylistique de transmission de l'expression dans la fiction et qu'ils sont l'une des couches intéressantes et riches du discours familier iakoute et aideront à l'utilisation correcte du

vocabulaire de la langue maternelle [3, p. 24].

Le but de l'étude est d'identifier les variétés d'antonymes dans la langue iakoute, en fonction du type logique et sémantique du contraire.

Antonymes (du gr. anti-vs + onyma-nom) – ce sont des mots, différents dans le son, ayant des significations opposées: *vrai – faux, bon – mauvais, parler-se taire.* Les antonymes se réfèrent généralement à une partie du discours et forment des paires [6]. Cependant, cela ne signifie pas qu'un mot particulier peut avoir un antonyme. Les relations antonymiques permettent d'exprimer l'opposition des concepts dans une série polynomiale "non fermée", cf.: *concret – abstrait, abstrait; joyeux – triste, triste, triste, ennuyeux* [6, p. 49].

En russe, l'antonymie est déjà représentée par la synonymie: seuls les mots qui se rapportent à une caractéristique-qualitative, quantitative, spatiale et appartenant à la même catégorie de réalité objective en tant que concepts mutuellement exclusifs: *beau – laid, beaucoup – peu, matin – soir, supprimer – rapprocher* entrent dans les relations antomiques. Les mots ayant d'autres significations n'ont généralement pas d'antonymes; comparez*: téléphone, mémoire, écrire, trente, Moscou*. La plupart des antonymes caractérisent des qualités (*grand-petit, rapide-lent, sombre-léger*); beaucoup indiquent des relations spatiales et temporelles (*spacieux – étroit, jour – nuit, gauche – droite)*; moins de paires antomiques avec une valeur quantitative (*beaucoup – peu, le seul – nombreux*). Il y a des noms contre-positifs d'actions, d'états).

Dans les manuels de la langue russe, les antonymes sont divisés en deux catégories: linguistique et contextuelle. Dans les antonymes linguistiques, l'opposition des significations se manifeste sous une forme isolée (fixée dans les dictionnaires). Dans les antonymes contextuels, l'opposition des significations ne se manifeste que dans le contexte.

Les antonymes linguistiques sont inter-mot (ils sont appelés autrement énanthosémiologie) et intra-mot. Les inter-mots sont divisés en trois groupes: 1) opposés; 2) complémentaires; 3) exprimant la direction opposée [5, p. 9].

Selon Afanassiev, dans la langue iakoute, les paires d'antonymes sont dans la plupart des cas exprimées par des adjectifs et des adverbes [4]. Il y a des verbes antonymes, utilisés principalement dans le genre de la créativité verbale. Il y a peu d'antonymes exprimés par des noms.

Il faut dire que la langue iakoute a un riche patrimoine folklorique. À cet égard, les chercheurs de la langue iakoute ont identifié les antonymes contextuels comme un des types les plus courants d'antonymes.

Une source pour la recherche de paires d'antonymes ont servi de

“Grand dictionnaire de la langue iakoute” en 15 volumes, “Iakoute-russe”, publié sous la direction de Sleptsov en 1972, le “Dictionnaire les antonymes dans la langue iakoute” Allakhskii, en contenant 157 lexicale paire d'antonymes.

Nous avons recueilli plus d'un millier de paires d’antonymes, exprimées par des noms, des adjectifs, des adverbes et des verbes.

Sur la base de la classification des antonymes en russe, nous avons identifié deux catégories d'antonymes: 1) linguistiques; 2) contextuelles. Les antonymes de la langue peuvent également être divisés en intra-mot et inter-mot. Les antonymes inter-mots peuvent être: 1) opposés (graduels); 2) complémentaires (supplémentaires); 3) antonymes-conversifs; 4) direction opposée des actions.

Considérons les antonymes linguistiques. Le vocabulaire de la langue iakoute est caractérisé par son expressivité. Dans le discours familier et artistique, nous pouvons trouver de nombreux exemples d'énanthosémiologie: *Бу туох өйдөөх оҕотой! 'Quel enfant intelligent!'*. Dans cette déclaration, le locuteur critique l'enfant pour son ignorance envers les adultes, en utilisant le mot "intelligent" dans le sens de "fou". Ici, l'antonymie se produit à l'intérieur d'un seul mot. L'utilisation du mot dans son sens opposé est sarcastique, généralement écrite entre guillemets.

Dans la langue iakoute, les antonymes intra-verbaux sont souvent exprimés par des verbes. Il faut dire que la stylistique du verbe dans la langue iakoute est assez riche, car c'est le verbe qui a beaucoup de catégories grammaticales qui transmettent non seulement l’expressivité mais aussi un riche spectre de valeurs modales. Dans le discours familier, il y a un point intéressant où la forme positive du verbe exprime la forme négative et la forme négative – positive. Confirmons par des exemples: *Итинтэн ордук хайдах таптыай? 'Et comment aimer autrement?'*. La sémantique de ces questions rhétoriques a un contenu opposé: *Итинтэн ордук хайдах да таптаабат. `Иначе любить нельзя (не любит)`; `Sinon, vous ne pouvez pas aimer' (n'aime pas)'.*

La forme négative du verbe peut dire le contraire: *Дьэ, диэмэ даҕаны ‘Eh bien, ne dites pas’ (‘oui, dites-le)’*; *Ырыаҕын өйдүүгүн дуо, доҕоор? Өйдөөмүнэ (вместо: өйдөөн) ‘Помнишь слова песни? – Как же не помнить (вместо: да, конечно помню) ‘Au lieu de: tu te souviens des paroles de la chanson? - Comment ne pas se souvenir (au lieu de: oui, bien sûr, je me souviens)*'.

Ensuite, nous analysons les antonymes inter-mots.

1. Les antonymes contrastés ou graduels forment une opposition

graduelle (graduée) qui reflète un changement progressif de qualité, de caractéristique, de propriété. Par example: *тымныы – сөрүүн – сылаас – итии 'холодный – прохладный – теплый – горячий','froid – frais – chaud – brûlant'.* Voici un autre paradigme des antonymes: *инчэҕэй – үөл – сиик тээх – кураанах 'мокрый – сырой – влажный – сухой' 'mouillé – brut – humide - sec*'. Une telle caractéristique peut être donnée au bois de chauffage. Faisons attention au mot – *үөл*. Dans ce cas, il n'est utilisé que dans l'expression – *үөл мас, qui signifie "arbre fraîchement coupé"*. Les noms de couleurs donnent également naissance à un paradigme: *үрүҥ – бороҥ – хара 'белый – серый – черный' 'blanc – gris-noir'*. Cependant, ces valeurs de couleur ne peuvent pas être adjacentes au même mot en même temps. Dans la langue iakoute mot *үрүҥ* en combinaison avec d'autres mots peuvent avoir plusieurs valeurs: *үрүҥ туллук 'bruant blanc', үрүҥ күн 'soleil blanc', үрүҥ чөмчүүк 'perle blanche', үрүҥ санаа светлые / добрые мысли' 'lumineux/de bonnes pensées', үрүҥ үлэһит букв. пер. 'белоручка; человек, занимающий высокую должность, интеллигент с высшим образованием'; un homme occupant un poste élevé, un intellectuel avec une éducation supérieure', үрүҥ саллаат 'belogvardeets', etc.* Il n'est pas permis d'utiliser *хара туллук 'bruant des neiges noir' (dans la nature il n'y a pas une telle espèce d'oiseaux) ou бороҥ санаа 'pensées grises'* (il est habituel d'utiliser des pensées blanches/noires dans une paire).

2. Les antonymes complémentaires ou contradictoraux ne forment que des oppositions binationales, la négation de l'un signifie l'affirmation de l'autre. Par exemple: *кырдьык – сымыйа 'правда – ложь' 'vrai – faux', өл – төрөө 'родиться - умереть' 'né - mort'.* Il ne devrait pas y avoir de terme moyen entre les antonymes complémentaires. Antonymes complémentaires sont utilisés dans les proverbes et adages: *Кырдьык үрдүгэр сымыйа ыттыбат; 'Правда всегда поднимается над ложью, как масло над водой.'; 'Sur la vérité le mensonge ne peut pas grimper, au-dessus de l'huile de l'eau ne s'affiche pas'; Киһи өлөөрү төрүүр 'Человек рождается для того, чтобы умереть'; 'l'Homme est né pour mourir'; Киһи эриэнэ иһигэр, сүөһү эриэнэ таһыгар 'Пестрота человека внутри его, а коровы – снаружи'. 'Panachure de l'homme à l'intérieur de lui, et les vaches à l'extérieur'.*

3. Les antonymes-conversifs. "Les conversives sont des mots exprimant la relation du contraire dans la déclaration originale (directe) et modifiée (inverse)" [5, p. 49]. Dans la langue iakoute antonymes – conversifs peuvent être des verbes exprimant l'action: *бар – кэл 'идти - приходить' aller - venir, киир – таҕыс 'зайти – выйти' entrer – sortir',*

былдьаа – бэрис ‘отобрать – угощать’ sélectionner – traiter’, ыл – биэр ‘дай – отдай’, хомуй – ыс ‘собери – раскидай’‘, n'avait pour seul – биэр ‘donne – donne -’, хомуй – ыс ‘assemble – раскидай’. Dans ce cas, la traduction littérale des verbes ne permet pas de transmettre un exemple modifié de mots iakoute. Ici, les actions ont une relation logique inverse, comme: acheter ↔ vendre. Dans les mystères iakoute les antonymes-conversifs se rencontrent assez souvent: *Аҕаһа алдьатар, убайа оҥорор ‘Сестра ломает, брат строит’ ‘Sœur casse, frère construit’; Сайын таҥнар, кыһын сыгынньахтанар баар үһү. ‘Зимой одевается, летом раздевается’ ‘Hiver s'habille en été, se déshabille’; Тыаһа суох кэлэр, тыаһа суох барар баар үһү. ‘Без шума приходит, без шума уходит’. ‘Sans bruit vient, sans le bruit sort’.*

4. Antonymes exprimant la direction opposée des actions, des propriétés et des signes: *бытаан – түргэн ‘медленный - быстрый’ ‘lent - rapide’, үөр – хомой ‘радоваться - огорчаться’ ‘réjouissez – vous – se chagriner’, хойут – эрдэ ‘поздно - рано’ ‘tard - tôt’.* Cependant, l'opinion des scientifiques iakoute sur les antonymes de la relation spatiale et temporelle est ambiguë. Afanassiev écrit les paires ‘nord - sud’, ‘à gauche - à droite’, ‘dedans - dehors" qui n'ont aucun lien, mais il est considéré antonymes, car indiquent des directions opposées dans l'espace [4, p. 71-72]. Ce type d’antonymes peut être trouvé dans la langue parlée, la littérature, le journalisme: “Илин уонна арҕаа” ‘Восток и запад’ (titre d'un roman de N. Iakoute) ‘*Est et l'ouest’; олоҕум усталаах туоратыгар (фразеол).’ tout au long de la vie‘; Биэрэр илии билэр, ылар илии билбэт ‘Рука, отдающая (что-либо) знает многое, а берущая – ничего не знает’. Main qui donne (quelque chose) sait beaucoup, et le preneur ne sait rien'.*

La deuxième catégorie d'antonymes-contextuelle a été distinguÉe par un certain nombre de chercheurs de la langue iakoute [3, 4]. L'œuvre folklorique orale de la langue iakoute regorge d'antonymes contextuels.

Les antonymes contextuels sont autrement appelés stylistiques ou pragmatiques. Ce sont des mots opposés dans un certain contexte. La polarité des significations de tels mots n'est pas fixée dans la langue, leur opposition est conditionnelle.

Les antonymes contextuels sont plus fréquents dans la créativité folklorique orale, la fiction, le journalisme. Par exemple: *Алгыс баһа сыалаах, кырыыс баһа хааннаах ‘Слова благословения жирны, а проклятья – кровавы’ ' les mots de bénédiction sont gras et les malédictions sont sanglantes* '(traduction textuelle). Ici, les paires d’antonymes “алгыс – кырыыс”, “сыалаах – хааннаах” ne sont pas des antonymes, elles sont occasionneles. Voici un autre exemple de proverbes: *Аттаахтан*

кымньыытын, сатыыттан тайаҕын былдьаабыт ‘От всадника отобрал кнут, от пешего – трость’ 'du cavalier a pris le fouet, de la marche – la canne'. Le cavalier est un marcheur, le fouet est une canne opposée les uns aux autres.

L'utilisation correcte des antonymes contextuels dans le discours contribue à la création d'une réception stylistique – antithèse. L'antithèse en tant que méthode stylistique est largement répandue non seulement dans la créativité poétique populaire, mais aussi dans les œuvres littéraires.*“Хараҥаҕа тыкпыт сырдык” (“l'Étincelle de la lumière dans les ténèbres” “Үчүгэй Үөдүйээн уонна Куһаҕан Хоолдьугур” (“Хороший Едюян и Плохой Холжугур”) “Bon Edeien et Mauvais Kholgugur”, “Сэрии уонна эйэ” (“Война и мир”), (“Guerre et paix”), “Алмаас уонна таптал” (“Алмаз и любовь”) (“le Diamant et l'amour”), “Ини-бии” Братья (старший и младший (“les Frères (ainé et cadet))”.*

Sur la nécessité d'étudier les antonymes dans la langue iakoute, Antonov a écrit: “Dans le vocabulaire familier iakoute, il y a beaucoup de mots appariés exprimés par des antonymes qui forment une intégrité ou une forme de pluralité. Les antonymes dans la fiction enrichissent et saturent le style, et servent ainsi de moyen expressif. L'étude des antonymes jouerait un rôle important dans l'étude du vocabulaire, de la stylistique et de la culture du discours de la langue iakoute” [3, p. 42].

Ainsi, la sélection des variétés d'antonymes devient une partie inébranlable de la lexicologie de la langue iakoute.

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UNUSUAL FUNCTION OF DIMINUTIVES IN M. ZOSHCHENKO'S SMALL PROSE

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In the study, along with a brief overview of the work of the 20th century Russian writer M. Zoshchenko, it is shown that the means of expression in the works of the analyzed author are diminutives. In M. Zoshchenko's small prose, diminutives perform various functions (characterological, didactic, ironic, actualizing the image of the "little man", representing the world of a child and a woman, etc.). The use of diminutives for developing the image of a small person is revealed. The satirical orientation of literary texts by M. Zoshchenko did not leave aside the appeal to such a mean of expressiveness as diminutive. The diminutives in the texts of small prose by M. Zoshchenko containing ecphrasis fulfill the function of a comic (in particular, in such a form of irony as antiphrasis). It has been shown that diminutives- somatisms are often both in the 20th and 21st centuries are used in a figurative and reprehensible sense. At the same time, the presence of ecphrasis in the text of M. Zoshchenko is aimed at the implication of the didactic function.

Keywords: diminutives; means of expression; M. Zoshchenko's prose; ekphrasis; antiphrasis; irony; comic; figurative meaning of diminutive; diminutives-somatisms.

The creative work of M. Zoshchenko the Russian satirist of the XX century attracts a significant number of philologists from different countries. At present, the study of M. Zoshchenko's works in the world is quite developed. The language style of M. Zoshchenko was highly appreciated by an academician of the XX century. V.V. Vinogradov [Vinogradov

1928]. The expert of the Russian language K. Chukovsky believed that the unique style of M. Zoshchenko was formed due to the fact that the writer changed many professions and thoroughly studied the speech of his contemporaries.

The works of Yu. Tynyanov, V. Shklovsky, Yu. Tomashevsky and others are known in literary criticism. The study of M. Zoshchenko's works consists of monographs, critical articles and a significant number of research articles, dissertations, for example: [Komarova 2000; Chzhon Te On 1999].

Chzhon Te On notes that there are three directions of characterization of the writer's work studies: 1) "justifiable" - critics and researchers recognized the value of M. Zoshchenko's creative heritage; 2) "accusatory interpretations", repeating the point of view of the Communist Party, accused that the writer supports the townsfolk and philistines, describes "petty-bourgeois morality"; 3) foreign scientists investigated "existential" issues, examined how certain phobias were reflected in the writer's work. So, A.K. Zholkovsky believed that the unity between the comic and the psychoanalytic should be studied: fears, phobias, "preventive measures" and other "existential diseases" that arise from a communal apartment that has left an indelible "sincere" prototype, from the problems of a large family in which, from infancy formed the mind of the future writer [Zholkovsky 1999].

At present, the creative work of M. Zoshchenko is investigated not only in literary, but also in the linguistic aspect. So, L.A. Titova examines the linguostylistic means of creating comic. The scientist considers the individual features of M. Zoshchenko's language 1) the vernacular, inherent in different parts of speech; 2) colloquial phraseology, 3) the transformation of set expressions, manifested mainly in replacing the component of phraseological units or in adding words to phraseological units; 4) a mixture of vocabulary belonging to different styles of speech; 5) violations of lexical semantic compatibility; 6) copyright neologisms; 7) comparisons; 8) the grammatical means of creating the comic [Titova 2016].

Our research studies the small prose of M. Zoshchenko in the linguopoetic aspect. The methodology of linguopoetic analysis considers the literary text as a hierarchical system of meanings given by the author, creator of the work [Syriitsa 2014]. The methodology of the undertaken research is also composed of 1) the theory of diminutives, 2) philological research of ecphrasis.

Starting from the works of V.V. Vinogradov, linguists noted the richness and diversity of the diminutives in the Russian language [Vinogradov 2001]. Most researchers use diminutives to mean words with diminutive

suffixes; these are nouns and adjectives. The main purpose of diminutives is to indicate the smallness of the subject of speech or the incompleteness of the manifestation of a feature. Meanwhile, often diminutive, indicating a smallness, convey the speaker's attitude to the message. Z. Rudnik-Karvat notes that the dimensional value of diminutives is soldered to the emotional-evaluative attitude of the speaker. Moreover, in the Russian language, the scientist emphasizes, diminutive derivatives only as dimensional are used very rarely [Rudnik-Karvat 1998].When using words with a meaning of diminution, the quantitative and evaluative characteristic of the original word leads to semantic shifts that occur due to diminutization [Ivanyan 2016; Silla 1998; Spiridonova 1999]. As A.N. Gvozdev noted, a feature of assessment suffixes is that they convey an expressive or emotional coloring not only to one word, but to the entire statement as a whole [Gvozdev 1973: 209]. Currently, linguists continue to study diminutives actively, see, for example: [Shmeleva 2017; Pankov 2017]. As the researcher I.V. Fufaeva notes, in modern Russian speech there is an “expansion" of diminutives [Fufaeva 2016: 257].

Lingupoetic analysis focuses on the actualization of author's meanings. Actuators of these phenomena may be various linguistic units. Recently, philologists have been actively studying ecphrasis, by which they understand the mean of verbal descriptions in the text of a work of various art forms, mainly fine art [Ecphrasis 2002]. In Russian fiction, ecphrasis has a long tradition dating back to the 19th century, for example, N. Gogol’s novel “Portrait” is entirely based on ecphrasis — a description of a portrait of a pawnbroker; ecphrasis performs a plot-forming function. Ecphrasis performs the plot-forming function in O. Wilde’s novel “Portrait of Dorian Gray” and D. Tartt’s modern novel “The Goldfinch”. In the above examples, the reference ecphrasis is fictitious [Mikhailova 2020].

The object of this study is the diminutives presented in small prose of M. Zoshchenko. The subject of the research is the function of the comic, actualized by the named diminutives. The research hypothesis is as M. Zoshchenko’s small prose is characterized by a satirical orientation, on the one hand, and an orientation toward reduced colloquial speech, on the other hand, the study of diminutives in terms of the implementation of the comic function (irony, satire) should give non-trivial results. The purpose of the study is to characterize the features of the comic function, actualized in small prose by M. Zoshchenko with the help of diminutives.

The research material was the small prose of M. Zoshchenko, taken from the Collected Works in 7 volumes. This volume includes short stories and feuilletons of 1925-1930th and is called "Nervous people" [Zos-

hchenko 2008]. Examples of diminutives were collected by continuous sampling; the total number of examples was 559 word usage.

The limits of the article allows us to illustrate two examples of the diminutives use from the small prose of M. Zoshchenko in a satirical manner. This feuilleton “In Pushkin days. The first speech about Pushkin ”and the story “I won’t let you go ”.

In M. Zoshchenko’s feuilleton “In Pushkin days. The first speech about Pushkin ”the narration is conducted on behalf of the representative of the“ zhakt ”(zhakt is a housing-rental cooperative partnership) of one of the houses. In a solemn speech about A. Pushkin during the celebrations of this great Russian writer, the narrator does not talk so much about the role and importance of Pushkin, but goes astray and goes on to tell about the problems of the residents of his house, about non-payment of rents, etc. M. Zoshchenko satirically conveys the speech of a poorly educated representative of the “ zhakt ”; in speech, the characterological function is updated (the function of verbally exposing the addressee). The narrator in an amateurish way discusses the work of the great poet, in particular, he says:

Pushkin’s poems, I say, are surprising. Each line is popular. Those who did not read and they know him. Personally, I like his lyric poems from "Eugene Onegin" - "Why, Lensky, do not you dance" and from "The Queen of Spades" - "I would like to be ***suchochek.*****"**
(Voices. This is an opera libretto. This is not Pushkin’s poems.) (Zoshchenko. In Pushkin days. The first speech about Pushkin, a feuilleton).

Of course, the text of the feuilleton is satirically colored, includes a significant amount of means of expressing the comic (alogisms, the irony of the situation, etc.). The writer ridicules the stupid speeches of the representative of the "zhakt", who does not distinguish between Pushkin's theme and the problem of the zhakt. It can be seen from the speech of the representative of the zhakt that the addressee did not read the works of A. Pushkin, he knows firsthand about them.

The diminutive *suchoch**ek*** is formed from the diminutive *such**ok,*** which in turn is formed from the nomination of *suk.* Therefore, the named diminutive is a “double” diminutivization. An astute reader from the text of the feuilleton understands that the representative of the zhakt in his speech recalled the text of the song by Tomsky and the players' choir in the third act of the seventh scene by P. Tchaikovsky's «The Queen of Spades». Although Tchaikovsky’s opera was written based on the eponymous novel by A. Pushkin, the text for the opera differs from Pushkin’s work. The libretto was written for the opera by P. Tchaikovsky’s brother M.

Tchaikovsky, including a comic poem by G. Derzhavin "If only lovely girls" (1802) with an erotic connotation, which was remembered by the satirical character M. Zoshchenko.

With one (double) diminutive *suchochek*, the master of the word M. Zoshchenko actualizes in the text a significant cultural layer, ecphrasis in the broad sense of the term (description of the opera). The actualization of the "alien word" in the text of the feuilleton (I would like to be ***suchochek***) is given through its deformation: in the original *(I would like to be suchochek).* Deformation indirectly indicates that in the Russian discourse in the 30th of XX century the processes of simplifying speech passed.

Linguopoetic analysis reveals that an "alien word", containing a double diminutive in the text of the feuilleton, performs a number of significant functions: educating readers (through replicas of listeners of the speech of the representative of the zhakt), we call this function didactic, implicit in the text; connecting the reader to the rich background of knowledge of the Russian culture (poem by R.G. Derzhavin in 1802; novel by A.S. Pushkin in 1833, opera by P.I. Tchaikovsky in 1890). On the whole, the "alien word" *(I would like to be suchochek)* fulfills a characterological function, implicitly didactic (addressed to naive readers of the feuilleton), ironic: the "double" diminutive *suchochek* has a secretly raunchy character and dissonates with a celebration *(Pushkin days).*

In the story of M. Zoshchenko "I won't let you go", ecphrasis of the fine art was actualized; this is not fictional, but authentic ecphrasis. The content of the story correlates with the content of the painting of the Russian artist - Peredvizhnik of the late XIX - early XX centuries V. Makovsky "I won't let you go" (1892). The creative work of the artist-realist V. Makovsky is figuratively compared with the picturesque textbook of the Russian history of the XIXth century, containing touching and ironic stories "in colors" about people from different walks of life. "A Story in Colors" by V. Makovsky "I won't let you go", introduces the audience to the tragic fate of a simple family: the picture shows how a woman and a child block the drunkard's entrance to the pub.

The story of the same name by M. Zoshchenko is also dedicated to the theme of drunkenness. The writer compares the situation of drinking alcohol before the revolution with the situation of the present (1936). Note that in a short story, the diminutives are presented high-frequently, there are ten of them. In order to create a panoramic picture of the functions of diminutives in small prose of M. Zoshchenko let us briefly digress from the main topic of the study, listing all the functions of diminutives that actualize the author's meanings in the analyzed story.

Only one diminutive conveys exclusively the semantics of the small without introducing emotion into the utterance (*kamorka*). When describing the son of a worker - a drunkard, the measured meaning of the diminutive is combined with emotional coloring.

In the speech of the authorized storyteller of the child, along with neutral nominations *(child, son, boy),* emotionally colored diminutives are presented - nouns *(baby, kid, small boy, nose, button),* and also diminutive - adjective *(curly-haired).* In general, 50% of the diminutives in the story describe the world of the child, which generally correlates with statistics on small prose by M. Zoshchenko of this thematic group; add that in other stories, there are widely represented diminutives in the nominations of the woman's world.

Another thematic group of diminutives is conditionally called by us "the world of a small person" and is related to the cross-cutting theme of the work of M. Zoshchenko, who, following N. Gogol, A. Chekhov, F. Dostoevsky, depicted the world of a simple, poor, sometimes powerless person. In this story, this topic presents 20% of the total amount of language material *(kamorka, kepochka).* Drunkards who were not able to get home in the "Tsarist days" in pre-revolutionary times in Russia were placed in a darkened room *(kamorka);* the drunkard whom the authorized storyteller observes "these days," is *in an ordinary blue work clothes and in* ***kepochka*** *(cap).* Diminutives with the semantics of cramped space and headgear, indicated by an emotionally colored word, create images of the world of a small person. Note that the worker's cap hardly looked small, therefore, the diminutive has a figurative meaning, it does not convey a measured value, but is designed to arouse feelings of regret and pity at the addressee of the speech.

Let us pass to the characterization of the actual comic function of the diminutive in a text containing ecphrasis. This function is actualized in 20% of the analyzed story's diminutives and concerns the description of the situation of drunken people on the street in pre-revolutionary Russia:

It used to be that you walk on Sunday or on some tsarist day, and you almost nearly step on the lying citizens. And over them innkeepers and policemen are bustling about. They rub their ears and substitute bubbles with ammonia to their nose so that they recover and can reach their police station on their (1) ***nozhkhax*** *(legs). And there they are, (2)* ***milenkie*** *(nice), in kamorka (a dark room), like firewood, dumped on top of each other.*

In (1), in the diminutive, the speaker's irony is updated in relation to the object of speech; the addressee perceives the subject of speech from the position of censure, alienation. The diminutive is a figurative use of

somatism, because the speaker does not mean that adults have nozhki, not legs. Compare with a similar use of diminutive-somatism in a figurative sense, transmitting censure and alienation in a modern text from the "Rossiyskaya Gazeta" April 4, 2020: *But in recent years we have been given signals more than once. In the hardly visible Iceland on the map rebelled the fourth largest volcano with the "easily" pronounced name Eyyafyadlayekyudl. And it seems that a purely local eruption blocked in 2010 air flights across Europe. Ebola fever began in Africa, and we only shrugged with* ***plechiki****: it's there, far away, from the poor black people, not ours* (https://rg.ru/2020/04/09/pochemu-mir-posle-pandemii-uzhe-ne-budet-prezhnim.htm).

In (2), diminutive *(milenkie)* is an adjective substantivat, conveys such a kind of irony as antiphrasis, the use of a word in a meaning opposite to the usual one. Scientists note that the comic effect of antiphrasis can be of different tones: "from good-natured mockery, irony and satirical depiction of reality to a sharp sarcastic exposure" [Skovorodnikov 2005: 50]. In (2), antiphrasis in the diminutive actualizes good-natured mockery.

Let us summarize the study of one function of diminutives in M. Zoshchenko's small prose. The satirical orientation of the work of the analyzed writer pursued the high mission of educating the Russian reader of the 1920th and 1930th XX century, the reader not always educated, sometimes naive, with shortcomings, but thirsting for knowledge, meeting with a rich layer of the Russian culture. One such reader made a speech at the funeral of M. Zoshchenko: "You not only made fun, you taught us how to live ...", see about this: [Krasovsky 2006: 281]. The writer himself in the novel "The Blue Book" (1934) said that "with our laughter we want to light at least a small lamp, like a torch, in the light of which some people would notice what is good for them, what is bad, and what is mediocre "[Zoshchenko 2008]. In general, an appeal to the diminutive prose of M. Zoshchenko yielded non-trivial results, showing that the satirical component of the texts of the analyzed writer is manifested in this unique means of expression.

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MATHEMATICS IN THE TECHNOLOGY OF ORGANIZATION AND OPERATION OF DIGITAL COMMODITY PROCESSES - MICRO-ECONOMICS, MACRO-ECONOMICS, MEZO-ECONOMICS

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Interpretations of the technology of organization and work of mathematics in modern commodity processes are presented. This new direction in Russian philosophical culture and World Economic Theory is the Technology of Triedinstvo from an idealistic beginning. The basis of scientific experience is formed both in Russian philosophy and in the Russian Mathematical School (P.L. Chebyshev, N.I. Lobacheskiy, etc.) it is technologies of Triedinstvo, Vseedinstvo, of harmony of diversity of the complex of components of the process. These technologies make it possible to systematize all the accumulated experience of previous generations in the organization and operation of economic systems.

Keywords: The technology of Triedinstvo from an idealistic beginning; Mathematical technologies in economics; Complexity levels of logic and alphabet of digit subject matter - vector, matrix, function; Technology of mathematical device of proportionality in practice of commodity processes in creation of value, digits express proportionality; The figure in the economy is monad, bit, trit; Static dynamics, process logic.

Instead of introduction.

1. What is *Trud* itself as the only source of value?
2. Matter, space, time of commodity processes.
3. Vector, matrix, function, or simply the technology of organization and operation of *numbers* in the reflection of the *Subject* of commodity processes.

4. What is the technology of the mathematical device for the practice of commodity processes in the entire complexity of their organization and operation?

And in conclusion, introduction to the topic.

Instead of introduction to the topic.

(the material presents in theses the translation on a modern scientific basis of the topic of Technologies of Organization and Work Culture of Life of the Ethno-Russian People of 195 nationalities)

1 What is *Trud* itself, as the only source of value?

Trud is primarily a *process*, during the organization and operation of which the "Troynaya tochka" is allocated, or simply three triune sets of processes that work as a single process:

- the first aggregate is three triune abilities to work - these are physical, communicative, mental or simply abilities of the labor force;
- the second set of processes is the *process* of labor itself or the creation of a new value or the embodiment of labor in a product;
- the third set of processes is the organization and operation of the *stages* of the *cost* itself or labor embodied in the product — these are labor costs, this is the economic usefulness of these costs, this is the cost itself or labor embodied in the product.

What is a property *Persona*?

These are three triune levels of complexity of its (persona's) organization and work:

- the first level of complexity is private or simply domination among others (this is activity, relationships, knowledge) of economic activity - physical, managerial, mental;
- the second level of complexity is the state Persona of ownership, where economic relations dominate among others, or simply laws, tariffs, *money*, etc. or simply economic relations; political; legal;
- the third level of complexity is *knowledge* about the *rules* of organization and operation of commodity processes - it is ordinary consciousness and knowledge about the rules of commodity processes, it is empirical (empirical is experience) consciousness and knowledge, it is scientific consciousness and knowledge based on which technology works or simply real *rules* reflected in knowledge.

2. Matter, space, time of commodity processes?

Firstly, these are three triune aggregates of organization and work of reality of the very objectivity of commodity processes:

- this is the *real reality* of material, social, spiritual commodity process-

es, where private property prevails among others (this is private, state, INTER-state) or it's just the dominance of economic activity or the ability of insect people, like physical, managerial, mental labor, in each of which there are three triune sets of abilities - these are real, perceptual, conceptual;

- this is the *simulated reality* in which the *rules of organization and operation* of relations are modeled through the ability of the Personas of property. The rules for the organization and operation of relations in commodity processes in their three triune *set* of relationships are material (physical, chemical, biological), social (this is economic, political, legal), spiritual (or simply commodity production of knowledge). Or is it simply the dominance of the state persona of ownership or simply economic relations or the regulatory framework of the organization and operation of the state system;

- this is the *reflected reality* or simply *conceptual* objectivity of the *rules* of organization and operation of commodity processes. This is just economic *knowledge* about the rules of organization and operation of commodity processes.

Matter, space, time are just three triune sets of processes of organization and work of commodity processes in their defined (matter, space, time) three triune sets of processes - these are *subjects*, *technologies* of their work, *tendencies* of quantitatively qualitative feedback.

Subjectivity is three triune sets of processes - material, social, spiritual.

Technology is three triune sets of complexity levels of organization and work of any kind - three monistic, three dialectic, three Triedinstvo technologies.

A trend is simply three triune aggregates of quantitatively-qualitative interconnections between components during their organization and work - this is evolution, revolution, leap.

What is *mathematics* itself in commodity processes?

This is simply a *reflection* in the consciousness and *knowledge* of insect people of *periodicity* in the organization and operation of the three triune set of processes in life - these are material, social (this is economics, politics, law), spiritual (or simply commodity production of KNOWLEDGE - ordinary, empirical, scientific).

What is *periodicity*?

This is simply a property in the organization and work of all sorts of things or the regular recurrence of something, at any intervals of the frequency of actions, is one of the essential conditions for the organization

and work of all sorts of things in the practice of life of insect people. Where one of the aggregates of periodicities dominates, the second works in contradiction, and the third harmonizes the work of the process as a whole.

Moreover, the frequency itself, like any other of the processes is organized and operates by three triune sets of technologies for the participation of components in the process, is random, spontaneous, constant.

3. Vector, matrix, function three triune levels of complexity of the rules of organization and work of the periodicity of the practice itself and their mathematical reflection.

(or simply the technology of organization and work of *numbers* in reflection of the frequency of *rules* of commodity processes)

- What is a *number*??

This is a visual, verbal, virtual reflection of the periodicity in the practice of commodity processes during their organization and the operation of the *rules* of commodity processes and not only them.

Numbers are just a system of signs in their three triune set of difficulty levels - it is arithmetic (monistic), algebraic (dialectic), number theory (Triedinstvo from an idealistic beginning). The numbers are organized and work to record specific periodicity values in their three triune set of difficulty levels for their organization and work. Numbers are called only those signs that themselves individually describe certain periodicities. But there are their (of technologies of periodicity), technologies for organizing and operating a *vector, matrix, function*, as a unit and connecting processes, directions of work (rectilinear, curvilinear, crossed). So, for example, the minus sign, or decimal point, etc., although they are used to write numbers, are they just random, spontaneous, constant factors of the work of commodity processes, but they are not numbers.

- What is the *technology* of organizing and operating periodicity and numbers in its three triune complexity levels?

The complexity levels of organization and operation of both the very periodicity in the practice of commodity processes, and their modeling and reflection in mathematics are three triune

- these are three *monistic,* where the principle of domination works;
- these are three triune *dialectical* technologies, where the principle of contradiction works;
- these are the three triune sets of *Triedinstvo* technologies where the principle of harmony of the diversity of the set of components works.

Monistic technology is the three triune aggregates of dominance in the commodity processes of an *object, technology, trend,* one of the three triune aggregates of processes is material processes, social, spiritual.

Dialectical technology is the three triune sets of the principle of the contradiction of *relations* between the seller and the buyer (or the market) - this is materialistic dialectics, existential, idealistic.

Triedinstvo is a technology of harmony of the diversity of three triune sets of processes - material, social, spiritual. And the essence of Triedinstvo technology is that each of the three triune has its own *beginning* - material, existential, spiritual.

And therefore, in the practice of commodity processes and in mathematics, there are three triune aggregates of technologies - this is the technology of Euclid and such (straightforward); this is the mathematics of Lobachevsky and such (curved); this is Chebyshev's technology without such (crossed or simply divisibility of diversity).

4. What is the technology of the mathematical device of the practice of commodity processes in creating value, in all the complexity of their organization and operation?

This is simply a technology for organizing and operating three triune sets of *stages* in the process of the formation of value itself:

- the first stage is the *need for labor*, as the only source of value, or simply the process of production of value;
- the second stage is the *determination of the economic utility* of labor costs in production or simply market relations of supply and demand;
- the third stage is simply the *organization and work of value itself*, as labor embodied in a product.

What works at the core of the *value* itself?

The basis of the cost itself is the organization and operation technology of such an economic indicator as the "Masshtab tsen". the basis of this economic indicator is the so-called "Troynaya tochka of labor".

This is an indicator which reflects three triune mathematical indicators of labor in the organization and operation of commodity processes:

- the first is three triune processes of labor - physical, managerial, mental;
- the second is three triune aggregates of *industries* in commodity processes - material, social (this is economics, politics, law), spiritual (or simply commodity production of knowledge - ordinary, empirical, scientific);
- the third is three triune aggregates of the processes of education and work of value - this is labor power, the labor process, embodied labor.

How does *value* itself work in commodity processes?

Value, or simply labor embodied in a product, has three triune sets of processes of its (value) organization and work distributed (or simply dispersed, etc.) in matter, space, time, these are incomes, expenses, accumulations:

- the first set of processes of organizing and operating costs is *expenses* or simply labor costs in the course of commodity *production*;
- the second set of value processes is *income* from labor costs or simply market relations;
- the third set of processes of value is the *accumulation* of value in three triune products - these are material, social, spiritual.

And here it's just necessary to talk about the *stages of generational change,* the technology of organizing and working commodity processes, or just about the statics, dynamics, logic of the organization and work of generations and the very rules and mathematical technologies of calculating value, or just about economic schools.

What is an economic *school* as a technology for calculating value?

It's just a body of *knowledge* about the rules of organization and work of the value allocated to the three triune processes - this is matter, space, time:

- this is the dominance of ordinary knowledge;
- this is a contradiction of the ordinary and empirical level of complexity;
- this is the harmony of the diversity of three triune levels of complexity - these are ordinary, empirical, scientific.

Moreover, any economic school in its own way solves the problem of the *proportionality* of the distribution of value in the three triune aggregate processes — the dominance of physical labor; contradiction of physical and mental; harmony of the diversity of the physical, managerial, mental. Therefore, the question arises of money, as the value itself and the carriers of value or monetary material.

What is *money and monetary material* or stages of historical development of economic schools?

Money is simply an economic indicator that reflects the level of the productive power of *aggregate* labor in its "Troynaya tochka" in the corresponding processes of matter, space, time.

But monetary material or a carrier of value in commodity processes is simply three triune aggregates of *objectivity* - it is a natural commodity; it is a simulated value carrier or paper, etc.; it is a carrier of value reflected through consciousness and knowledge, or simply non-cash payment.

Moreover, it is necessary to interpret the main economic indicator that works at the basis of commodity production of *money is the "Masshtab tsen"* or simply the cost filling of money material.

What is the price scale?

The price scale, or simply the quantity and quality of value that monetary material carries and its *liquidity*, or consumer capabilities of monetary material that are also distributed in matter, space, time, is:

- the first set of processes of technology (or simply an economic school) for calculating the price scale in modern Civilization is the Classical School of Economics or simply the Labor Theory of Value, which was brilliantly interpreted by an ingenious German scientist comrade Karl Marx. Here, value is determined by the quantity and quality of physical labor embodied in a *material* product;

- the second technology for calculating the scale of prices or the monetary filling of a monetary unit is the NEO-classical economic school. Here, the value is determined by the *economic usefulness of the labor* submitted for exchange (or to the market).

- The third technology for calculating the price scale is the *complete structure* of aggregate labor, or simply the "Troynaya tochka" of labor. This is the Russian School of Economics based on Triedinstvo technology from an idealistic beginning.

Therefore, in the technology of calculating the price scale, various levels of complexity of mathematical technologies work - these are aricHmetics or monistic technology; algebra or dialectical technology; it is Triedinstvo from an idealistic beginning or number theory.

And in conclusion to the introduction to the topic.

In modern Civilization, two technologies of commodity organization and the work of statehood work - materialistic dialectics (this is Russia and such) and existential dialectics (this is Europe and such). And in the practice of commodity processes, well or in real reality, Triedinstvo technology works from an idealistic beginning, which *combines* three triune sets of processes *into a single process* - these are material commodity processes, existential (this is economics, politics, law), idealistic (or simply commodity production of knowledge - ordinary, empirical, scientific). BUT objective processes simply dominate, subjective work in contradiction, and spiritual harmonize the organization and work of the practice of commodity processes in general.

The classical economic school or materialist school, or Marxism, works as a technology for the *production* of goods, although only in material production. It is simply the dominance of private property.

A neoclassical school of economics or marginalism, or just a market economy or just a supply-demand relationship. This is simply a contradiction of private and state property under the rule of private property.

NEO-labor theory of value or simply the Russian School of Economics, which is based on Triedinstvo technology from an idealistic beginning. It's just the harmony of the diversity of the three triune aggregates of Personas involved in the product processes - it's private, state, INTER-state. Well, or is it just the "Troynaya tochka" of commodity processes distributed in matter, space, time.

So comrade materialists who simply do not understand what money is, there are objectively working *rules for organizing and operating commodity processes*, and there is technology. Moreover, there are simply the names of these processes or simply the subjective reflection and interpretation of objectively working rules of the organization and work of the practice of commodity processes. Among the workers in the commodity production of money, there are three triune sets of categories — these are specialists; hucksters or just bribe takers; these are simple parrots.

EVALUATION OF THE RESULTS OF SURGICAL TREATMENT OF PATIENTS WITH TRANSVERSE FLATFEET

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The article considers the problem of assessing the long-term results of surgical treatment of patients with pathology of the anterior foot. An improved scale for assessing the results of treatment is proposed, which, in contrast to the generally accepted and most commonly used in clinical practice of AOFAS and Groulier scales, takes into account the subjective assessment by the patient and the doctor. A comparative study was conducted involving 128 patients. All patients were interviewed on three scales for evaluating treatment outcomes. When analyzing the results, the percentage of positive ratings given by the doctor and the patient practically coincides (91.4% and 89.8%, respectively). However, a further analysis shows that the percentage of good marks given by patients is much higher (76.5%) than by doctors (64.8%). All this suggests that today doctors are more demanding and picky about the results of surgical treatment than patients. The introduction into clinical practice of an improved scale for assessing treatment results is advisable for further improving the choice of surgical treatment for various types and degrees of deformation of the anterior part of the feet.

Keywords: flat feet, hallux valgus deviation of the first toe, foot deformity, treatment results.

Relevance

The foot is an organ with late development in the process of phylogenesis. Performing the unique function of supporting and moving a person, the foot is more than any other component of the musculoskeletal system of a person subject to pathological changes in shape associated with external and internal causes and leading to a violation of the static-dynamic function of the entire lower limb.

Currently, effective reconstructive operations have been developed to treat various degrees of transverse flatfoot and hallux valgus deviation of the first toe, but the percentage of various complications and technical shortcomings remains rather high. All this limits the possibilities of optimal restoration of the feet function.

Despite the successes of traumatology and orthopedics in the field of forefoot surgery, many unresolved and controversial issues remain. One of these issues can be considered an assessment of the results of treatment of pathology of the forefoot. In fact, sometimes we see a good cosmetic and radiological result, and a complete dissatisfaction of the patient with the results of treatment. Also sometimes we have the opposite picture.

Purpose of this study was an optimization of the assessment of the results of surgical treatment of anterior foot pathology, taking into account objective data, additional examination data and subjective sensations of the patient.

To achieve this goal, we set the following **tasks:**

1) To conduct a subjective assessment of the results of treatment of patients on a scale: good, satisfactory, unsatisfactory, find it difficult to answer;

2) Conduct a subjective assessment of the results of treatment by a doctor on a scale: good, satisfactory, unsatisfactory;

3) Conduct an objective assessment of treatment results on the well-known AOFAS and Groulier scales;

4) Based on the data obtained, develop an improved scale for assessing treatment results with its subsequent implementation in practice.

Materials and research methods

We analyzed the results of treatment of 128 patients with pathology of the forefoot, who were treated at the clinic of traumatology, orthopedics and emergency surgery of SamSMU in the period from 2014 to 2015.

The following evaluative techniques were applied:

1) Evaluation of the result on the AOFAS scale. The results of treatment are evaluated as follows: excellent - 95-100 points; good - 75-94 points; satisfactory - 51-74 points; bad - 50 points or less

2) Evaluation of the result on the Groulier scale. We have taken the classic scales. The result of treatment using the Groulier scale is evaluated as follows: excellent - 71-85 points; good - 60-70 points; satisfactory - 29-59 points; bad - 28 points or less

3) Evaluation of the results on a scale improved by us. We evaluated the treatment results as follows: excellent - 95-100 points; good - 75-94 points; satisfactory - 51-74 points; bad - 50 points or less. In assess-

ing the patient's result of treatment within the framework of our improved scale, we used four-degree gradation (good, satisfactory, unsatisfactory, difficult to answer). The assessment was carried out exclusively subjectively. The patient was recommended to consider the presence of pain, swelling, contractures, degree of correction, ease of wearing shoes. When evaluating the result of treatment with the operated surgeon, three-degree gradation was used (good, satisfactory, unsatisfactory). The assessment was carried out taking into account objective data, cosmetic and functional results. In addition, the degree and type of deformation before surgery and the amount of correction achieved were taken into account.

Evaluation of the results of surgical treatment of foot deformities on the AOFAS scale (Kitaoka)

Evaluation of the results of surgical treatment of patients with anterior foot deformities using the AOFAS scale is widely used in many countries of the world [12]. The results of treatment are evaluated as follows: excellent - 95-100 points; good - 75-94 points; satisfactory - 51-74 points; bad - 50 points or less.

Evaluation of the results of surgical treatment of foot deformities on the Groulier scale

The long-term results of surgical treatment of patients with anterior foot deformity using the Groulier scale are evaluated by the following components:

1. The condition of the first ray - correction of deformation (under load), pain and range of motion in the first metatarsophalangeal joint.

2. The condition of the forefoot - metatarsalgia, plantar hyperkeratosis, flattening of the forefoot.

3. Functional activity - difficulties in wearing shoes, restrictions on walking distance, sports and domestic load.

The result of treatment using the Groulier scale is evaluated as follows: excellent - 71-85 points; good - 60-70 points; satisfactory - 29-59 points; bad - 28 points or less

Subjective assessment by the patient

Depending on the functional requirements for the foot and the psychological structure of the patient, the assessment of the results of treatment by him can vary in a very wide range. For many patients, the disappearance of pain and the ability to wear regular shoes are acceptable as a good treatment result. For some, even having the potential to wear model shoes occasionally is more than a good result. For some patients, even a slightly hypertrophic suture or minor swelling that appears at the end of the day is an unsatisfactory result.

For a subjective assessment, a three-degree assessment is traditionally used: good, satisfactory and unsatisfactory. In our opinion, it is advisable to add the option “find it difficult to answer”. According to our observations, at the first follow-up examination (3 months after the operation), some patients cannot formulate how satisfied they are with the result of treatment.

We used a number of mandatory, in our opinion, questions asked at the control examination. To facilitate this task, we created a small questionnaire for the patient.

Questions offered by us.

1) Do you experience pain in the feet during normal exercise?
2) Do you experience pain in the feet under a heavy load?
3) Did the pain become weaker after surgery?
4) Did the pain become stronger after surgery?
5) Do you have edema on the operated foot?
6) Can you wear regular shoes easily?
7) Can you wear model shoes easily?
8) Are you satisfied with the aesthetic result?
9) Are you satisfied with the range of motion in the joints of the foot?
10) Are there any other complaints? What kind?
11) How do you generally evaluate the result of treatment (good, satisfactory, unsatisfactory, difficult to answer)?

Questions 1 through 9 may be answered by “yes”, “no”, “difficult to answer”, a patient can answer in a free form to question № 10. When answering question 11, it is proposed to choose one of four options for evaluating treatment results.

This questionnaire, in our opinion, can only be used to help the patient answer the most important, 11th question. Thus, this part of the evaluation of treatment outcomes remains subjective, but does not become unimportant!

Subjective assessment by a doctor

For the doctor, obviously, in assessing the results of treatment of a patient with pathology of the forefoot, the elimination or significant decrease in the degree of deformation, the presence of edema, the amplitude of movements, as well as the pain syndrome upon examination are the most important. It is quite obvious that the assessment given by the patient and given by the doctor is far from always correlating. In some cases, the doctor may be very pleased with the anatomical removal of the deformity and the aesthetic appearance of the operated foot, and the patient will complain of certain pains and dysfunctions, being com-

pletely dissatisfied with the results. In fairness, it should be noted that a diametrically opposite situation is also possible, when the absence of a complete correction of the deformation and the presence of any other restrictions objectively (according to the doctor) present in patient do not bother them at all, since they returned to their usual life and don't feel any inconvenience.

For a subjective assessment of the result of treatment by a doctor, we used the traditional three-degree scale: good, satisfactory and unsatisfactory. The “difficult to answer” score is hardly acceptable for a doctor.

Evaluation of the results of surgical treatment of foot deformities on our scale

As a rule, the assessment of the long-term results of surgical treatment of anterior foot deformities, according to the AOFAS and Groulier scales, is the same, which indicates the equivalence of the methods used for assessing treatment results.

However, they practically do not take into account the subjective assessment of the result of treatment, which often makes conclusions diametrically different from the opinions of the patient himself. The perversity of this situation lies in the fact that the use, in some cases, of any justified treatment methods leads to a large percentage of unsatisfactory results, based on the applied rating scales. This prompted us to reconsider the assessment of the results of surgical treatment of diseases of the forefoot. We have developed, tested and implemented our scale for evaluating the results of treatment (Tab. 1). Based on the well-known AOFAS and Groulier grading scales, which we somewhat reworked, in addition, we added subjective factors for evaluating the results.

We evaluated the treatment results as follows: excellent - 95-100 points; good - 75-94 points; satisfactory - 51-74 points; bad - 50 points or less.

Table 1. Scale for evaluating the results of the treatment of deformity of the forefoot, proposed by us

Pain (30 points)		
Pain in the big toe	No	10
	Moderate, rare	8
	Strong, daily	5
	Very strong, constantly present	0

Metatarsalgia	No	10
	Decreased or is irregular	5
	Constant	0
Hyperkeratoses	No or asymptomatic	10
	Yes, slightly painful	5
	Yes, painful	0
Function (30 points)		
Activity limitation	No daily activity limits	10
	No daily activity limits, only with overload	7
	Daily restrictions, inability to overload	4
	Restrictions excluding any activity	0
Shoe requirements	Fashionable, comfortable, not requiring insoles	10
	Comfortable with orthopedic insoles	5
	Only specially selected or brace	0
Range of motion in the first metatarsophalangeal joint	Full or small restriction (volume 75^0 and more)	10
	Moderate restriction (volume 30 - 74^0)	5
	Significant limitation (volume less than 30^0)	0
Angular deformities of the forefoot (radiological indicators) (10 points)		
The degree of recovery of angular deformations	Fully restored	10
	There are minor deviations from the norm	5
	Not recovered or significant loss of correction	0
Subjective assessment of treatment outcomes (30 points)		
Assessment of the result of treatment by a patient	Good	20
	Satisfactory	10
	Unsatisfactory	0
	Difficult to answer	10
Assessment of the result of treatment by a doctor	Good	10
	Satisfactory	5
	Unsatisfactory	0

Results and discussion

We analyzed the long-term results of surgical treatment of diseases of the forefoot in 128 patients who were treated at the clinic of traumatology, orthopedics and emergency surgery of SamSMU in 2014-2015.

All patients underwent an evaluation of the results of surgical treatment using all the previously described methods. As a result, we received the data presented in table 2.

Table 2. Treatment results for patients with anterior foot pathology, depending on the type of outcome assessment.

	Great	Good	Satis-factory	Unsatis-factory	Difficult to answer	Total
Assessment of the result of treatment by a patient	-	98 (76,5%)	17 (13,3%)	6 (4,7%)	7 (5,5%)	128 (100%)
Assessment of the result of treatment by a doctor	-	83(64,8%)	34(26,6%)	11 (8,6%)	-	128 (100%)
Assessment of the result of treatment on AOFAS scale	9 (7%)	91(71,1%)	20 (15,6%)	8 (6,3%)	-	128 (100%)
Assessment of the result of treatment on Groulier scale	10(7,8%)	92(71,9%)	17(13,3%)	9(7%)	-	128 (100%)
Assessment of the result of treatment on our scale	13(10,1%)	101 (78,9%)	8(6,3%)	6(4,7%)	-	128 (100%)

As can be seen from table 2, the evaluation of treatment results on the AOFAS and Groulier scales is almost the same, which confirms the literature data.

When analyzing subjective evaluations, paradoxically, the percentage of positive evaluations (good and satisfactory) made by a doctor and a

patient practically coincides (91.4% and 89.8%, respectively). However, upon further analysis, we see that the percentage of good marks given by patients is much higher (76.5%) than by doctors (64.8%). All this suggests that today doctors are more demanding and picky about the results of surgical treatment than patients. But still, do not forget that the opinion of the patient cannot be ignored.

After analyzing the results of treatment on a scale proposed by us, we see a significant difference in the results towards a larger number of positive treatment outcomes.

Conclusions

In our opinion, during the follow-up examination of the patient operated on in the forefoot, there should be a certain algorithm of questioning and research, which will make it possible to judge the objective and subjective result of treatment.

It is advisable to write in the consultativeform the subjective result of treatment according to the patient, according to the doctor and using one or all of the treatment assessment scales (AOFAS, Groulier, our scale).

Perhaps this may be a separate form, which is attached to the advisory:

Subjective assessment of the patient: good, satisfactory, unsatisfactory, find it difficult to answer (underline as necessary);

Subjective assessment of the doctor: good, satisfactory, unsatisfactory (underline as necessary);

Result on the AOFAS scale: _____ points - excellent, good, satisfactory, unsatisfactory (underline as necessary);

Result on the Groulier scale: _____ points - excellent, good, satisfactory, unsatisfactory (underline as necessary).

Result on the scale proposed by us: _____ points - excellent, good, satisfactory, unsatisfactory (underline as necessary).

Control examinations should be carried out 3, 6 and 12 months after surgery or more often, if necessary.

Undoubtedly, the introduction into widespread practice of such measures for evaluating treatment results will slightly delay the time of follow-up examinations and add work, but we consider it necessary to further improve the choice of surgical treatment for various types and degrees of deformation of the anterior foot. In addition, all this will make the results of a particular operation more predictable.

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INFRARED RADIATION WITH TERAHERTZ MODULATION IN THE ACUTE ISCHEMIC STROKE

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The results of using infrared (IR) radiation with terahertz (THz) modulation in 112 patients in the acute period of ischemic stroke (IS) are presented. In the main group (n = 38), IR radiation with THz modulation on the projection of the AI focus was used, patients in the control group (n = 37) were on basic drug therapy, and in the placebo group (n = 37) the physiotherapeutic treatment was simulated. Clinical and neurological status and neurofunctional indices were evaluated using the NIHSS, MMSE, HADS scales, and duplex scanning of brachiocephalic vessels was performed. It has been shown that the transcranial use of infrared radiation with THz modulation on the projection of the IS focus in the early period helps to significantly reduce the severity of clinical symptoms, significantly regress neurological deficits, fully restore cognitive functions and improve psychoemotional status by restoring adequate blood supply to the affected hemisphere.

Keywords: ischemic stroke, infrared radiation, terahertz radiation.

Introduction

Ischemic stroke (IS) accounts for 80% of all strokes and continues to be a serious medical and social problem due to the widespread, deep and prolonged disability of patients [1-3]. The main consequences of a stroke are represented by physical, cognitive, psychological and social problems [1-3].

Relevance

A leading role in the development of IS is played by a violation of cerebral hemoperfusion followed by the launch of an "ischemic cascade", which ends with irreversible destruction of neurons in the form of apoptosis or necrosis [1,4]. However, data on morphological and functional changes in brain tissue during the development of IS indicate delayed final death of brain cells and the reversibility of some destructive processes [1,5-7]. The earliest possible therapeutic effect on the focus of ischemia and peri-infarction area can lead to a reduction in the area of potentially reversible brain damage and the restoration of impaired body functions. For this purpose, early restoration of adequate blood supply and neuroprotective therapy are justified pathogenetically [1,4,6,8,9]. However, the effectiveness of pharmaceutical neuroprotection in IS remains low, which necessitates the study of new methods of therapeutic effects in such patients [1,8,9]. At the present stage, methods of physiotherapy are mainly used only in the long rehabilitation period of IS. Physical factors in the early period of IS are used to a limited extent, as a rule, as symptomatic therapy [1]. Transcranial methods of physiotherapy in the acute period of the disease are rarely used in routine practice in connection with the severity of the patient's condition and the presence of a number of contraindications.

Currently, the most actively developing section of physical treatment methods using combined optical infrared and submillimeter radiation is attracting the most attention. This section is called terahertz (THz) therapy due to the biological effects of submillimeter waves associated with their resonant physiological interaction with complex protein and lipid cell structures [1, 12]. The activation of the mechanisms of plasticity and restoration occurs with the external action of THz waves on the signals generated by one's own body [1,5,10,11,12]. The positive effect of THz radiation on the morphology and regeneration of neurons, the structural and functional plasticity of neural systems after damage, the stabilization of cell membranes and the protection of the integrity of the cell structure has been proven [1,10,11,13]. In combination with pharmacotherapy, THz radiation can serve as an inducer of the delivery of biologically active compounds into the cell, and antioxidants and cytoprotectors can be modulators of this process [1].

For targeted delivery of THz radiation to tissues, a carrier range is used - infrared (IR), with the help of its modulation, since the latter has the ability to penetrate deeper into tissues [1, 10-14]. The diameter of the emitter used in this study of the IR-Dipole apparatus is 9 cm, due to which there

is an effect not only on the ischemic zone, but also on the peri-infarction region of the affected hemisphere [1, 10, 13].

Purpose of the study consisted in providing the rationale for the use of IR radiation with THz modulation in patients in the acute period of ischemic stroke.

Material and methods

The basis of this work was a prospective randomized controlled trial conducted at the department of physiotherapy and medical rehabilitation of Mechnikov North-West State Medical University and on the basis of "St. Petersburg City Hospital №38 named after N.A. Semashko." The study was approved by the Local Ethics Committee of Mechnikov North-West State Medical University of the Ministry of Health of the Russian Federation.

The object of the research was 112 patients in the acute period of IS, atherothrombotic subtype according to the international TOAST criteria. The studied patients were randomly assigned to 3 groups. The main group (n = 38) consisted of patients who recived IR radiation with THz modulation on the projection of the IS focus in addition to the basic drug therapy. The control group (n = 37) consisted of patients who received basic drug therapy according to the standards of medical care for stroke. The "placebo" group (n = 37) - for who the procedure on the projection of the IS focus was simulated without connecting the device to the power grid.

The criteria for inclusion of patients in the study were: confirmed by spiral computed tomography IS, atherothrombotic subtype; prescription from the moment of its development - an acute period, from 3 to 13 days from the onset of the disease; age of patients from 55 to 75 years; stable severe and moderate to severe condition; lack of contraindications to physiotherapy; written informed consent. The criteria for exclusion of patients from the study were: hemorrhagic stroke or hemorrhagic transformation of the ischemic lesion confirmed by CT scan data, condition after thrombolytic therapy, convulsive syndrome.

Representatives of the study groups were standardized by gender, age, severity of general condition, severity of neurological and cognitive deficiency, drug therapy (matched-controled principle). Regardless of the treatment group, standardized basic drug therapy was rigorously carried out for patients. All patients included in the study gave voluntary informed consent.

The study included three experimental points (before treatment, 10 days after a course of physiotherapy and 90 days after treatment) and

consisted of an assessment of the clinical and neurological status, analysis of the level of cognitive impairment using the MMSE (Mini-Mental State Examination, Folstein M. Et al., 1975), the psycho-emotional status of patients using the hospital anxiety scale and depression HADS. An important component of this work was the analysis of cerebral blood flow using duplex scanning of brachiocephalic vessels before and after treatment with an ultrasound scanner "Siemens acuson S 2000" (Germany). Neuroimaging diagnostics was carried out on a "Siemens Somatom Emotion 16" multispiral 16-slice computer tomograph (Germany).

The basic drug therapy in the acute period of IS was carried out in accordance with clinical recommendations and standards. (Order of the Ministry of Health of the RF of 29.12.2012 №1740н).

Physiotherapeutic treatment was carried out using the apparatus “IR-Dipole”, LLC “Dipole structures”, St. Petersburg. Physical factor - electromagnetic waves of the IR range with a wavelength of 1 - 56 microns, modulated with THz frequencies in the entire radiation spectrum. The radiation flux density was 2.4 mW/cm^2. The diameter of the emitter was 9 cm, which was installed transcranially on the projection of the IS focus. The technique was contact, stable. The exposure time was 22.5 minutes The course of treatment was 10 procedures daily.

The data obtained were processed using the "Statistica for Windows" software version 10 using mostly nonparametric criteria.

Results and discussion

The average age of 59 (52.7%) men and 53 (47.3%) women included in the study was 67.3 years. Of the concomitant pathologies in patients, cerebral atherosclerosis, hypertension, which are the main etiopathogenetic risk factors for the occurrence of an atherothrombotic subtype of IS, were most often encountered. Clinical and neurological examination of patients initially revealed a predominance of symptoms with motor and sensory disorders against a background of general weakness and headache. Among the main complaints, psychoemotional disorders in the form of anxiety and irritability stood out.

In a neurofunctional study of patients, a severe degree of IS was initially detected (according to the NIHSS scale). Cognitive impairment in the form of mild dementia (MMSE) was accompanied by clinically pronounced anxiety and depression (HADS). The blood flow rate at admission was reduced in the internal carotid artery (ICA) on the side of the affected hemisphere (table 1).

Table 1. Initial average values of neurofunctional indicators.

Indicator	Points
US National Institute of Health Stroke Scale NIHSS	15.42
MMSE Cognitive Disorder Scale	22.34
HADS Hospital Anxiety and Depression Scale	Anxiety 16.31 Depression 19.47
Duplex scanning of brachiocephalic vessels, cm/s	35.39

When analyzing the results of a clinical study after the treatment, higher recovery rates of motor, sensory, and psychoemotional disorders, a significant reduction in the severity of general weakness and headache in patients of the main group attract attention. Differences compared with other groups are statistically significant ($p < 0.05$). In the placebo group, a slight satisfactory result was noted as a positive response to therapeutic effects.

An analysis of neurofunctional studies after treatment revealed significant positive dynamics. Initially, the stroke corresponded to a severe degree (15.42 points on the NIHSS scale), and at the end of the course of therapy it regressed to a mild degree in all the studied groups, and in the main group this indicator was statistically significant (3.23 points on the NIHSS scale, $p < 0.05$) (table 2).

The initial cognitive impairment in the form of mild dementia was comparable in all compared groups, corresponding to an average of 22.34 MMSE points. When analyzing the dynamics of indicators of cognitive functioning, their significant increase was established to 28.26 points ($p < 0.05$) with a complete regression of cognitive deficit in the main group of patients compared with the control and placebo groups in which predement disorders were observed at the end of the course of treatment (24.62 and 24.97 points on MMSE, respectively). Upon admission, all patients noted the presence of anxiety, low mood and lack of interest in the environment, indicating the presence of a depressive component. The initial average data on the HADS scale in patients of the three groups were comparable, had a clinical severity, the average score was 16.31 and 19.39 points of the level of anxiety and depression, respectively. After the course of treatment, there was a significant decrease in the level of anxiety and depression to subclinical values in the main group to 9.23 ($p < 0.05$) on the anxiety scale and 11.36 points ($p < 0.05$) on the depression scale. In the comparison groups, positive dynamics were also observed, but was significantly lower than in patients of the main group, and remained at the level of clinical disorders (table 2).

Table 2. Dynamics of average values of neurofunctional indicators.

Grading scales		Average score n = 112		
		Main group n=38	Control group n=37	"Placebo" group =37
NIHSS	Before treatment	15.42	15.39	15.43
	After treatment	3.23*	4.64Δ	4.28Δ
MMSE	Before treatment	22.32	22.28	22.42
	After treatment	28.26*	24.97Δ	24.62Δ
HADS anxiety	Before treatment	16.33	16.27	16.33
	After treatment	9.23*	12.81Δ	12.69Δ
HADS depression	Before treatment	19.39	19.41	19.37
	After treatment	11.36*	15.34Δ	15.44Δ

* - statistically significant differences from baseline ($p<0.05$)
Δ - statistically significant differences between the main and comparison groups ($p<0.05$)

The initial mean blood flow velocity in the ICA was reduced on the side of the affected hemisphere to 35.39 cm/s. After treatment, the main group showed a restoration of blood flow velocity in the ICA on the side of the ischemic focus to average values of 58.16 cm/s, which is significantly higher than in the comparison groups ($p <0.05$) (table 3).

Table 3. Change in cerebral hemodynamics in patients after a stroke.

Groups	V ps ICA (cm/s)	
	Before treatment	After treatment
Main group n=38	35.41	58.16*
Control group n=37	35.38	49.37Δ
"Placebo" group» n=37	35.39	49.45Δ

* - statistically significant differences from baseline ($p<0.05$),
Δ - statistically significant differences between the main and comparison groups ($p<0.05$)

Findings

1. The results of the studies demonstrate that the transcranial use of IR radiation with THz modulation in patients in the acute period of IS significantly reduces the severity of clinical symptoms, leading to a significant regression of neurological deficit.

2. The data obtained demonstrate that the transcranial use of IR radiation with THz modulation in patients in the acute period of IS leads to a complete restoration of cognitive functions and a significant improvement in psychoemotional status by restoring adequate blood supply to the affected hemisphere.

Conclusion

Thus, the early inclusion of transcranial use of IR radiation with THz modulation in the complex treatment of patients in the acute period of IS has a statistically significant positive effect on cerebral hemodynamics and the restoration of clinical and neurofunctional parameters, which can increase the effectiveness of neurorehabilitation measures.

An application has been filed for the grant of a patent of the Russian Federation for an invention to the Federal Service for Intellectual Property.

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COMBINATION OF SURGICAL AND ORTHODONTIC TREATMENT OF PATIENTS WITH UNILATERAL CLEFT LIP AND PALATE

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Discusses the problem of maintaining the primary cheiloplasty in patients with the large size of the diastasis with an unilateral cleft lip and palate Explained the feasibility of pre-surgical orthodontic treatment in patients with unilateral cleft lip and palate using ortho-implants with elastic chain. The surgical and orthodontic protocol of manipulations is described. The clinical example the installation of ortho-implant with further correction of the size of the diastasis.

Keywords: unilateral cleft lip and palate, ortho-implants, elastic chain.

Relevance of the problem

Congenital unilateral complete cleft lip and palate is a severe malformation, which is characterized by severe structural and functional dysfunctions, disfiguring patient's face and negatively affecting their social and psychological status.

According to WHO, the birth rate of children with cleft lip and palate in the world averages 1:600. In Russia this indicator according to different authors ranges from 1 in 500 newborns to 1 in 750 newborns.

One of the most relevant problems of modern medicine is the development and improvement of methods of early rehabilitation of children with congenital pathology of the maxillofacial region, because congenital malformation leads to deformation of mid face, disharmony of facial skeleton, grossly violates functions of various vital organs and systems, facial aesthetics and adversely affects formation of child's psycho-emotional status.In most cases, this pathology leads to children's disability, which emphasizes the relevance of this medical and social problems in the world.

Desire of surgeons to carry out primary operations at an early age contributes to development and application of new techniques to restore anatomical and aesthetic integrity of upper lip and nose wing structures, which can be carried out for children with unilateral cleft lip and palate during first days of life.

Our long-term experience with children with cleft lip and palate, scientifically based approach to strategy and tactics of treatment of such children allows us to offer an algorithm for early comprehensive rehabilitation of children with cleft lip and palate. Main purpose of proposed algorithm of treatment of children with cleft lip and palate is early rehabilitation with early recovery of anatomy and function of maxillofacial area.

A rational early orthodontic preparation before surgery is very important.

Analysis of the results of orthodontic elimination of dentoalveolar deformities in patients with unilateral cleft lip and palate shows that a special approach is needed in their treatment.Individual planning of orthodontic preparation, choice of rational methods and means of orthodontic treatment depending on the age of the patient, method of planned heilo - and uranoplasty, position of the teeth, type of cleft, severity of dental and maxillofacial deformities.

In recent years, orthodontic appliances of various designs have been used in Russia to correct dentoalveolar anomalies and deformities in congenital diseases in early childhood. Therefore, there are great opportunities for a successful treatment of patients in this category. However, in

Russian scientific literature there is not enough data on use of these appliances in patients with unilateral cleft lip and palate. Urgency of the problem of treatment children with unilateral cleft lip and palate remains high.

Objective: To increase the efficiency of surgical treatment of children with unilateral cleft lip and palate by reducing the size of the defect and reduction in the period of rehabilitation

Material and methods: During the period from 2015 to 2018 an orthodontist and maxillo oral surgeon working in collaboration have developed an algorithm for presurgical orthodontic treatment of children with unilateral CLP and have treated 40 patients aged from 3 days to one year.

We make an impression of the upper jaw, to make a cast dental model (a control model is simultaneously made for the further investigations and measurements). Individual dental tray is made for making an impression after mini-screws are taken off. With the help of a sliding caliper, measurements of the size of diastasis between large small fragments of the upper jaw were carried out.

In small and large fragments of the upper jaw was mini screws were fixed. At the head of a mini-screw was fixed an elastic chain. Within two weeks was used for the activation of the elastic chain between the fragments of the upper jaw by stretching it between mini-screws. The movement force between the fragments was reciprocal and was determined by a dynamometer.

Two weeks before the operation of primary cheiloplasty mini-screws was removed from the fragments of the upper jaw. The impressions were re-taken with an individual tray and a diagnostic and control model were cast for anthropometric measurements and 3D scanning. It had been followed by a primary-stage cheiloplasty.

Orthodontic Protocol.

In all 40 patients with unilateral cleft lip and palate during primary treatment, the impression was removed by using silicone mass. Control model and diagnostic model were made for preparation of an individual tray(Fig. 1,2,3), also anthropometric measurements were made by using 3D scanning. Diagnostic models were studied by the method of J. H. Sillman. Parameters in the transversal plane were taken into account: width between canine of the alveolar arc (a-A1), intermolar width of the alveolar arc (b-B1); width in the region of the cusps (C - C1)

Figure 1. Patient 14 days old

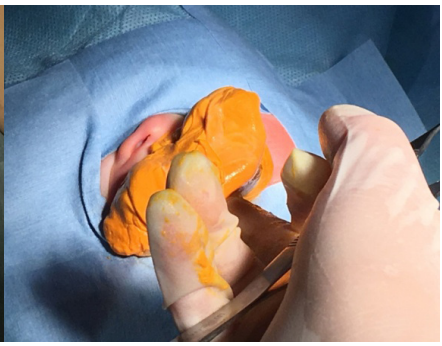

Figure 2. Making an impression of the upper jaw

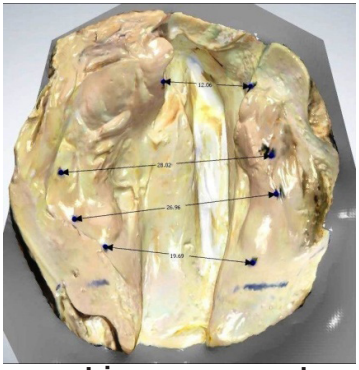

Figure 3. Anthropometric measurements made by 3D scan

Surgical Protocol.

Before surgical treatment mini-screws are fixed on a small and a large fragments of the upper jaw. On the area of the projection of canines and molars. Mini-screws interconnected with elastic chain. The traction force which we apply on mini-screws is measured by the dynamometer (120 grams) (Figure 11). The orthodontist together with the surgeon examine the patient daily. Check the stability of the mini-screw and tension of the chain. A week after the fixing of the mini-screw orthodontist activates the elastic chain on 50 grams. After 2 weeks under optimum condition of fragments of the upper jaw, under endotracheal anesthesia extraction of the mini-screws are made, re-imprint with individual tray and primary cheiloplasty are made. Then the control and diagnostic model are made and 3D scanning and anthropometric measurement of the model is carried out. (Fig. 4,5,6,7,8,10,11,12,13)

Figure 4. Screw driver

Figure 5. Mini-screw 1,5x8x1,5

Figure 6. Fixation of the mini-screw

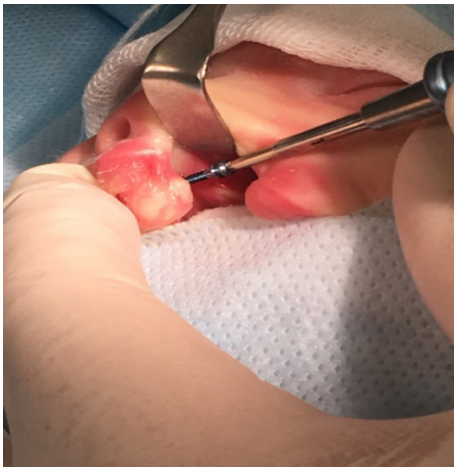

Figure 7. Fixation of the mini-screw in bigger fragment of the jaw

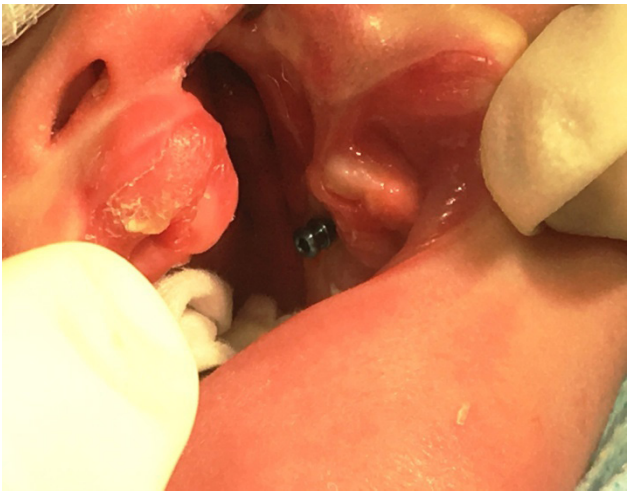

Figure 8. Fixation of the mini-screw in the smaller fragment of the jaw

Figure 9. Fixation of elastic chain

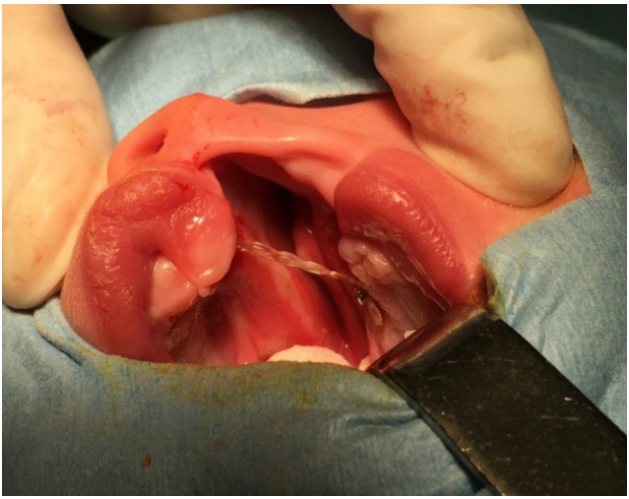

Figure 10. Fixation is done between the mini-screws

Figure 11. Dynamometer

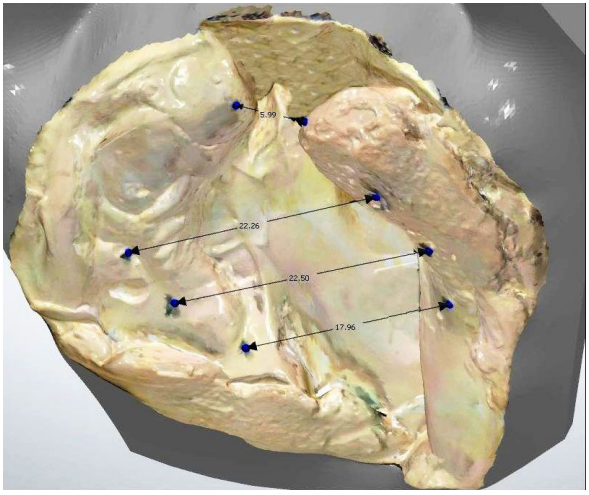

Figure 12. 3D Scan of the model

Figure 13 The result after 2 weeks

Research result

We have made clinical and anthropometric studies of models of 40 patients with UCLP in the preoperative and postoperative period, a diastasis between small and large fragments of the upper jaw decrease by 6-8 mm(50%) .

Conclusion: the use of the mini-screws helps to reduce the diastasis between the fragments of the upper jaw; reduce the timing of the beginning of the primary operation; It creates favorable situation for the vital functions of the child ,such as sucking and breathing, nutrition which allows the child to gain weight and develop.

Figure 14 Child after 2,5 months

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ÉVALUATION DE LA TENEUR EN SUBSTANCES BIOLOGIQUEMENT ACTIVES DANS LES MATIÈRES PREMIÈRES FRAÎCHES DE CASSIS (RÍBES NÍGRUM)

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Dans cet article, nous avons réalisé une étude qualitative et quantitative d'un certain nombre de groupes connus de substances biologiquement actives telles que l'acide ascorbique, les caroténoïdes et les anthocyanes.

L'analyse qualitative a été réalisée par des réactions qualitatives caractéristiques et une chromatographie sur couche mince. Une évaluation quantitative des groupes étudiés a été réalisée par des méthodes pharmacopées bien connues (anthocyanes), des méthodes iodométriques (acide ascorbique), ainsi qu'en utilisant un extrait lipophile (caroténoïdes). La teneur en acide ascorbique était de 2,23%, les caroténoïdes - 0,5-2,0 mg / 100 g et les anthocyanes - 0,182 g / 100 g.

Mots clés: plantes du genre Ribes, substances biologiquement actives, acide ascorbique, anthocyanes, caroténoïdes, spectrophotométrie, chromatographie sur couche mince.

Le cassis est une culture traditionnelle russe, bien connue de chacun de nous. Cependant, elle est aimée et appréciée également dans les pays européens: en Pologne, Suède, Finlande, Angleterre, France et autres pays. [1]

Il y a des centaines d'années, la société, ne soupçonnant même pas les bienfaits des vitamines contenues dans le cassis, s'intéressait intuitivement à ses fruits: presque beaucoup en mangeaient frais ou le séchaient en réserve. Au départ, personne ne cultivait volontairement des baies noires aigre-douces – on en cueillait tout simplement dans la forêt. Aux bords des bois, le long des fleuves d'Europe et de Russie centrale, le cassis européen augmentait. En Europe du Nord on trouvait du cassis similaire : le cassis scandinave. La population de Sibérie utilisait des groseilles de Sibérie comme nourriture – résistantes au gel, avec des feuilles avec un arôme de résine. En Extrême-Orient, il y avait une groseille sauvage populaire, abondante et spécifique. Les Sibériens de l'Est, ainsi que la population de Primorye, n'avaient pas l'occasion de rester indifférents au cassis mousseux (Rībes procūmbens), une délicieuse plante forestière aux baies étonnamment grosses, attrayantes et alléchantes. [2]

Les habitants du continent nord-américain n'étaient pas aussi chanceux que les Eurasiens. Des cassis pédonculés et des groseilles Hudson étaient à leur disposition sous la forme de cassis, mais avec des baies inodores, ainsi que des goûts amers. [15]

Aux XI-XIV siècles, les groseilles européennes locales ont commencé à être transplantées dans des jardins. Une série de siècles de sélection, et entre les mains des jardiniers russes et européens étaient des variétés prolifiques avec des baies suffisamment grandes d'un arrière-goût et d'un arôme agréables. Cependant, au début du 20e siècle, les variétés ordinaires sont tombées gravement malades. L'oïdium introduit d'Amérique a infecté le cassis, ce qui l'a mis dans une position difficile. En Occident, les chimistes ont commencé à sauver la culture – la ligne d'invention des moyens de lutte contre la maladie. En Fédération de Russie, ils ont choisi la voie la plus radicale: ils ont décidé de passer aux espèces permanentes qui devaient être créées en premier. [3]

Au cours de la même période historique, la population croissante de la Sibérie, du Nord et de l'Extrême-Orient a commencé à domestiquer les groseilles, et des variétés résistantes adaptées à ces régions étaient donc nécessaires. Ainsi, au fil du temps, la création de différents types de groseilles a été nécessaire. Pour le Nord et la Sibérie d'Extrême-Orient, des groseilles à la résistance hivernale accrue étaient nécessaires, pour le Sud – résistant à la chaleur et résistant à la sécheresse, et pour le Centre du pays – adapté aux caprices du temps changeant. Dans le même temps, les variétés étaient censées être fructueuses, faciles à cultiver, aussi grandes que possible à gros fruits. [5]

Les baies de cassis sont largement utilisées dans l'industrie alimentaire sous forme fraîche, séchée, congelée et en conserve. Elles peuvent

être utilisées pour la confiture, les bonbons aux fruits, la garniture aux bonbons, la marmelade, la gelée, les jus, les vins, les liqueurs, les boissons gazeuses. [2] Les bourgeons et les feuilles sont utilisés dans les industries de la distillerie, de la confiserie et des vitamines.

Le cassis a également des propriétés curatives. Une décoction chaude de jeunes feuilles de cassis peut aider avec les affections générales, les rhumes, les maladies de la vessie et des calculs rénaux - en tant que diurétique, ainsi que les rhumatismes, la goutte et les maladies articulaires. Les enfants atteints de scrofule sont recommandés pour donner une décoction. Feuilles et baies – un remède populaire contre le scorbut. [4]

Un domaine de recherche scientifique intéressant est l'étude de la composition des composants du cassis frais, menée par des scientifiques de différents pays avec des échantillons de cette plante poussant dans leur région, au cours de laquelle il a été révélé qu'il existe des différences significatives dans la composition de cette matière première cultivée sous différentes latitudes.

La présence d'un nombre important de publications scientifiques qui déterminent à la fois la composition chimique de divers groupes de substances biologiquement actives de cassis et les caractéristiques des effets pharmacologiques de cette matière première, il est pertinent de mener des études visant à sélectionner des critères de qualité pour le cassis frais et le cassis séché avec une inclusion supplémentaire dans la documentation réglementaire en cours d'élaboration. Actuellement, la normalisation du cassis est effectuée conformément à GOST 6829-2015, qui comprend la détermination de caractéristiques de qualité similaires comme le type d'apparence de la matière première, la couleur, l'odeur, le goût, la fraction massique des plantes présentant des défauts, la fraction massique des parasites agricoles non traités, la présence d'impuretés minérales, ce qui n'est pas permet d'évaluer la teneur en substances biologiquement actives et de réguler la qualité du matériau. [5,6]

Le but de cette recherche est une étude approfondie de la littérature scientifique, documentation patente et réglementaire reflétant l'état actuel de l'étude de la teneur qualitative et quantitative en substances biologiquement actives dans le cassis.

Matériaux et méthodes de recherche.

Pour atteindre cet objectif, nous avons utilisé des méthodes documentaires, systémiques et structurellement logiques, l'analyse de contenu, le suivi d'articles scientifiques dans des périodiques. GOST 6829-2015 «Cassis frais» a été élaboré et une analyse qualitative et quantitative de la teneur en substances biologiquement actives de cassis frais a été réalisée.

La détection qualitative de l'acide ascorbique a été réalisée par chromatographie sur couche mince (CCM) et chromatographie liquide à haute performance (HPLC). Pour l'analyse, des extraits aqueux des fruits ont été préparés: 1,0 g de la matière première broyée a été versée avec de l'eau dans un rapport de 1:10 et insistée à température ambiante pendant 1-2 heures. Les extraits résultants ont été filtrés et analysés. [6,7,8,9]

Les anthocyanes sont les dernières substances de la chaîne métabolique des composés phénylpropanoïdes des plantes (Fig. 1).

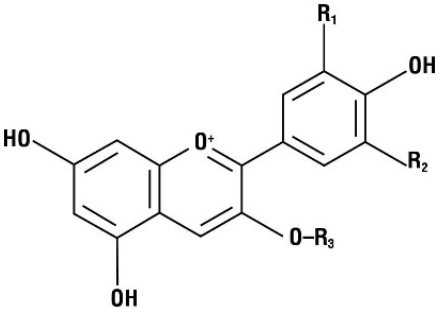

Figure 1. Formule d'anthocyanine

La somme des anthocyanes a été déterminée par spectrophotométrie directe. [10] La teneur de la somme des anthocyanes a été déterminée par la formule 1:

$$X = \frac{A * 25 * 50}{M * 1 * 100}$$

Formule 1. La formule pour trouver la somme des anthocyanes, où A est la densité optique de la solution d'essai, m est la masse des matières premières, g, 100 est le coefficient d'absorption spécifique de l'anthocyane isolée.

Les caroténoïdes sont des pigments orange et jaunâtres présents dans les chloroplastes et les chromoplastes (Fig. 3). Les caroténoïdes sont des tétraterpènes.

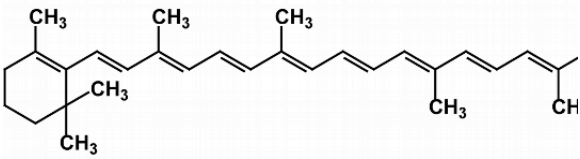

Figure 3. Formule caroténoïde

Pour calculer la concentration de caroténoïdes dans l'extrait, sa densité optique a été déterminée par spectrophotométrie à des longueurs d'onde correspondant aux maxima du spectre d'absorption des pigments étudiés dans ce solvant. [11]

Résultats et discussion.

Un chromatogramme typique des composants hydrophiles de l'extrait de cassis est présenté sur la figure 4. Il s'ensuit que dans les fruits mûrs de R. nigrum, l'acide ascorbique est la partie principale des acides, quelle que soit la variété [12]. La teneur moyenne en acide des baies de cassis est de 2,23%. Ces données peuvent également être retracées sur les données soumises par N.M. Osokina [16]:

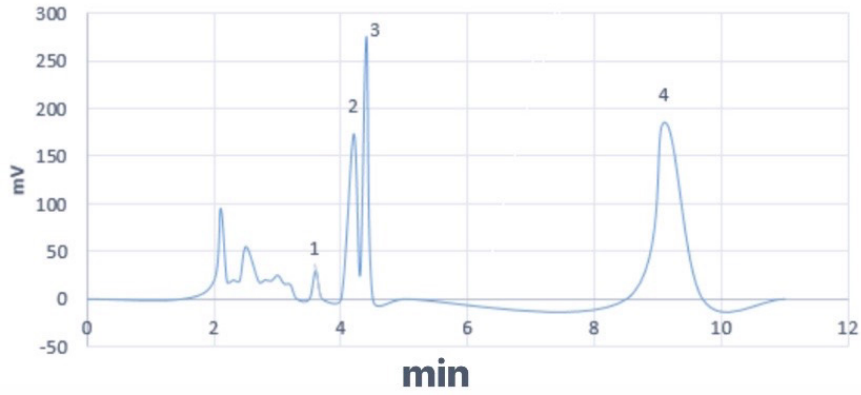

Figure 4. Acide 3-ascorbique

Des baies de cassis contiennent en quantité importante d'autres substances biologiquement actives – les anthocyanes. [13] Le profil chromatographique qualitatif du complexe d'anthocyanes de tous les fruits de R. nigrum étudiés dans cet article s'est avéré être pratiquement inchangé, comme dans tous les travaux publiés connus à ce jour. (fig. 5) [17]

Des caroténoïdes ont également été trouvés dans les baies et les écorces de cassis; la teneur en ces substances biologiquement actives est bien inférieure à celle des anthocyanes. [14] De plus, la teneur totale en caroténoïdes sous différentes formes variait de 8 à 19 mg% et la teneur maximale de ces substances biologiquement actives est caractéristique des fruits de couleur la plus foncée. Selon L.S. Le cassis doré Sankin [18] dans les conditions de l'Altaï contient de 5 à 12 mg de caroténoïdes (Fig. 6).

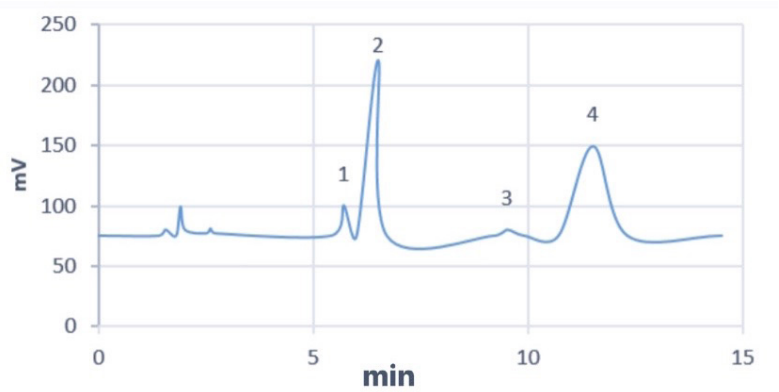

Figure 5. Séparation des anthocyanes des fruits de la variété de cassis "Zusha"

1 - Dp-3-Glu; 2 - Dp-3-Rut; 3 - Cy-3-Glu; 4 - Cy-3-Rut.

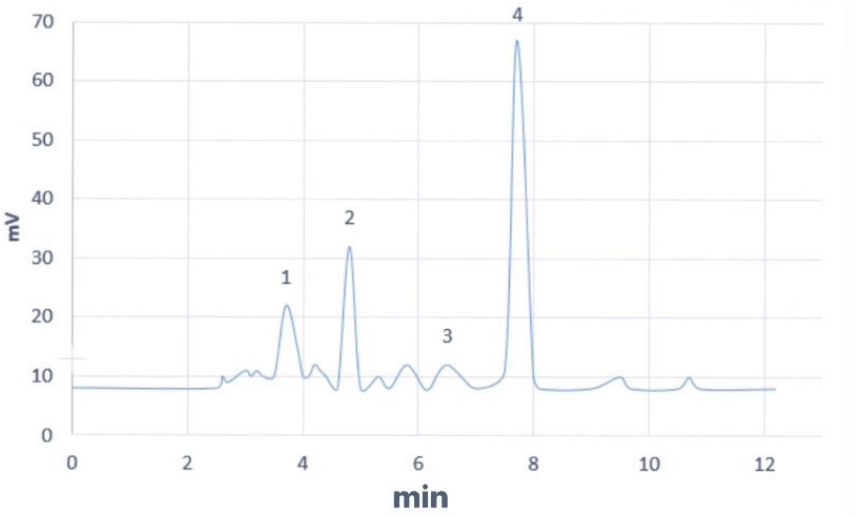

Figure 6. Chromatogramme de la séparation des caroténoïdes des fruits de R. aureum Pursh; 1 - dérivés dihydroxy; 2 - b-cryptoxanthine; 3 - lycopène; 4 - b-carotène

Les résultats de la détermination quantitative de l'acide ascorbique,teneur totale en anthocyanes et caroténoïdes présentés dans le tableau:

Échantillon d'essai	La teneur quantitative en acide ascorbique,%	La teneur quantitative en anthocyanes, mg / 100 g	La teneur quantitative en caroténoïdes, mg / 100 g
Cassis frais	2,23	182	0,5-2,0

Ainsi, une détermination quantitative du contenu dans les matières premières de l'acide ascorbique, des anthocyanes et des caroténoïdes, sur la base desquelles il est prévu d'élaborer des normes pour la teneur en substances biologiquement actives, selon la figure 7:

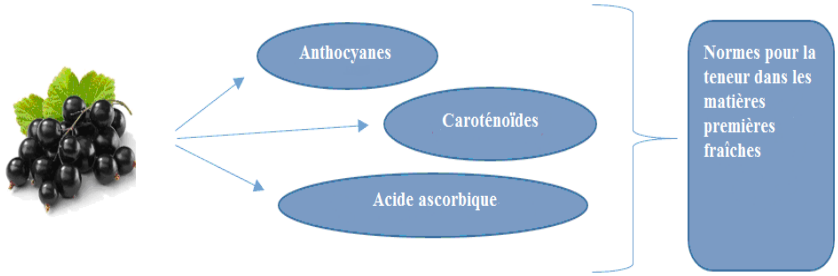

Figure 7. Normes pour la teneur en substances biologiquement actives dans les matières premières fraîches de cassis

Conclusion. Au cours de l'expérience, les auteurs ont déterminé la teneur en acide ascorbique, caroténoïdes et anthocyanes dans le cassis frais. L'identification de ces groupes BAS a été effectuée au moyen de réactions qualitatives et de CCM; la spectrophotométrie a été utilisée pour quantifier la quantité d'anthocyanes. La teneur en substances pour le cassis cru frais était de 2,23% d'acide ascorbique, 0,5-2,0 mg / 100 g de caroténoïdes et 0,182 g / 100 g d'anthocyanes.

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MARKERS OF MOTOR PERFORMANCE IN YOUTH FOOTBALL

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Purpose of the study: examine the parameters of motor performance of young professional football players as markers of the effectiveness of gaming activities and compare them with an expert assessment of the technical and tactical preparedness of professional coaches.

Research methods and organization: The experiment was attended by 20 football players from a professional football academy who played two periods in 15 football matches. We used a sports GPS global positioning system, the Catapult system (Optimeye S5; Catapult Innovations of Australia, Melbourne). Professional football coaches after each official game put up an expert assessment of the implementation of technical and tactical preparedness by players in points from 1-10.

Results: Markers were installed: speed zone 4.5-5.5 m / s, m; IMA decal, amount of assessment of motor performance of young athletes specializing in football, which are comparable with the expert assessment of the success of the implementation of technical and tactical preparedness in the game. Statistical analysis did not reveal significant differences in markers regarding football roles - forwards, defenders, midfielders.

Conclusion: An algorithm is proposed for urgent control of specialized motor activity in conjunction with an assessment of the technical and tactical component of training youth football players.

Keywords: football, markers of motor performance, GPS technology, expert assessment of the trainer

Introduction

Football is a team, intermittent, non-linear sport *[1, 2].* The activity of players on the football field requires the implementation of large volumes of multidirectional movements, which have a short duration due to frequent changes. An important aspect of a rational learning and training strategy is the adaptability of the process. The development and implementation of monitoring the volume and intensity of physical activity creates new opportunities for assessing specialized motor performance in team sports *[3]*. Many variable global positioning systems (GPS) allow sports scientists and trainers to objectify the movement of training sessions and competitive games *[4].* Monitoring the position, speed and nature of the movement of players is essential for personalizing physical activity *[5, 6].* However, today there is no consensus on the question: which variables are most useful in the rational management of physical activity on the football field? In this regard, the goal of our research is to study the parameters of motor performance using the global positioning system - GPS, as markers and evaluate their effectiveness based on an expert assessment of the implementation of technical and tactical preparedness by football players in the game.

Research methods and organization

Young professional football players were tested (n = 20; 16.8 ± 0.6 years; height 177.4 ± 6.2 cm; weight 69.9 ± 2.7 kg). The tracking of physical activity was carried out during 15 official football matches. Sports GPS - global positioning system; Catapult system (Optimeye S5; Catapult Innovations of Australia, Melbourne) was used. GPS technology consists of: mini devices that fit in a pocket located in the area of the blades of an elastic top vest; a mobile case (Fig. 1), which integrates motor activity data from mini devices into the OpenField analytical platform (Fig. 2); Cloud server to store them.

Figure 1 – Catapult GPS mini-devices in a mobile case

The following independent variables were recorded: Speed zone 4.5-5.5 m/s - the number of meters when moving at a speed of 4.5-5 m/s; Speed zone 5.5-7 m/s - the number of meters in the speed zone 5.5-7 m/s and Speed zone> 7 m/s - the number of meters in the speed zone> 7 m/s; micromotions: IMA accel high - high-intensity accelerations; IMA decal high - high-intensity braking and IMA Cod left high - high-intensity direction changes to the left side and, accordingly, to the right side - IMA Cod right high.

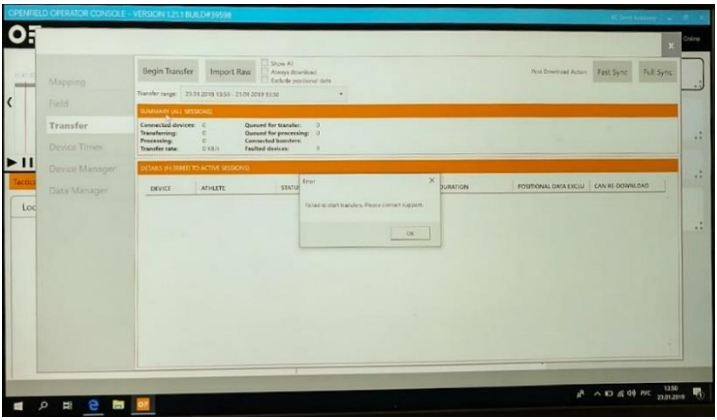

Figure 2 – OpenField analytic platform

After each match, an expert assessment of professional football coaches with licenses was carried out: A - youth (n = 2), B - youth (n = 2) and C (n = 2) in order to assess the success of the game activity of each young football player. Depending on the number of successful technical and tactical actions, points were set in the game: 1-2 - "the technical arsenal in the game is low and there is no understanding of the tactical model", 3-4 - the technical and tactical component is "very low", 5-6 points - " satisfactory ", 7-8 -" good ", 9-10 -" excellent ". Based on the relative values of various physical load variables, the methods of correlation analysis were implemented in the framework of a linear model. The results are shown as the arithmetic mean and standard deviation ($M \pm \grave{o}$). Pearson's correlation coefficient was calculated to identify the relationship among the analyzed parameters. Comparison between football roles was performed by the oneway ANOVA analysis of variance. Statistical applications STATISTICA 12.0 and Microsoft Office Excel 2017 were used.

Research results

The successful technical and tactical activity of young sportsmen-football players is represented by a score of professional trainers (Table 1).

Table 1 - Expert evaluation of the implementation of technical and tactical preparedness in the game by young football players, (M±ò , n = 20)

Football match	Expert coach, points
1	6,8±1,7
2	7,2±1,7*
3	7,1±1,6
4	7,7±1,6
5	8,3±0,8*
6	7,2±1,6
7	7,4±1,7*
8	7,2±1,7
9	7,8±1,1*
10	7,06±1,7
11	6,8±1,7*
12	7,5±1,5*
13	7,2±1,4*
14	7,2±1,8*
15	6,5±1,8

*Note: *- significance of differences p <0.05 in terms of expert evaluation of coaches of official matches with respect to the first game*

A number of external variables recording motor performance on the football field turned out to be closely related to the expert assessment of the coaches (Tables 2, 3). The indicator of the number of meters worked in the speed zone 4.5-5.5 m/s (speed zone 4.5-5.5 m/s) is more consistent with the expert assessment of the activity of young football players on the field. The graphical linear trend is growing relative to each game and is as close as possible to the coaching model of the technical and tactical preparedness of a football player (Fig. 3).

It should be noted that with the increase in the footage of movement at a speed of 4.5-5.5 m/s, the success of the arsenal of technical actions and understanding of the tactical model of the game among football players grows, which is manifested in the success of the game activity. The contribution of the activity of football players in high-speed zones of 5.5-7 m/s and> 7 m/s to the game success is insignificant (Table 2).

Table 2 – GPS-indicators of the movements of young football players in different speed zones, (M±ò , n = 20)

Football match	Speed 4,5-5,5 m/s, m	Speed 5,5-7 m/s, m	Speed >7 m/s, m
1	887,7±147,3	258,8±78,8	30,9±26,02
2	840,2±150,7*	265±79,6	47,2±31,04
3	813,2±160,8	232,8±86,04*	42,7±30,9
4	848,5±206,5*	247,2±83,1	48,4±30,1
5	858,6±96,1*	291,7±71,3	50,7±28,5
6	812,8±186,9	243,5±78,6	52,8±35,3
7	862,5±142,9*	254,9±74,4	49,8±30,5*
8	904,07±128,5	260,5±73,3	40,2±24,8
9	872,2±163,8*	243,2±43,2	34,6±27,7
10	797,4±161,8	270,9±78,06	46,07±21,6
11	851,5±237,4	313±79,8*	51,7±20,6
12	1416,7±303,4*	286,9±67,9	54,2±32,6
13	812,2±150,6*	305,9±67,1	40,2±24,2*
14	1395,4±235,2*	269,5±71,5	37,7±29,2
15	752,9±127,8	263,7±77,2	39,6±33,01

*Note: *- significance of differences p <0.05 in terms of intensive micromotion (IMA) in official matches relative to the first game*

A survey of players and sports doctors revealed a greater number of complaints of damage and aseptic myositis of the posterior thigh in games 12 and 14, compared with other performances. It is in these football matches that the average group footage of movements in various speed zones is greatest (Fig. 3). Paulsen et al., (2012) notes that running speed is a significant factor in damage to muscle tissue, and this was probably the reason why players turned to doctors.

What differences between indicators of intensive micromotion (IMA) we received? Inertial motion analysis (IMA) is the number of accelerations, braking, and direction changes at high intensity of movements (> 3.5 m/s) *[8]*. The results of the study show that the external factor, the amount of sudden braking (IMA decal), changes significantly more dynamically than the other indicators of micromotion - IMA (Table 3). These data are consistent with the results of specialists who found that the physical need of sportsmen-football players in the skills of deceleration/braking is higher than the skills of movements with a sharp change of direction and acceleration *[3]*.

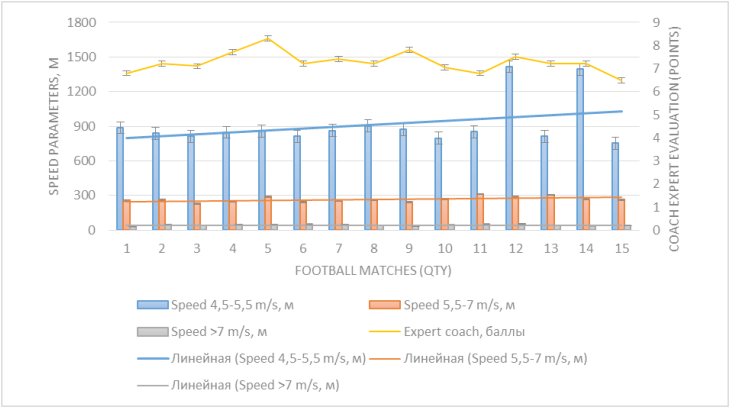

Figure 3 - a linear model of the correlation relationship of speed zone markers, meters (speed 4.5-5.5 m/s; speed 5.5-7 m/s; speed> 7 m/s) and expert assessment of the implementation of technical and tactical readiness of players, points

Table 3 – GPS inertial micromotion indicators (IMA) of young professional football players, (M±ò , n=20)

Football match	IMA accel, qty	IMA decal, qty	IMA left, qty	IMA right, qty
1	5,2±3,2*	5,6±1,1	3,5±3,2	4,5±3,09
2	3,8±3,1	4,4±0,5	4,3±2,7	4,8±3,09
3	3,5±3,2	6,3±1,5*	4,8±3,7	4,4±3,5
4	4,2±3,2*	4,2±0,7	3,9±3,01	4,6±3,5
5	3,7±3,1	6,5±0,5*	6,3±4,4*	4,7±3,1
6	4,3±2,9	4,2±1,03	3,2±2,6	5,4±3,3*
7	3,5±3,2	5,1±0,7*	4,4±3,3	4,5±2,9
8	5,4±3,5	6,4±0,6*	5±2,6	5,4±3,2*
9	3,8±3,2	6,6±1,1*	5,3±2,8	4,1±3,3
10	3,6±3,2	6,6±0,4*	3,4±2,7	3,6±2,7
11	4,1±3,2*	6,4±1,1*	3,4±2,4	4,4±2,9
12	4,8±3,1	6,2±0,9*	3,6±3,06	4,4±2,8
13	3,2±2,8	5,4±0,7	3,6±2,6	4,6±3,3
14	4,6±3,1*	6,3±1,2*	3,6±1,7	5,4±2,1*
15	4,1±3,3	6,9±1,4*	5±1,01	5,9±2,6*

*Note: *- significance of differences p <0.05 in terms of intensive micromotion (IMA) in official matches relative to the first game*

There are studies in which a relationship has been established between data obtained by inertial sensors on locomotor movements over short distances and excessive load on the joints of the lower extremities [8]. During the study period, the peak group average values of the parameter of inhibitory micromotion (IMA decal) in games 3, 5, 8-12, 14-15 give a significant load on the flexion-extensor function of the knee joint (Fig. 4).

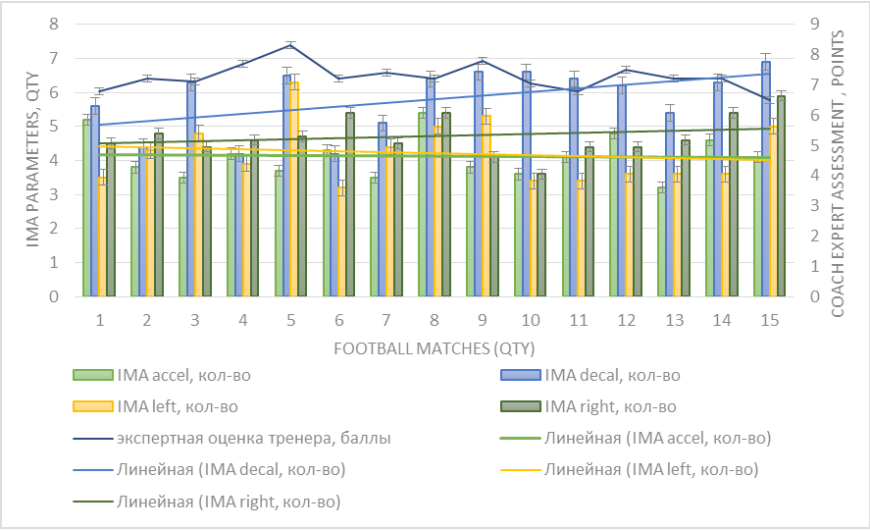

Figure 4 – Linear model of correlation of inertial micromotion markers, qty (IMA accel, IMA decal, IMA Cod left high, IMA Cod right high) and expert assessment of the implementation of technical and tactical preparedness by players, points

Figures 5, 6, 7 show differences in the markers of motor performance in football players with different game roles. Fig. 4 shows the relative symmetry of the external factor - the number of meters in the speed zone of 4.5-5.5 m/s between attackers (forward), midfielders and defenders. Analysis of variance indicates a significance level ($p < 0{,}00028$) of less than 0.05, which generally indicates the existing difference (Table 4).

Box diagrams of the indicator of the number of brake high-intensity movements (IMA decal) in Fig. 6 express the absolute and uniform level between football roles, however, the statistical variance calculation presented in Table 4 showed a significance level ($p = 0.36985$) greater than 0.05, proving the absence of differences.

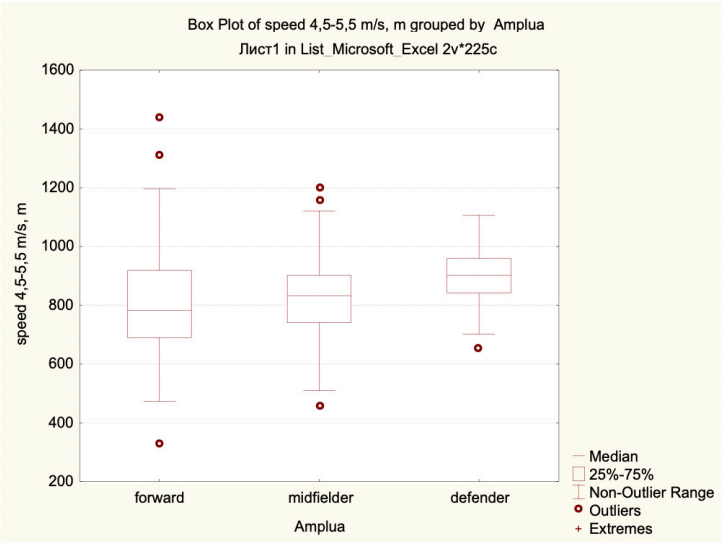

Figure 5 – The indicator of the footage of movement in the high-speed zone is 4.5-5.5 m/s for attackers, midfielders, defenders

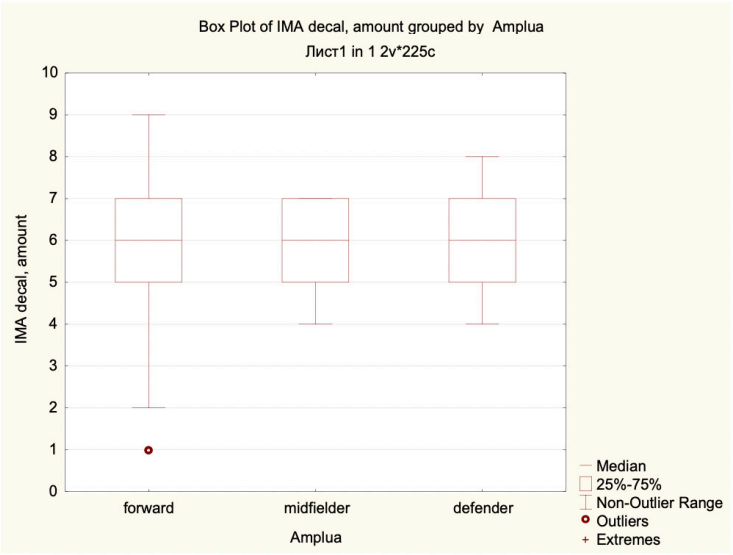

Figure 6 – High Intensive Slowdowns (IMA decal) for attackers, midfielders, defenders

Table 4 – comparative analysis of variance of markers of motor performance relative to the football role (forwards, defenders, midfielders)

Variable	Analysis of Variance Marked effects are significant at p>0,05							
	SS Effect	Df Effect	MS Effect	SS Error	Df Error	MS Error	F	P
Speed zone 4,5-5,5 m/s, m	389732,4	2	194866,2	505509098	220	22977,72	9,48066	0,00028
IMA decal, amount	3,52888	2	1,76444	392,053	222	1,76600	0,99911	0,36985

Conclusions

1. Markers of motor performance of young football players are identified: speed zone 4.5-5.5 m/s, m; IMA decal, amount, having a close relationship with the implementation of the technical and tactical potential in gaming activities.

2. Statistical analysis did not show significant differences in the established markers regarding football roles.

3. The algorithm for monitoring specialized motor activity and technical and tactical activity of football players developed and presented in Figure 7 is the optimal component in managing the training process in youth football.

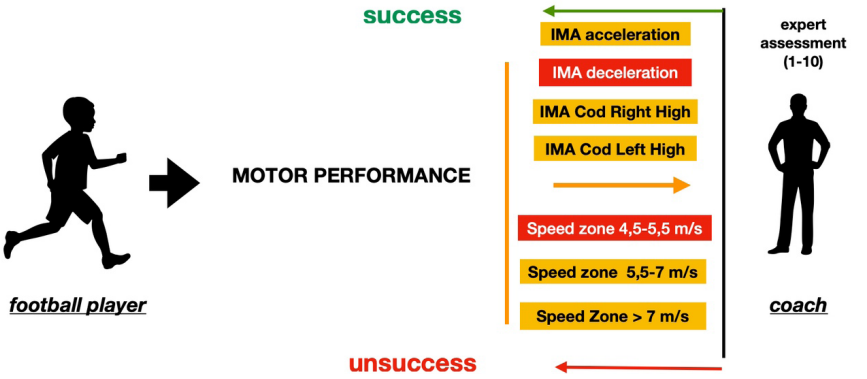

Figure 7 – algorithm for monitoring the success of motor performance in young professional football players

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ANALYSIS OF THE PHYSICOCHEMICAL PROPERTIES OF RECOMBINANT L-PHENYLALANINE-AMMONIUM LYASE [1]

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In this work, the physicochemical properties of recombinant L-phenylalanine-ammonium lyase (PAL) were studied, the activity of the enzyme at various pH and temperature was determined in order to establish their optimal values.

Keywords: antitumor properties, recombinant L-phenylalanine-ammonium lyase, enzymatic activity.

Of primary importance in solving the problem of oncological diseases are studies aimed at revealing the molecular genetic mechanisms of the functioning of drugs used to treat cancer patients.

Currently, the fundamental problem of practical oncology is the low selectivity and high toxicity of known antitumor drugs. An alternative approach to solving this problem is enzyme therapy of cancer. The advantages of using enzymes to suppress the growth of malignant cells over the known means of antitumor therapy are as follows: low toxicity of enzymes; a unique mechanism of action based on the elimination of certain amino acids necessary for tumor growth; lack of pharmacokinetic interactions with antineoplastic agents.

A promising enzyme preparation for the treatment of cancer is L-phenylalanine-ammonium lyase (PAL). This enzyme catalyzes the reversible deamination of the amino acid L-phenylalanine to trans-cinnamic acid and

[1]This work was carried out as part of a research project funded by the Scholarship of the President of the Russian Federation (SP-1361.2018.4) on the topic: "Development and practical implementation of genetic engineering technologies for obtaining new drug candidates for targeted therapy of cancer"

ammonia [1]. The antitumor effect of the drug is due to a decrease in the level of L-phenylalanine in leukemic tumor cells, which, unlike normal cells, are not able to synthesize their own L-phenylalanine. As a result, protein synthesis is disrupted, as well as DNA and RNA synthesis. In this case, healthy cells are not affected. It has been proven that the lifetime of L-asparaginase is shorter than that of L-phenylalanine-ammonium lyase [2].

The aim of this work is to study the physicochemical properties of recombinant PAL: determination of activity, pH and temperature optimum, thermal stability.

To determine the pH optimum of recombinant L-phenylalanine-ammonium lyase, the pH was varied from 2.0 to 12.0 using buffer solutions and PAL activity was measured.

L-phenylalanine-ammonium lyase activity was determined spectrophotometrically using a "DU 800" spectrophotometer (Beckman Coulter). The calculation was carried out in the time interval from 2 to 7 minutes The activity was calculated by the formula from the Sigma method using a mimic trans-cinnamic acid extinction coefficient of 19.73, in accordance with the formula:

$$Активность\,(Ед/мл) = \frac{(\Delta ОП_{270}/мин\,Опыт - \Delta ОП_{270}/мин\;Контроль) \times Vр.см. \times f}{19{,}73 \times Vооб.} \quad (1)$$

$$Удельная\;активность\,(Ед/мг \cdot белка) = (Ед/мл) \times {}^{1}\!/_{C}\,, \quad (2)$$

where $V_{r.mix}$ – the volume of the reaction mixture (ml);

f – dilution factor of the initial solution of the PAL drug;

19,73 – millimolar extinction coefficient of trans-cinnamic acid at 270 nm;

V_{vol} – sample volume in ml;

C – protein concentration in stock solution (mg/ml).

The unit of activity was taken as the amount of PAL, which catalyzes per minute the conversion of 1 μmol of L-phenylalanine to trans-cinnamic acid and NH_3 at a pH of 8.5 and a temperature of 30 °C.

The experimental results are presented in Figure 1.

Based on the analysis of Figure 1, it was concluded that the curve of the dependence of PAL activity on the acidity of the medium has a clear maximum at pH = 8.5 (activity is 3.32 U/mg).

In order to determine the temperature optimum of recombinant PAL, the temperature was varied in the range from 20 to 70 °C and the enzyme activity was measured (Figure 2). After analyzing the results, we determined that the optimal temperature for the functioning of recombinant L-phenylalanine-ammonium lyase is 50 °C.

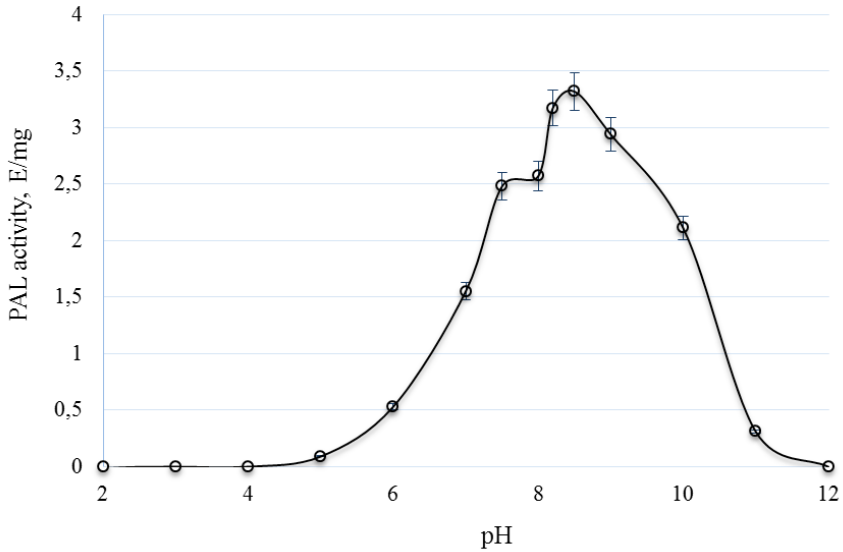

Figure 1 – Dependence of L-phenylalanine-ammonium lyase activity on pH

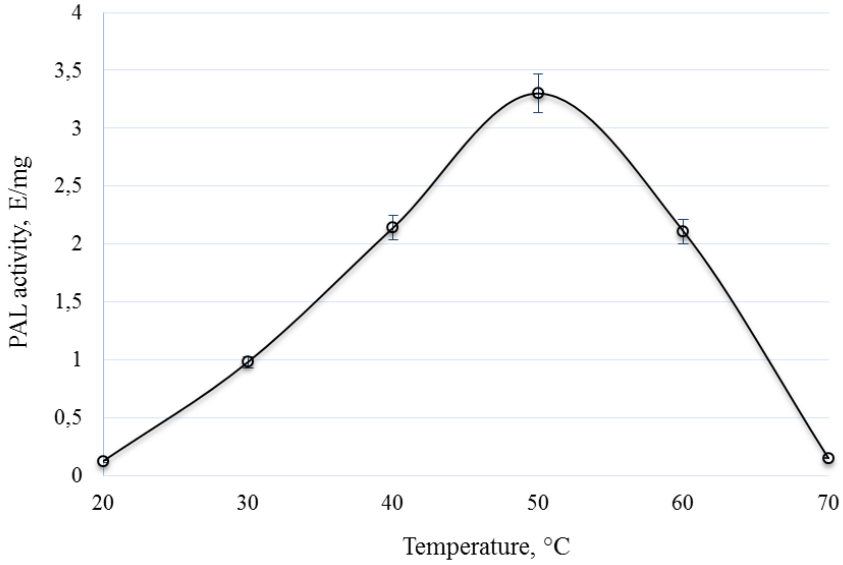

Figure 2 - Temperature dependence of L-phenylalanine-ammonium lyase activity

The next studied property of recombinant L-phenylalanine-ammonium lyase was the thermal stability of the enzyme. Thermostability of recombinant PAL was studied at a pH of 8.5. The enzyme was kept at temperatures of 70 °C, 80 °C and 90 °C for 10 min and the degree of protein denaturation was measured. The results obtained are shown in Figure 3, from which it follows that with increasing temperature the thermal stability of the enzyme decreases. When the recombinant L-phenylalanine-ammonium lyase was kept for 300 s at a temperature of 70 °C, its degree of denaturation was 18.5%, at a temperature of 80 °C – 21.3%, at a temperature of 90 °C – 24.6%. When the recombinant L-phenylalanine-ammonium lyase was kept for 600 s at a temperature of 70 °C, its denaturation was 33.6%, at a temperature of 80 °C – 44.2%, at a temperature of 90 °C – 55.6%.

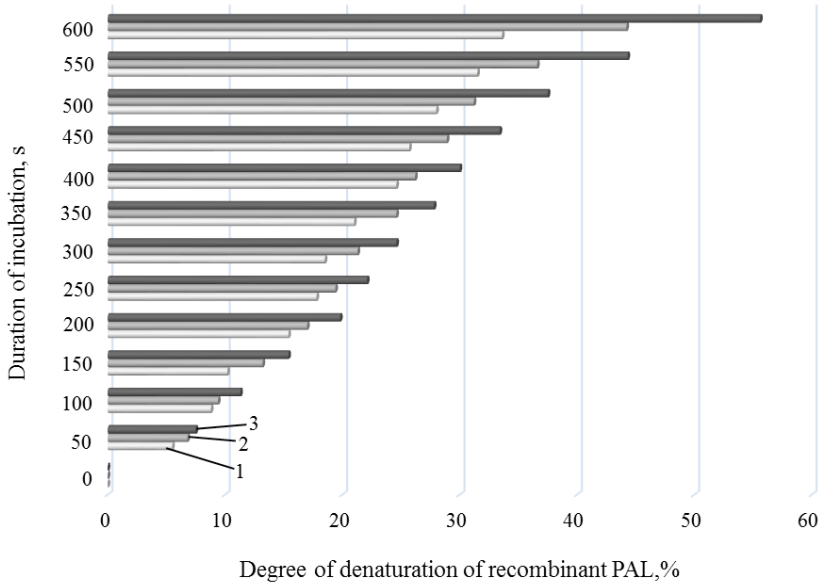

Figure 3 – Dependence of the degree of denaturation of recombinant PAL on incubation time at different temperatures: 1 – 70 °C, 2 – 80 °C, 3 – 90 °C

Further studies are aimed at analyzing the antitumor properties of recombinant PAL in order to establish the possibility of its use as a promising agent for targeted therapy of cancer.

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ANALYSIS OF ALLERGENICITY AND HEPATOTOXICITY OF ENZYMATIC HYDROLYSATES OF COCONUT OIL [1]

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In this work, the allergenicity of enzymatic hydrolysates of coconut oil was studied using mast cells from laboratory mice, and its hepatotoxicity was studied using an MTT assay based on measuring the loss of lactate dehydrogenase. The results obtained indicate the absence of allergenicity and hepatotoxicity in enzymatic hydrolysates of coconut oil.

Keywords: coconut oil hydrolyzate, allergenicity, hepatotoxicity, mast cells.

Caries – is an infection associated with microorganisms found in saliva. Despite the use of various methods of prevention and treatment, caries and gingivitis, as before, remain one of the most common oral diseases in adults and children. Most of the traditional preventive measures, for example, methods for improving oral hygiene, limiting the use of sugar-containing foods and drinks, removing dental deposits, remineralization and filling, are in some cases not effective enough.

In the literature there is information about the possibility of prevent-

[1]This work was carried out as part of a research project funded by the Scholarship of the President of the Russian Federation (SP-1366.2018.4) on the topic: “Development of bactericides for oral care based on enzymatic hydrolysates of vegetable oils and the study of their toxicological safety indicators”

ing the development of dental caries using coconut oil. Although the exact mechanism of the antimicrobial action of coconut oil is still unknown, it has been hypothesized that monolauric acid and other medium-chain monoglycerides have the ability to disrupt bacterial cell walls, penetrate and destroy cell membranes, and inhibit metabolic enzymes, causing the death of bacteria. Thus, enzymatic hydrolysates of coconut oil seem to be a promising object for creating new effective agents for the prevention and treatment of infectious diseases of the oral cavity, in particular caries [1].

At the previous stages of the study, coconut oil hydrolysis products were obtained using various lipolytic enzymes.

The aim of this study is to analyze the allergenicity and hepatotoxicity of the obtained enzymatic hydrolysates of coconut oil.

Allergenicity is the ability of factors of various nature to cause allergies. The allergenicity of coconut oil enzymatic hydrolysates was determined using mast cells from laboratory mice. The experiment was carried out as follows. On a glass slide coated with 0.3% neutral absolute alcohol, 1 drop of mast cells, blood serum of laboratory mice and enzymatic hydrolysates of coconut oil were applied (concentrations from 0.5 mg/ml to 5.0 mg/ml in increments 0.5 mg/ml) and kept for 12 hours, taking observations every 4 hours. Mast cells and blood serum from the same mice (1 drop) and the difference in the percentage of mast cell degranulation in the experiment and in controls judged the allergenicity of enzymatic hydrolysates of coconut oil [2].

The results of a study of the allergenicity of enzymatic hydrolysates of coconut oil are presented in table 1.

Table 1 - Results of testing the allergenicity of enzymatic coconut oil hydrolysates

The concentration of enzymatic hydrolyzate, mg/ml	The percentage of mast cell degranulation in the test			The percentage of mast cell degranulation in the control			Reaction result, %		
	4 h	8 h	12 h	4 h	8 h	12 h	4 h	8 h	12 h
0,5	10	12	17	4	7	11	6	5	6
1,0	11	15	15	6	9	12	5	3	3
1,5	8	11	14	4	6	10	4	5	4
2,0	9	12	15	5	8	11	4	4	4
2,5	11	14	18	7	10	14	4	4	4
3,0	10	13	17	5	9	12	5	4	5

The concentration of enzymatic hydrolyzate, mg/ml	The percentage of mast cell degranulation in the test			The percentage of mast cell degranulation in the control			Reaction result, %		
	4 h	8 h	12 h	4 h	8 h	12 h	4 h	8 h	12 h
3,5	9	11	16	4	8	11	5	3	5
4,0	12	15	17	8	12	15	4	3	2
4,5	10	16	18	6	10	13	4	6	5
5,0	9	14	17	6	9	12	3	5	5

Based on the analysis of Table 1, it was concluded that the enzymatic hydrolysates of coconut oil did not have sensitizing properties, since the percentage of mast cell degranulation in the case of all tested concentrations of hydrolysates does not exceed 10%.

Hepatotoxicity is understood as the property of chemicals acting on the body in a non-mechanical way to cause structural and functional disorders of the liver.

Hepatotoxicity of coconut oil enzymatic hydrolysates was evaluated using a system based on the combination of human cell lines (Huh-7 hepatomas and THP-1 monocytes), proposed by Y. Edling et al. [3]. The THP-1 human monocyte suspension was grown in RPMI-1640 medium containing 10% heat-inactivated bovine serum albumin (FBS), 1 mM sodium pyruvate, 0.05 mM 2-mercaptoethanol, penicillin (100 IU/ml) and streptomycin (100 μg/ml). Huh-7 human hepatoma cells were grown in DMEM containing 10% FBS, penicillin (100 IU/ml) and streptomycin (100 μg/ml). In co-cultures, cells were grown in a mixed medium (1:1) in a transwell, where the cells were separated by a porous membrane (pore size 3 μm, distance 1 mm). In co-cultures, Huh-7 cells were seeded at an initial concentration of 75×10^4 cells per well, cultured overnight, and then THP-1 cells (30×10^4 cells per well) were added. All cells were cultured in Costar 12 well plates.

The hepatotoxicity of coconut oil enzymatic hydrolysates was studied using an MTT assay based on a measurement of the loss of lactate dehydrogenase (LDH). Individual or joint cultures were grown in the presence of coconut oil hydrolysates in a nutrient medium (the concentration of hydrolysates varied from 0.5 mg/ml to 5.0 mg/ml in increments of 0.5 mg/ml), then the medium was removed and LDH loss was measured using a special kit. The experimental results are presented in Figure 1.

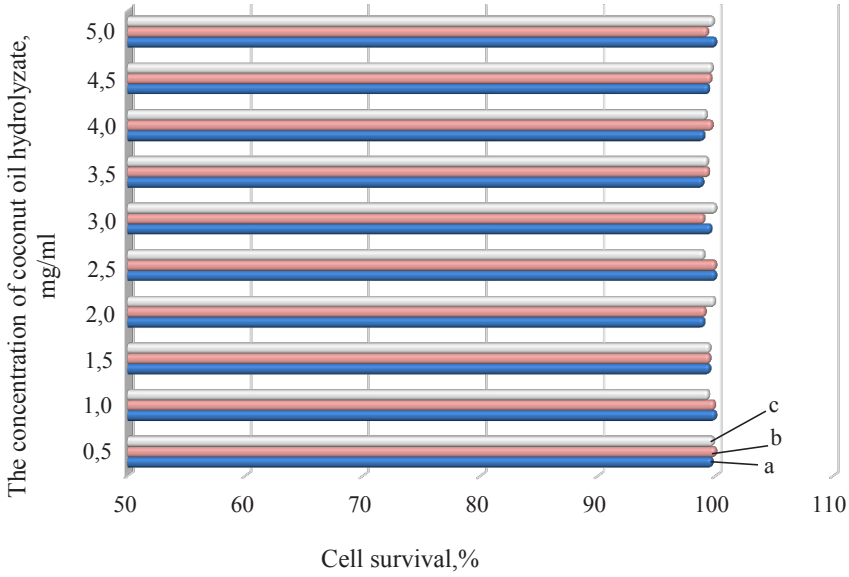

Figure 1 – Hepatotoxicity of enzymatic hydrolysates of coconut oil: a – cell line Huh-7, b – cell line THP-1, c – co-culture (Huh-7 + THP-1)

From figure 1 it follows that cell survival in all variants of the experiment (in the entire range of studied concentrations of enzymatic coconut oil hydrolysates) remains high (at the level of 100%), which allows us to conclude that the enzymatic coconut hydrolysates do not have hepatotoxic properties.

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ANALYSIS AND IDENTIFICATION OF METABOLITES OF PSYCHROPHILIC MICROORGANISMS ISOLATED FROM BOTTOM SEDIMENTS OF LAKE BAIKAL [1]

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The metabolites of selected psychrophilic microorganisms were identified and their properties (antibacterial activity, pH optimum and thermal stability) were analyzed.

Keywords: metabolites, psychrophilic microorganisms, peptides, antibacterial activity, pH optimum, thermal stability.

In the modern world, studies aimed at finding new antimicrobial agents with a wide spectrum of activity and a low level of microbial resistance are becoming increasingly relevant. One of these substances is antimicrobial peptides - bacteriocins, produced mainly by gram-positive bacteria. Despite the obvious importance of the search for new types of bacteriocins, most applied research is focused on lactic acid bacteria, while microorganisms isolated from natural communities also have high potential for use in this field of biotechnology.

A promising source of microorganisms capable of producing bacterio-

[1]This work was carried out as part of a research project funded by the Scholarship of the President of the Russian Federation (SP-1374.2018.4) on the topic: “Screening and characterization of the antagonistic properties of microorganisms - extremophiles isolated from the bottom sediments of Lake Baikal in connection with the creation of new antimicrobial preparations "

cins are bottom sediments of lakes, for example, Lake Baikal [1, 2].

At the previous stages of work, psychrophilic microorganisms were isolated from the microbial communities of the bottom sediments of Lake Baikal: *Bacillus megaterium*, *Pseudomonas fluorescens, Pseudomonas putida, Pseudomonas aeruginosa*, *Pseudomonas oleovoran*.

The purpose of this work is the analysis and identification of metabolites of selected psychrophilic microorganisms.

For identification of metabolites produced by selected psychrophilic microorganisms of the species *B. megaterium*, *Ps. fluorescens Ps*. *putida*, *Ps*. *aeruginosa*, *Ps. oleovorans* microorganisms were grown on LB liquid medium (tryptone - 1%, yeast extract - 0.5%, NaCl - 1%) at a temperature of 25 °C. To obtain the inoculum, five colonies of the same type taken from a daily culture seeded with a thinning bar were placed in 5 ml of LB liquid medium and cultured in a shaker thermostat at a temperature of 25 °C to OD_{600} equal to 0.6–1.0, after which 50 µl of cell Suspensions were transplanted into 50 ml of LB liquid culture medium and cultured until an OD_{600} of 0.6–1.0 was also achieved. The resulting cell suspensions were centrifuged for 15 minutes at 5000 rpm. The culture fluid was separated from the cell debris and lyophilized by freeze drying “Labconco” at a temperature of –20 °C. The resulting dry residue was extracted with methanol to remove organic compounds, and then dissolved in 10 ml of TG (Tris-glycine) buffer, pH 3.5.

The resulting solution containing the peptide fraction was subjected to chromatographic separation using an NGC Biorad HPLC on a Uno-Q1 column in a gradient pH 2.5–8.9. Buffer solutions were the eluent: phase A — citrate-phosphate buffer with a pH of 2.5; B - Tris-glycine buffer pH 8.5; gradient B phase 0% - 100% for 15 column volumes (1 column volume - 1 ml). The chromatographic parameters are presented in table 1.

As a result, four large fractions of metabolites A/1-A/4, A5/-A/7, A/8-A/11, A/12-A / 14 (Figure 1, Table 2) produced by selected psychrophilic microorganisms and presumably containing bacteriocins were identified (*B. megaterium*, *Ps. fluorescens Ps*. *putida Ps*. *aeruginosa*, *Ps. oleovorans*).

Table 1 – Chromatography parameters

Run: Run 04, Trace Type: λ 3 (280 nm)			
Best Fit:	8	Min Height:	N/A
Slope:	10	Min Width:	N/A
Sensitivity:	Medium	Start Range:	N/A
Size:	N/A	End Range:	N/A

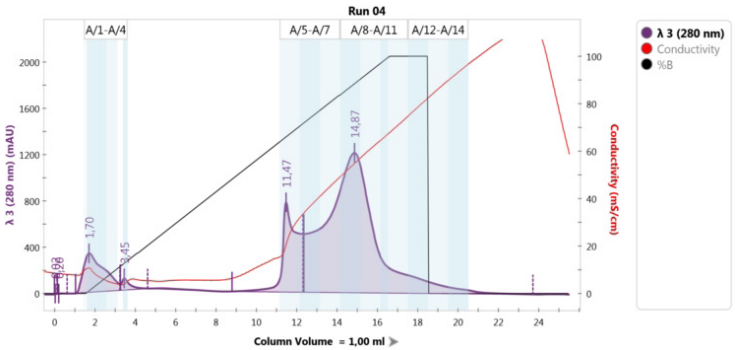

Figure 1 – Chromatogram of metabolites produced by psychrophilic microorganisms (B. megaterium, Ps. fluorescens Ps. putida, Ps. aeruginosa, Ps. oleovorans)

Table 2 – Metabolites produced by selected psychrophilic microorganisms

№	Rack/ Tube	Tube Location	Start (CV)	End (CV)	Collected Volume (ml)	Area (ml·mAU)	Relative Area (%)
1	A/1	1	1,45	1,52	0,07	16,39	0,37
2	A/2	2	1,58	2,56	0,98	254,00	5,80
3	A/3	3	2,56	3,12	0,56	69,27	1,58
4	A/4	4	3,38	3,62	0,23	20,89	0,48
5	A/5	5	11,15	12,15	1,00	520,21	11,87
6	A/6	6	12,15	13,15	1,00	520,07	11,87
7	A/7	7	13,15	14,15	1,00	666,95	15,22
8	A/8	8	14,15	15,15	1,00	1104,14	25,19
9	A/9	9	15,15	16,15	1,00	682,76	15,58
10	A/10	10	16,15	16,52	0,37	94,25	2,15
11	A/11	11	16,52	17,51	1,00	183,73	4,19
12	A/12	12	17,51	18,52	1,00	130,56	2,98
13	A/13	13	18,52	19,51	1,00	76,64	1,75
14	A/14	14	19,51	20,51	1,00	42,89	0,98

For selected fractions, antibacterial activity studies were performed using *E. coli*.

To obtain a culture of *E. coli,* used as a model microorganism, five colonies of the same type, taken from a daily culture seeded with a thinning bar, were placed in 5 ml of LB liquid medium and cultured in a shaker thermostat at a temperature of 37 °C to OD_{600} equal to 0.1. Next, the obtained inoculums in a volume of 1 ml were applied to Petri dishes with LB agar and distributed by shaking, after which the excess was removed with an automatic pipette. For ten minutes, Petri dishes with inoculums were dried at room temperature, after which pre-prepared sterile paper disks soaked in solutions of the obtained protein fractions were applied. The cultivation was carried out at a temperature of 37 °C for 12 hours

Antibacterial activity was found for fractions: A/1 and A/7. The belonging of the detected metabolites to bacteriocins was confirmed by polyacrylamide gel electrophoresis (Figure 2).

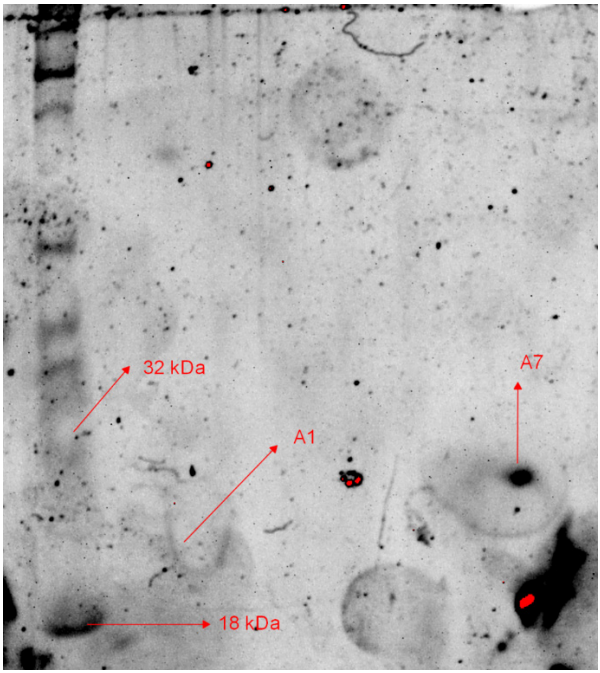

Figure 2 – PAGE-electrophoresis of fractions of metabolites A/1 and A/7

Electrophoresis was performed using a ready-made PAA gel (BioRad, USA) and TGB buffer (Tris-base 25 mM, glycine 250 mM, SDS 0.1%, water) at a voltage of ~ 10V/cm in a concentration gel and ~ 180V in a resolution

gel. Based on the results presented in Figure 2, the studied compounds are low molecular weight oligopeptides.

The determination of the pH spectrum in which the peptides are active was carried out by culturing according to the above-described method for determining the antibacterial activity when hydrochloric acid and sodium hydroxide were added to the LB medium to change the acidity. The results showed that the metabolites of fractions A/1 and A/7 are active at neutral and low alkaline pH. The determination of thermal stability was carried out using cultivation in the temperature range from 25 °C to 50 °C. Peptides have been shown to lose activity at temperatures above 45 °C.

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SYNCHRONIZATION OF REPRODUCTION IN BIRD COLONIES AND POPULATIONS AND DETERMINATION OF ITS LEVEL

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Based on many years of research (1972-2018) on the biology, ecology, and behavior of gull birds, the high synchronization of their reproduction in colonies is specially considered. This sign varies greatly depending on their size and is well expressed in small colonies. This is due to the fact that large colonies are formed from small ones, often differing in terms of reproduction. As a result, the duration of the breeding season of a large colony covers the entire breeding season of the species. The features of synchronization of breeding birds in colonies are examined in detail. Based on the collected materials, a special index was developed and proposed for use, which allows one to assess the level of synchronization of bird breeding in clusters and colonies - Isr (index of breeding synchronization).

Key words: colonial birds, colony size, reproduction synchronization, synchronization index.

Introduction

Special studies of gull birds, whose membership in colonial birds is not in doubt, made it possible to single out a complex of features characteristic of the colonies of this group of species: high nesting density, synchronization of breeding, and aggressive defense reactions [4, 6, 9, 13, 14, et al.]. Almost all researchers do not consider it fundamentally important that all these characters are present in the colony at the same time, giving preference to a high density of bird nesting. At the same time, we showed that this sign is also characteristic of other socio-demographic groups of birds — aggregations, local aggregations, subcolonies, bird bazaars [6]. To one degree or another, defensive reactions are also characteristic of all dense bird groups — from ground-based distracting demonstrations to aggressive reactions that end with an opponent's blow with their beak, wing, paw or sprinkling with their droppings [4, 6, 9].

A sign characteristic only of colonial species is a high synchroniza-

tion of breeding birds in the colony. In its most striking form, it appears in relatively small colonies. In large colonies formed from a large number of small ones, this feature is often veiled due to differences in the timing of their formation. As a result, synchronization of the general breeding cycle is allocated only for individual, relatively isolated in space from the main colony of its structural units – subcolonies [4, 7, 9, 15]. That is why, a special study of breeding synchronization was carried out on a few species and is still a poorly studied phenomenon of bird colony. A detailed study of it is constrained by the lack of clear criteria to isolate and evaluate the synchronization of reproduction in bird colonies. In this regard, we have undertaken special works on its study. The results of these studies are presented in this paper.

Work area, material and methodology

Work performed in the Selenga river delta (Lake Baikal) (1972-1985), described in detail in several publications [2, 5, 9-10], characterized by very high productivity and relatively small size (about 1120 km^2). Almost all species of gulls, with the exception of the white-winged tern, *Chlidonias leucopterus*, use only about 600 km^2 of its total area for nesting [5]. These wetland ecosystems are the best in the Baikal region, which allows us to collect here the massive materials needed to solve these problems. They are distinguished by mountain-floodplain water regimes, characterized by short-term, but high spring floods and several summer rises in water levels (from 2 to 7), caused by intense melting of snowfields in the mountains, prolonged rainfalls and heavy rains [5]. On large lacustrine systems, a significant role in the survival of bird clutches can be played by overtaking phenomena (Selenga river delta) [10]. Another limiting factor is the predation of birds and mammals. In addition, haying, grazing and the presence of shepherd dogs, spring burning of vegetation, plowing and high recreational loadings have a great influence on birds. Certain losses are also caused by interpopulation factors (abandoned clutches, unfertilized eggs, eggs with dead embryos, etc.) [9-10].

During the work, we collected materials on synchronization of reproduction in 269 colonies of 8 species of gull birds. All nests in control colonies were labeled with numbered pegs. The eggs were marked with indelible paint in strips or Roman numerals corresponding to the order of their laying, at the sharp end. The nests were monitored after 2 days and, as an exception, during periods of inclement weather, after 3-4 days, up to a specific final state: masonry death for various reasons or hatching and rearing of chicks. The onset of clutch formation (the timing of the ap-

pearance of the first egg in the nests) was determined based on direct observations and the flotation method [8, 10-12]. This made it possible to fairly accurately restore the course dreeding of any species. The periods of mass nesting of birds were distinguished on the basis of the graphic method [3, 10]. Material analysis was performed using standard statistical approaches. When assessing the shape of the distribution of the curves characterizing the course of breeding birds, we used the asymmetry coefficients (A) and kurtosis (E). The normality of the clutch distributions on the timing of formation was established on the basis of the Kolmogorov-Smirnov criterion of agreement [1].

Results

Long-term work and analysis of the collected materials show that the dynamics of egglaying in the colonies is well different from its course in dense groups of non-colonial bird species. In colonial birds, a positive excess is well pronounced - the seasonal course of breeding has a peaked distribution. The excess is very well expressed in small colonies, characterized by a very high synchronization of reproduction - the majority of birds begin to lay eggs in 2-3 and rarely 4 days [7, 9-10]. However, the reliability of this indicator, in such cases is very low. The specificity of this parameter is that in order to obtain reliable differences from the normal or other types of distributions, it is necessary to use very large samples (n = 100 or more) [1]. In this case, it must be borne in mind that even a small colony is an independent reproductive unit and, therefore, an aggregate that allows for separate processing and evaluation of its parameters.

The forms of the egg-laying curves for all species of gull birds are extremely diverse, especially in small colonies. However, there is a general tendency toward the pre-property formation of colonies with a positive excess, especially as their size increases. However, positive asymmetry increases in the same direction. The reason for this is the large loss of clutches from various environmental factors and the appearance of a significant number of repeated (compensation) clutches. As a result, the end of egglaying is shifted to a later date, which stretches, sometimes very strongly, the right edge of the distribution. The frequency of manifestation of a positive excess is markedly reduced only in cases where well-defined asymmetry appears in individual colonies. But even in such situations, both tendencies are often manifested — an acute peak distribution (positive excess) and, mainly, positive (left-side) asymmetry (Table 1).

Table 1

The ratio of the distribution patterns of the laying process of various species of gull birds

Species	The number colonies	Distribution form, in %				
		Asymmetry		Excess		Asimmetry+ Excess
		positive	negative	positive	negative	
1	2	3	4	5	6	7
Little Gull (*Larus minutus)*	41	2.4	-	82.9	-	2.4
Black-headed Gull (*L. ridibundus*)	26	34.6	-	61.5	3.9	23.1
Mongolian Gull (*L. mongolus*)	42	-	-	71.4	2.4	-
Common Gull (*L. canus)*	41	-	-	75.6	-	-
White-winged Tern (*Chlidonias leucopterus*)	34	20.6	17.7	47.1	17.7	23.5
Whiskered Tern (*Ch. hybrida*)	18	-	-	77.8	-	-
Common Tern (*Sterna hirundo*)	28	-	-	71.4	7.1	-
Caspian Tern (*Hydroprogne caspia*)	39	2.6	5.1	53.9	12.8	5.1

Note: only reliable values of indicators of the distribution form of the laying course are used.

To compare the phenology of bird nesting in colonies, it is necessary to have clear criteria for identifying the period of their mass reproduction. Visual highlighting of this period according to the charts of the course of breeding birds is often a difficult task. The solution to the problem is to use a formalized graphical method [3]. It works well even in difficult situations of multimodal distribution, covering the entire breeding period of a large colony.

In such situations, the breeding season includes several peaks of different sizes, which greatly complicates the identification of the period of mass breeding of birds. The distribution of clutches in the colony by the timing of formation is quite complicated, which requires the use of nonparametric statistical approaches. The calculation can be carried out us-

ing Spearman's rank correlation coefficient [1]. After the special analysis, 5 factors were taken as the main parameters of the colony (Table 2).

Table 2

Correlation of the main indicators of gull bird colonies due to synchronization of reproduction

Parametrs	Species							
	Common Gull	Mongol Gull	Black-headed Gull	Little Gull	Common Tern	Caspian Tern	White-winged Tern	Whiskered Tern
1	2	3	4	5	6	7	8	9
The size of the colony - total duration of the egg-laying	0.9***	0.9***	0.8***	0.9***	0.6***	0.9***	0.7***	0.8***
The size of the colony - duration of the mass egg-laying	0.8***	0.9***	0.8***	0.8***	0.8***	0.8***	0.8***	0.9***
The size of the colony - number of birds participating in the mass egg-laying	-0.11	-0.5**	-0.14	-0.29	-0.28	-0.33*	-0.8**	-0.6*
Duration of mass egg laying - number of birds breeding at that time	-0.2	-0.22	-0.4*	-0.26	-0.24	-0.19	-0.6**	-0.6***

*Note: In this work, the Spearman rank correlation coefficient was used. Reliability of indicators related to synchronization of bird breeding - * P <0.05; ** P <0.01; *** P <0.001.*

The level of connection of all these parameters of the colony varied greatly, but several features that are distinguished by a sufficiently large and reliable relationship are well to split off (Table 2). The highest correlation was observed for the size of the colony and the duration of both total and mass egg laying. The relationship between the size of the colony and the share of birds participating in the mass egg laying is reliable only in four species. The same group of birds is characterized by a high correlation between the duration of the mass egg laying and the share of birds that formed the clutches at this time. The highest correlation between them is characteristic of swamp terns, which develop the most unstable

habitats. In both cases, this relationship is negative, i.e. with an increase in the size of the colony, the share of birds that formed clutches during the period of mass reproduction decreases (Table 2).

Since the relationship between the size of the colony and the share of nests formed during the period of mass reproduction is reliable only in species with a large number of small colonies, it makes sense to identify the ratio of colonies of different sizes in all the species of gull birds that we studied. This analysis showed that the share of small colonies in almost all species, with the exception of Black-headed gulls, is clearly higher than for larger colonies. Only in the Black-headed gull it is 30.8%, and in other species it is 50.0% or more (Table 3). In order to exclude the influence of random sampling, we compared the data obtained with the materials of many years of accounting work (1973-2000). They were carried out in different conditions years and covered the entire Selenga river delta. As a result of these studies, more than 1300 colonies were examined [5, 9]. The spatial structure of gull birds and the size of their colonies in this region strongly depend on fluctuations in water level [4–5, 9]; therefore, we compared the shallowest years with seasons characterized by a very high water level close to severe floods.

Table 3

The share of colonies of different sizes (in %) in gulls and terns of the Selenga river delta (1977-1982)

Species	Thenumber colonies	The number of nests in the colony				
		up to 30	31-50	51-70	71-100	101 and more
1		2	3	4	5	6
Little Gull	41	51.2	22.0	14.6	7.3	4.9
Black-headed Gull	26	30.8	7.7	23.1	11.5	26.9
Mongolian Gull	42	69.0	4.8	11.9	9.5	4.8
Common Gull	41	58.5	14.6	17.1	4.9	4.9
White-winged Tern	34	50.0	17.6	11.8	8.8	11.8
Whiskered Tern	18	77.8	11.1	11.1	-	-
Common Tern	28	78.5	17.9	-	3.6	-
Caspian Tern	39	64.0	18.0	7.7	2.6	7.7

The comparison results confirmed the sharp predominance of small colonies in all species of gull birds, with the exception of the Black-headed Gull. This species has a large number of major colonies (more than 100

pairs) - 41.5%. In addition, the average size of the colonies in different species was not large - from 30 to 50 nests. The only exceptions were the Black-headed Gull (the average colony size was 117 nests) and Caspian Tern (74 nests) [5, 10]. However, subsequently, as the water level fell and a large number of sandy islands (carga) appeared, the number of small colonies in the Caspian Tern increased sharply, while in the Black-Headed Gull it decreased. The probable reason for this is the very wide range of food of the latter species and its use for nesting of the most productive area of the Selenga delta [5, 7, 9]. At the same time, an increased and reliable correlation of the number of clutches formed during the period of mass nesting with the colony size found in swamp terns, Caspian Tern and Mongolian gulls (Table 3), indicates the influence of some additional factor. This is emphasized by the fact that small colonies clearly prevail (about 50.0%) in Selenga river delta in all species of gull birds [5], but a reliable level of communication is characteristic only for some species. Obviously, this is due to the fact that they use the most unstable habitats for nesting, or their share in them is very high.

The analysis of the collected materials shows that the level of reproduction synchronization differs among different species of gull birds, which is very well indicated by a positive excess (Table 2). In this case, it is necessary to clarify what is meant by the level of reproduction synchronization. Synchronization in biology in general is the organization of biorhythms, i.e. their coordination in time and space, as well as the involvement in any process carried out in a relatively short time of a large number of individuals. In our case, we are talking about the process of reproduction and since the mass period stands out - it is at this time that the maximum possible number of birds should take part in it. This is observed very often, but not always and not in all species, as indicated by a special analysis of bird breeding [6, 9-10]. However, in colonial bird species, the synchronization of breeding rhythms in the colony is one of its main features [4, 6-7, 9, 13-14, 16].

The collected materials indicate that this phenomenon in all species of birds, both colonial and non-colonial (dense aggregations) requires special study. However, there are still no criteria to compare the level of synchronization of reproduction of different species. It is quite obvious that there is not a single individual attribute that could be used for this purpose. In such cases, it is necessary to develop special indices that combine the effects of several parameters. In its most general form, a special biological index is a relative indicator. It characterizes the change in the magnitude of a certain phenomenon in time and space. Unlike ordinary relative val-

ues, which are calculated according to individual characteristics, indices can include a system of attributes, i.e. the objects of index analysis are complex processes. Therefore, such indices are general indicators. It is quite obvious that it is desirable to use features that are weakly correlated with each other, but that have a rather strong influence on the feature being studied. In our case, the last two groups of factors considered are best suited for this role (Table 2). With an increase in the share of birds that formed clutches during the period of mass reproduction and a decrease in time of this period (mass egg laying), the synchronization of reproduction of birds in the colony increases. An ideal relationship between the level of synchronization and these factors - the entire colony is formed in one day. The case is quite rare, but constantly found in small colonies of all species of gull birds.

Since the index is always a relative indicator, and almost all of the signs examined by us are related to the size of the colony (Table 3), it should be included in the developed index. As a result of our work, this index has the following form:

$$I_{sr} = \sqrt[2]{(n/l)/N}, \quad 0 \le I_{sr} \le 1,$$

where: n is the number of clutches formed during the period of mass breeding of birds, in pcs. (by the date of laying the first egg in the nest); l - the duration of the period of mass egg laying, in days (accurate to tenths); N is the size of the colony (number of nests or pairs); *Isr* is the synchronization index. The essence of this indicator can be formulated as follows: the breeding synchronization index, as a relative indicator, indicates how many nests are formed on average during one day of mass egg laying, depending on its duration and the size of a concrete colony. Extraction of the square root increases the obtained value, sometimes very small (in very large colonies), which greatly facilitates the use of this index and improves its perception. The maximum estimate of the level of synchronization of breeding birds in the colony tends to 1.0 and sometimes reaches this value. The minimum value of this indicator tends to 0, but is unlikely to reach it. In any case, our minimum estimates of the level of synchronization of the entire breeding season of birds in a very large colony (about 5.0 thousand nests) did not fall below 0.05.

Comparison of the results of his calculation with actual observational data shows that he clearly responds to changes in colony parameters used to determine the level of egg laying synchronization and its other reproductive indicators. According to the results of statistical analysis, its high relationship with the main reproductive parameters of the colonies

was established, which allows us to consider the synchronization index as one of the most important and promising relative indicators [10]. Its use allows us to discover new, still very poorly studied relationships of various parameters of the reproductive processes of colonial bird species with environmental factors.

Discussion

Colonial species of gull birds is a specific group that has a set of adaptations that make it possible to master an extremely wide range of wetlands and marine habitats. They nest both in swampy meadows, coasts and rafts of inland water bodies, as well as on sea sand spits and islands, as well as steep cliffs and rocks, forming huge bird racket here. All areas of the colonial nesting of these birds, as a rule, are confined to places located directly among the clusters of food objects or within their reach during feeding of the chicks. In the latter case, they are often characterized by significant instability in colony placement, which often determines the high dynamics of the spatial structure of birds not only in different breeding seasons, but also within the same breeding cycle [4–7, 9–10].

It is well known that colonial birds differ from non-colonial species in the formation of group clusters of nests with different levels of nesting density (obligate colonial and elective colonial species) [9]. Synchronization of breeding birds is also one of the main signs of the colony. However, unlike nesting density, it is present in clusters of only truly colonial bird species. At the same time, dense nesting of birds, which reaches the level of elective colonial species, and sometimes even higher, occurs in almost all species, up to breeding exclusively in single pairs [6, 9]. Preliminary analyzes of available materials indicate that nesting clusters of different density levels can form almost all species of birds in areas of exceptional food abundance or in places with an acute shortage of sites suitable for nesting [4-7, 9-10]. In this regard, the phenomenon of dense nesting of birds in large clusters of any type needs a more thorough and detailed study.

The breeding synchronization index, as an integral feature of colonial nesting, can serve as an additional criterion for the separation of colonial and non-colonial bird species. Earlier, we proposed to isolate simple colonies with a high level of reproduction synchronization and complex colonies formed by combining several simple colonies, which often get the status of subcolonies after this [4]. Since the breeding periods in them may coincide or be very close, it is very difficult, and in some cases impossible, to isolate the synchronization of its individual subcolonies if they do not have a spatial boundary. Further study of the colonial species of gull birds

confirmed the correctness of our approach [7]. However, the analysis of the spatial structure of complex colonies, as a rule, characterized by large size, is extremely difficult and requires constant (almost daily) observations, combined with the mapping of new nests. Therefore, such research is rarely done, although such work is undoubtedly very promising.

In this regard, we consider it necessary to indicate that this index, along with an assessment of the level of synchronization of reproduction in nesting clusters of all bird species, can also be successfully used to assess the nesting conditions of non-colonial bird species. Depending on the conditions of a particular year, the breeding season of birds can be either very long or very compact. Verbal descriptions are difficult to use in the statistical evaluation of such cases - they require at least a rough point estimate of this parameter. The breeding synchronization index very well reflects the specifics of a particular breeding season of any bird species. Therefore, it can be successfully used for these purposes. In this case, it is also suitable for assessing the degree of synchronization of bird breeding throughout the entire nesting season - from single-breeding, but sometimes forming dense nesting clusters, to elective colonial and obligate-colonial bird species.

In the most striking form, at least on modern materials, synchronization of reproduction is manifested in colonies of gull birds mastering inland water bodies with an unstable hydrological regime (mountain-floodplain water regime). The very high dynamism of the spatial structure is, first of all, characteristic of colonial birds that develop such reservoirs (marsh terns genus of the *Chlidonias*). It is extremely interesting that adaptive traits characteristic of species that develop very variable habitats are preserved in birds nesting under stable conditions, i.e. the range of habitats used by most species is very wide. Adaptations used in extreme conditions appear in a particular region as the influence of limiting factors increases. This allows colonial birds to use habitats very different in terms of conditions and to develop different regions - from deserts and steppes to coastal tundra and ocean islands.

Conclusion

On the basis of many years of research (1972-2018) on the ecology, breeding and behavior of colonial species of gull birds, another factor was revealed that is characteristic only of colonial bird species - high synchronization of reproduction. The latter refers to a very high egg laying intensity, when in colonies up to 30-50 nests, the majority of birds begin nesting in 2-3 and sometimes 4 days. In large colonies, the level of intensity of reproduction synchronization decreases. The main reason for this is

their formation from several small “simple” colonies, which sharply differ in terms of nesting.

In the extreme case, the duration of breeding birds in a large colony can take almost the entire nesting season. Colonies of different sizes differ well in the duration of the period of mass breeding and in the share of birds that started nesting at this time. The degree of correlation of these characters is relatively small, but they determine the level of synchronization of reproduction of birds in the colony. With an increase in the proportion of birds that formed clutches during the period of mass reproduction and a decrease in time of this period (mass egg laying), the synchronization of reproduction of birds in the colony increases.

The breeding synchronization index, as a relative indicator, indicates how many nests on average are formed per day of mass egg laying, depending on its duration and the size of a particular colony. Extraction of the square root from this value increases the obtained value, sometimes very small (in very large colonies), which greatly facilitates the use of the index. Reproduction synchronization index, as an integral sign of colonial nesting, can serve as the main criterion for the separation of colonial and non-colonial bird species.

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STUDYING THE REGULARITIES OF THE CATALYTIC GAS-PHASE OXIDATION PROCESS OF METHANOL TO FORMIC ACID[i]

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The article explains the results of the development of a new method for producing formic acid during the catalytic oxidation of methanol in the vapor phase. For this, a multidimensional regression equation created, the coefficients of the equation were calculated, and their significance was determined. The adequacy of the regression equation verified and a more sensitive parameter identified. The problems of correlation of parameters of equations investigated. The statistical significance of the equation confirmed using the Fisher method.

Keywords: methanol, formic acid, catalytic oxidation, mathematical model, Fisher test

An analysis of patent and technical literature containing information about the named process indicates the absence of an effective and cost-

effective industrial process technology. Currently, there are two main methods for the industrial production of formic acid: hydrolysis of methyl formiate and hydrolysis of formamide. The disadvantage of these liquid-phase processes is multi-stage, capital and energy consumption, the formation of a number of by-products, pollution of the atmosphere and wastewater. In this regard, the efforts of researchers working in this field are aimed at developing effective high-activity catalysts, interfacing technological stages, and creating cost-effective technology for the production of formic acid [1-2].

As a result of systematic laboratory studies, an effective Pd^{+2} was developed containing a modified zeolite catalyst, using which experiments were carried out to obtain formic acid by gas-phase oxidation of methanol. This process is characterized by high yields of the target product with high selectivity, as well as the simplicity of technological design, which creates a good prospect for its implementation in the industry. The following are experimental data from a laboratory setup. The following technological parameters were adopted as controlled parameters, the values of which vary in predetermined intervals: $85 \le T \le 125^0 C,\ 900 \le V \le 3200 h^{-1}$, $0{,}13 \le P_{0_2} \le 0{,}6\, atm,\ 0{,}09 \le P_{CH_3OH} \le 0{,}43\, atm$, where T - temperature of the reaction medium, V - space velocity, P_{0_2} and P_{CH_3OH} - partial pressure of oxygen and methanol, respectively.

The experimental results shown in table 1.

Table 1.

№	T	P_{CH_3OH}	P_{0_2}	V	Y, Yield formic acid
1	70	0.07	0.1	850	23,5
2	70	0.07	0.1	3250	20
3	70	0.07	0.7	850	23,8
4	70	0.07	0.7	3250	19,3
5	70	0.47	0.1	850	24,5
6	70	0.47	0.1	3250	20
7	70	0.47	0.7	850	28
8	70	0.47	0.7	3250	23
9	130	0.07	0.1	850	29,5
10	130	0.07	0.1	3250	23
11	130	0.07	0.7	850	31,5
12	130	0.07	0.7	3250	26,8
13	130	0.47	0.1	850	32,6

14	130	0.47	0.1	3250	26,3
15	130	0.47	0.7	850	36
16	130	0.47	0.7	3250	30,5

Using the well-known methods [3], the regression equations for this process were compiled.

The multiple regression equation is presented as:

$Y = f(\mathrm{b}, X) + \mathrm{e}$, where $X = X(X_1, X_2, ..., X_m)$ - vector of independent variables; β - the vector of parameters (to be determined); ε - the deviation; Y - a dependent variable. The theoretical linear equation of multiple regression has the form:

$Y = \mathrm{b}_0 + \mathrm{b}_1 X_1 + \mathrm{b}_2 X_2 + ... + \mathrm{b}_m X_m + \mathrm{e}$, β_0 - the free term that determines the value of Y, in the case when all the explanatory variables Xj are equal to 0.

The empirical equation of multiple regression of the process of catalytic gas-phase oxidation of methanol can be represented as:

$Y = b_0 + b_1 X_1 + b_2 X_2 + ... + b_m X_m + e$, here b_0, b_1, ..., b_m - estimating the theoretical values of β_0, β_1, β_2, ..., β_m regression coefficients (empirical coefficients of the regression equation); e - the estimate of the deviation ε.

To estimate the parameters of the multiple regression equation, the least squares method (least squares) was used. According to this method, the vector *s* is obtained from the expression:

$$s = (X^T X)^{-1} X^T Y.$$

The X^T matrix has the form:

1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
70	70	70	70	70	70	70	70	130	130	130	130	130	130	130	130
0.07	0.07	0.07	0.07	0.47	0.47	0.47	0.47	0.07	0.07	0.07	0.07	0.47	0.47	0.47	0.47
0.1	0.1	0.7	0.7	0.1	0.1	0.7	0.7	0.1	0.1	0.7	0.7	0.1	0.1	0.7	0.7
850	3250	850	3250	850	3250	850	3250	850	3250	850	3250	850	3250	850	3250

Multiply Matrices, $(X^T X)$

16	1600	4.32	6.4	32800
1600	174400	432	640	3280000
4.32	432	1.8064	1.728	8856
6.4	640	1.728	4	13120
32800	3280000	8856	13120	90280000

In the matrix, $(X^T X)$, the number 16 lying at the intersection of the 1st row and the 1st column is obtained as the sum of the products of the elements of the 1st row of the X^T matrix and the 1st column of the X matrix.

We find the inverse matrix $(X^TX)^{-1}$ and the vector of estimates of the regression coefficients $Y(X) = (X^TX)^{-1}X^TY$

1.1644	-0.00694	-0.4219	-0.2778	-8.9E-5
0.00694	6.9E-5	0	0	0
-0.4219	0	1.5625	0	0
-0.2778	0	0	0.6944	0
-8.9E-5	0	0	0	0

15.5893
0.1127
7.3438
4.0625
-0.00211

The resulting regression equation has the form

$$Y = 15.5893 + 0.1127X_1 + 7.3438X_2 + 4.0625X_3 - 0.00211X_4$$

Next, we conducted a statistical analysis of the obtained regression equation: checking the significance of the equation and its coefficients, studying the absolute and relative approximation errors.

For an unbiased dispersion estimate, the following calculations performed:

Table 2.

Y	$Y(x)$	$e = Y - Y(x)$	e^2	$(Y - Ycp)^2$	|ε : Y|
23.5	22.606	0.894	0.799	6.989	0.038
20	17.544	2.456	6.033	37.746	0.123
23.8	25.044	-1.244	1.547	5.493	0.0523
19.3	19.981	-0.681	0.464	46.837	0.0353
24.5	25.544	-1.044	1.089	2.702	0.0426
20	20.481	-0.481	0.232	37.746	0.0241
28	27.981	0.0187	0.000352	3.446	0.00067
23	22.919	0.0812	0.0066	9.883	0.00353
29.5	29.369	0.131	0.0172	11.264	0.00445
23	24.306	-1.306	1.706	9.883	0.0568
31.5	31.806	-0.306	0.0938	28.689	0.00972
26.8	26.744	0.0562	0.00316	0.431	0.0021
32.6	32.306	0.294	0.0863	41.683	0.00901
26.3	27.244	-0.944	0.891	0.0244	0.0359
36	34.744	1.256	1.578	97.146	0.0349
30.5	29.681	0.819	0.67	18.977	0.0268
			15.217	358.939	0.499

Here ε=Y-Y(x)=Y-X*s unbiased error or absolute approximation error.

The value of the average approximation error is

$$A = \frac{\sum |\varepsilon Y|}{n} \times 100\% = \frac{0.499}{16} \times 100\% = 3.12\%.$$

And the dispersion estimate is equal to: $s_e^2=(Y-Y(X))^T(Y-Y(X))=15.217$

The unbiased variance estimate is: $s^2 = \frac{1}{n-m-1} \times s_e^2 = \frac{1}{16-4-1} \times 15.217 = 1.3834.$

Estimation of standard deviation (standard error for estimating Y):

$$S = \sqrt{S^2} = \sqrt{1.3834} = 1.176.$$

The multiple correlation coefficient is:

$$R = \sqrt{1 - \frac{0.0424}{1}} = 0.9786.$$

This means that the connection between the trait *Y* and the factors X_i is strong.

The significance of the parameters of the multiple regression equation also checked. The statistical significance of the regression coefficients b_0, b_1, b_2, b_3, b_4 is confirmed.

Next, we calculated the pair correlation coefficients by the formula:

$$r_{xy} = \frac{\overline{xy} - \overline{x}\,\overline{y}}{s(x)s(y)}$$

$$r_{yx_1} = \frac{2715.813 - 100 \times 26.144}{30 \times 4.736} = 0.714,\ r_{yx_2} = 0.31,\ r_{yx_3} = 0.257,\ r_{yx_4} = -0.534.$$

$$r_{x_1x_2} = 0,\ r_{x_1x_3} = 0,\ r_{x_1x_4} = 0,\ r_{x_2x_3} = 0,\ r_{x_2x_4} = 0,\ r_{x_3x_4} = 0.$$

To assess the significance of the regression equation, the Fisher F-test used.

The critical value of the F-criterion (F_{cr}) was found from the Fisher-Snedecor distribution table with a significance level - 0.05 and two numbers of degrees of freedom $k_1 = m$ and $k_2 = n\text{-}m\text{-}1$.

Fisher criterion calculated by the formula

$$R^2 = 1 - \frac{s_e^2}{\sum (y_i - \overline{y})^2} = 1 - \frac{15.217}{358.94} = 0.9576.$$

$$F = \frac{R^2}{1-R^2} \times \frac{n-m-1}{m} = \frac{0.9576}{1-0.9576} \times \frac{16-4-1}{4} = 62.118.$$

The table value for degrees of freedom

$k_1 = 4$ and $k_2 = n\text{-}m\text{-}1 = 16 - 4 - 1 = 11$, F_{kp} (4; 11) = 3.36. Since the actual value is $F > F_{kp}$, the determination coefficient is statistically significant and the regression equation is statistically reliable (i.e., the bi coefficients are jointly significant).

Conclusions:

As a result of the calculations, the multiple regression equation was obtained for the process of catalytic gas-phase oxidation of methanol into formic acid. A statistical analysis of the obtained regression equation was carried out: checking the significance of the equation and its coefficients, studying the absolute and relative approximation errors. By the maximum coefficient r_{yx_1} =0.714, we conclude that the temperature of the reaction medium has the greatest influence on the yield of formic acid. The statistical significance of the equation verified using the coefficient of determination and the Fisher test. It also established that the model parameters are statistically significant.

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FEATURES OF SELECTIVITY CONTROL OF INORGANIC ION EXCHANGERS

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The ion-exchange properties of tin (IV) phosphate during sorption of alkali metal cations are studied. It was shown that the selectivity series has the form $Cs^+ > Rb^+ > K^+ > Na^+$ and, with an increase in the tin (IV) content during synthesis, the distribution coefficients slightly increase, which is associated with an increase in the amorphous state of the ion exchanger. When using citric and sulfosalicylic acids as modifiers, the selectivity series for transition elements is as follows: $Fe^{3+} > Co^{2+} > Zn^{2+} \geq Cu^{2+} > Ni^{2+}$. For acetic, boric and formic acids: $Cu^{2+} > Fe^{3+} > Zn^{2+} > Co^{2+} > Ni^{2+}$.

A feature of inorganic ion exchangers is their selectivity. These include sorbents based on salts of tetravalent metals (zirconium, titanium, germanium, lead, hafnium, tin), to the synthesis of which is devoted to a large number of works. Recently, attention has been paid to their modification [1-7]. The least studied is tin (IV) phosphate, whose properties can be changed by introducing various modifiers.

Keywords: selectivity, modified phosphates, crystalline phosphates, cations, sorption of phosphates, ion-exchange mechanism, ion-exchangers.

Group IV metal phosphates are promising inorganic sorbents. However, the use of these ion exchangers is hindered by such disadvantages as poor reproducibility of properties from synthesis to synthesis. To improve the reproducibility of ion-exchange properties, increase the exchange capacity and selectivity of inorganic ion exchangers, modifying and applying syntheses are widely used.

The structure and ion-exchange properties of inorganic sorbents, including tin (IV) phosphate, largely depend on the methodological subtleties of their synthesis and modifier.

To control the ion-exchange properties of sorbents, application and modification with additives of inorganic ion exchangers are used. Different classes of inorganic and organic compounds are used as modifiers and applicators.

The authors of [9,10,28] studied the modification of inorganic ion exchangers based on metal (IV) phosphates by metal cations, including in the form of complex compounds, which is carried out by mixing the starting materials during gel structuring, upon contact of metal (IV) phosphate with salt solution. In this case, the introduction of metal cations is aimed at expanding the cavities in order to subsequently facilitate the entry of sorbed metals into the structure of the sorbent, especially those whose dimensions are larger than the cavity size of the unmodified sorbent.

Modification and application can take place by means of interlayer inclusion. During interlayer inclusion, neutral polar molecules are inserted between sheets of a layered insoluble compound, which include ionites based on metal phosphates of group IV of the Periodic system.

In order to study the possibility of controlling the selectivity of inorganic ion exchangers, tin (IV) phosphate samples modified by various classes of compounds were synthesized and studied. The synthesis was carried out by direct precipitation and high temperature boiling. In the synthesis of tin phosphate by high-temperature boiling, phosphoric acid of a concentration of 12 mol/l and a molar ratio of phosphorus: tin of 10 were used. Some deviation in the value of the molar ratio P: Sn in the initial mixture, in particular within the range of P: Sn = (8 ÷ 10) : 1, does not significantly affect the structure and ion exchange properties of the resulting ion exchanger.

A feature of the synthesis is the creation of conditions for the maturation of the sorbent structure. Due to the fact that the ion exchanger is supposed to be used for deep purification of elements with similar properties and for obtaining salts of high purity, only bidistilled water was used to achieve the required acidity when maturing its structure.

Table 1. Synthesis conditions of the modified ion exchanger

№ of sample	Modifier	Synthesis time, h	Ratio Sn:mod-ed, mole
1	-	48	-
2	-	6	-

3	$Na_3[Co(NO_2)_6]$	24	1:0,5
4	$Na_3[Co(NO_2)_6]$	48	1:0,5
5	$Na_3[Co(NO_2)_6]$	72	1:1
6	$Na_3[Co(NO_2)_6]$	72	1:0,5
7	$Na_3[Co(NO_2)_6]$	72	1:0,25
8	Cu^{2+}	24	1:10
9	Cu^{2+}	48	1:10
10	Cr^{2+}	48	1:10
11	Cr^{3+}	48	1:10

The structural features of unmodified and modified tin (IV) phosphate samples were studied by X-ray diffraction, infrared spectroscopy, X-ray fluorescence analysis, and electron microscopy.

X-ray phase analysis of the synthesized sorbents was performed on a "Dron-3" device using the powder method using CoKa radiation. Interplanar distances were determined from the values of angles 0, corresponding to the maxima of diffraction peaks in the diffraction pattern. IR spectra were recorded on a "Perkm-Elmer" spectrometer and on an IFS25 spectrometer in the region of 4000-400 cm. Samples were prepared by trituration in liquid paraffin. Derivatograms of the samples were obtained on a Q 1500D derivatograph of the F. Paulik – I. Paulik – L. Erdey system of the "MOM" company (Hungary).

It was established that the samples obtained by direct deposition (synthesis time is 6 hours) are X-ray amorphous, and the samples obtained by high-temperature boiling are crystalline.

A comparison of the IR spectra of unmodified (sample 1) tin (IV) phosphate and tin (IV) phosphate modified with sodium hexanitrocobaltate (sample 3) is shown in Fig. 1, and for samples 4,5,7 in Fig. 2. In the IR spectra of unmodified tin phosphate $Sn(HPO_4)_2 \cdot H_2O$ (sample 1) bands 510 and 615 cm^{-1}, are observed, related to the deformation vibrations of the distorted tetrahedron of the $[PO_4]^{3-}$, anion, as well as bands caused by symmetric (950, 965 cm^{-1}) and antisymmetric (1030.1080.1100cm^{-1}) stretching vibrations of the distorted tetrahedron of the $[PO_4]^{3-}$. anion. The

splitting of the bands is caused by the violation of the symmetry of the ideal tetrahedron of the $[PO_4]^{3-}$ anion in the crystal under the influence of the surrounding cations.

The stretching and bending vibrations of the hydroxyl group bound to phosphorus [ν (OH) and δ (POH)] are manifested in the spectrum by a wide band in the region of 2500-3300 cm^{-1} and bands of 1240, 1300 cm^{-1}, respectively. The bands 3480, 3560 cm^{-1} belong to the symmetric and antisymmetric vibrations of water molecules, coordinated with respect to the tin cation, and their deformation vibrations lead to the appearance of the band 1625 cm^{-1} When sodium hexanitrocobaltate $Na_3[CO(NO_2)_6]$, Cu(II) acetates, and chromium (II, III) are introduced into the tin phosphate crystal, a significant violation of the crystal structure occurs, and the environment of the anion changes. This leads to a broadening of the IR bands in the region of 900–1300 cm^{-1} and they merge into one wide band with a maximum at 1050 cm^{-1}, and its half-width increases by 1.5 times. The bands related to stretching vibrations of hydroxyl groups associated with phosphorus and water molecules also merge into one wide band in the region of 2500 - 3700 cm^{-1}. The IR spectra of the modified crystalline tin (IV) phosphates turn out to be close to the IR spectra of amorphous tin (IV) phosphate samples.

In addition, a band at 675 cm^{-1}, ppears in the spectra of modified tin (IV) phosphates, caused by bending vibrations of the $[NO_2]^-$, anion coordinated to the Co^{3+} atom.

According to IR spectroscopy, the largest structural change occurs in samples 3.5, and for samples 4.7 these changes are weak.

The exchange of cations on crystalline phosphates of Group IV metals is due to a complex structure. A feature is that the layers are arranged in such a way that cavities are formed. The holes connecting the cavities allow the spherical cation to enter the cavity. Sorption on amorphous ion exchangers is characterized by good kinetic properties due to the distribution of ion exchange groups over the entire volume of granules and the presence of zeolite cavities of various sizes. Confirmation of the volumetric nature of sorption is a direct proportionality between the amount of sorbed substance and the mass of the sorbent. The size of the cation has a significant effect on the course of the exchange process.

At the surface of the crystal, the hydrated cation gives up most of its water and diffuses into the cavity either in partially hydrated or fully dehydrated form. With an increase in pH, the exchange of large cations with a radius exceeding the pore diameter is possible, since the layers move apart. Cations located in cavities are able to hydrate again if there

is enough space in the cavities to accommodate water or if the hydration energy of cations is large enough to overcome the bonding forces of the layers or even push them to a new interlayer distance. Cations having a diameter exceeding the size of the holes and cavities are not capable of exchange even in a completely dehydrated state.

Sorption on metal phosphates of group IV can proceed by ion-exchange and non-ion-exchange mechanisms. In this case, ion exchange, which is the basis of the sorption process, consists in the replacement of protons of acidic phosphate groups with cations of sorbed elements.

With the introduction of various modifying additives, a different change in the structure of the sorbent occurs, which allows one to control the selectivity and exchange capacity of the sorbents. It is likely that this fact is ensured not only by defects in the structure of the obtained samples, but also by the possible “fixing” of the introduced modifying additive on the surface of the sample and its penetration into the inside of the sorbent. Therefore, the exchange capacity of the modified samples increases due to the possible formation of reaction centers in the form of additional functional groups on the surface of the ion exchanger and the appearance of a surface charge due to the exchange of tin (IV) hydrogen phosphate ions and the modifier. With an increase in the synthesis time of samples by high-temperature boiling, the modifier penetrates the sorbent, disrupting its structure, which becomes similar to amorphous ion exchangers, and also changes pore sizes and interplanar spacings between layers, making it possible to sorb large cations and separate elements close in properties.

When considering the ion-exchange mechanism on metal phosphates of a crystalline structure, special attention is paid to the crystal chemical aspects.

The nonion exchange mechanism can be realized in the form of the formation of a new phase of sparingly soluble compounds, isomorphic substitution of ions of the ion exchanger matrix, secondary sorption of coions, and other processes of complex physicochemical interactions in sorption systems. To ensure the diffusion of cations in α-$Me(HPO_4)_2 \cdot nH_2O$ their passage through the face of the coordination polyhedron formed by oxygen atoms with a radius of 1, 3A is necessary.

The differences between the ion-exchange properties of tin, zirconium, and titanium α-phosphates are associated mainly with unit cell sizes. The smaller these sizes, the smaller the size of the holes connecting the cavities, and the higher the steric obstacles for the passage of counterions from one cavity to another. A common method for studying the ion-exchange properties of group IV metal phosphates is their potentiometric

titration with solutions of the corresponding bases. The shape of the potentiometric titration curves is largely determined by the variety of functional groups, the crystallinity of the sorbents and the features of the absorbed ion. For phosphates with a high degree of crystallinity, the plateau has a zero slope, and for low-crystalline phosphates it has a small positive slope, since they are less ordered in the arrangement of phosphate groups, which affects the structure of the layers and the heterogeneity of exchange sites.

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THEORY AND PRACTICE OF ENERGY SAVING OF LOW-TEMPERATURE PROCESSES

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Promising in chemical technology is the liquefaction of low-temperature gases and gas mixtures and, associated with these processes, low-temperature distillation and fractional condensation. Energy efficiency is determined by the conversion coefficient ε_x equal to the ratio of energy flows characterizing the beneficial effect and costs. For refrigeration machines that consume energy in the form of work, the conversion coefficient is usually called the cooling coefficient ε_x.

Keywords: refrigeration capacity, liquefaction work, low temperature condensation.

The variety of chemical industries in which practically all known physical and chemical processes are carried out using substances with a wide variety of properties gives rise to many specific technological problems that can be solved using cold. Typical applications of cold in chemical technology should be highlighted, in particular, liquefaction of low-temperature gases and gas mixtures and, associated with these processes, low-temperature distillation and fractional condensation. Features of energy supply of low-temperature processes imply a combination of technological and energy subsystems. The combined use of internal energy resources (IER) of chemical production for the implementation of energy-intensive low-temperature processes can improve the operational characteristics of equipment and increase the degree of thermodynamic perfection of the processes of energy and substance conversion.

We present the calculation and analysis of the minimum work of separation of an ideal gas mixture into pure components.

The mixture to be separated is ideal. $\sum \tilde{y}_{jcm}=1 \frac{\text{kmol } j\ c-nt}{\text{kmol mix}}$. In our case, we mean physical separation methods i.e. without updating the chemical composition of the system. As an example, rectification, extraction, membrane separation methods, filtration can be considered.

The principle of non-decreasing entropy $dS \geq \frac{\delta Q}{T}$.

Calculation and analysis of the minimum work of separation of an ideal gas mixture into pure components.

Suppose a model of an ideal energy converter:
$T_{out} = T_{av}$; $P_{out} = P_{av}$ – isobaric-isothermal process

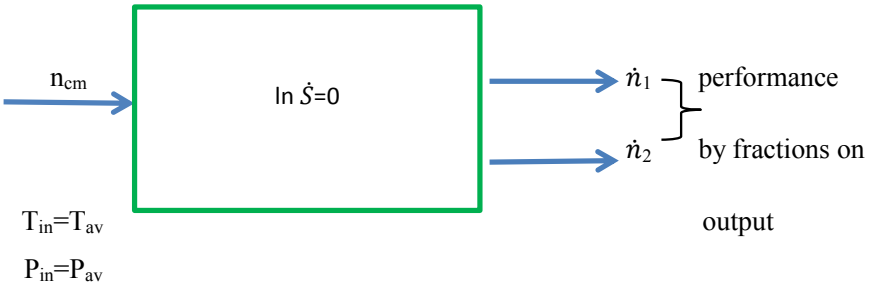

Fig. 1. Model of an ideal energy converter

The conditions of chemical equilibrium imply that the system has already reached thermodynamic equilibrium with the environment ($T_{in}=T_{environment}$; $P_{in}=P_{environment}$)

Next, we write the equation of balance of entropy: $dS=d_{av}S+d_{in}S$.

The entropy of the system changes due to external processes of energy exchange with the environment. When actual processes occur, accompanied by the presence of obstructive forces, an internal source of entropy arises inside the isolated system.

In the energy converter considered in our example, there is none. ($d_{in}S=0$, the entropy production inside the process is 0, i.e. there are no forces that impede the process).

$\dot{n}_{cm}= \sum_{j=1}^{n} n_i$, since the law of conservation of mass is observed:

On output $\sum_{j=1}^{mn} \tilde{y}_{cm}=1 \frac{\text{kmol } j\ c-nt}{\text{kmol } i-\text{th fraction}}$

The task is to determine $\dot{W}_{min}$kw

We substitute the equation of energy balance (the law of conservation of energy for our system)

dQ=dh+dW, where the enthalpy is equal to the sum of the Gibbs en-

ergy and the ballast part associated with entropy.

h=G+TS

We do not take into account the change in the kinetic and potential energy in the system.

$\dot{n}_{cm}$*h_{cm} - $\sum_{i=1}^{n} \dot{n}_{cm}$ + $\dot{Q}_{cm}$ - $\dot{W}_{min}$ = 0

Let us give the 2nd equation. Entropy balance equation.

$\dot{n}_{cm}$*S_{cm} - $\sum_{i=1}^{n} \dot{n}_{cm}$ *S_i + S_{av} + S = 0

$\int \sum_{i=1}^{n} \tilde{\Theta} = 1$

Divide each term of both equations by $\dot{n}_{cm}$ ($\frac{\text{kmol mix}}{s}$)

h_{mix} - $\sum_{i=1}^{n} \theta_i h_i$ + $T_{av}\tilde{S}_{av}$ - $\tilde{W}_{min}$(T,P) = 0 Θ_i – proportion of i-th fraction

$\dot{Q}_{av}$ = $T_{av}\dot{S}_{av}$ = -T_{av}(nċm S_{av} - $\sum_{i=1}^{n} niSi$)

$\dot{Q}_{av} = \frac{Kj\ c}{c\ mol\ mix}$

$\tilde{Q}_{av}$ = -T_{av} ($\tilde{S}_{cm}$-$\sum_{i=1}^{n} \tilde{\theta}_i \tilde{S}_i$)

$\tilde{W}_{min}$ (T, P) = h_{mix} – $\sum_{i=1}^{n} \tilde{\theta}_i \tilde{h}_i$ – T_{av} ($\tilde{S}_{cm}$ - $\sum_{i=1}^{n} \tilde{\theta}_i \tilde{S}_i$)

$\tilde{W}_{min}$ (T, P) = (h_{mix} – $T_{cp}S_{mix}$) – ($\sum_{i=1}^{n} \tilde{\theta}_i \tilde{h}_i$ - $T_{cp}\sum_{i=1}^{n} \tilde{\theta}_i \tilde{S}_i$)

$\sum_{i=1}^{n} \tilde{\theta}_i h_i$ - $T_{cp}\sum_{i=1}^{n} \tilde{\theta}_i \tilde{S}_l$ = $\sum_{i=1}^{n} \tilde{\theta}_i$ (h_i - $T_{cp}S_i$) = $\sum_{i=1}^{n} \tilde{\theta}_i \tilde{G}_i$

h_i - $T_{cp}S_i$ = G_i

$\tilde{W}_{cm} = \tilde{G}_{cm} - \sum_{i=1}^{n} \tilde{\theta}_i \tilde{G}_i$

$\sum_{i=1}^{n} \tilde{\theta}_i = 1$

$\tilde{W}_{cm}$(T, P) = $\sum_{i=1}^{n} \tilde{\theta}_i$ ($\tilde{G}_{cm} - \tilde{G}_i$) = $\sum_{i=1}^{n} \tilde{\theta}_i \tilde{W}_i$

$\tilde{W}_{cm} = \sum_{i=1}^{n} \tilde{\theta}_i \tilde{W}_i$ ($\frac{\text{Kj}}{kmol\ mix}$)

$\tilde{G}_{cm}$(T, P) = $\sum_{j=1}^{m} \tilde{G}_{jcm} \tilde{y}_{jcm}$

$\tilde{W}_i = \tilde{G}_{cm} - \tilde{G}_i$

$\tilde{G}_i$(T, P) = $\sum_{\substack{i=1 \\ j=1}}^{nm} \tilde{y}_{ji} \tilde{G}_{ji}$

$\sum_{j=1}^{m} \tilde{y}_{jcm} = \sum_{\substack{i=1 \\ j=1}}^{n} \tilde{y}_{ji}$

Subtract the Gibbs proportionof the *i*-th fraction from the total Gibbs energy of the mixture:

$\tilde{G}_{cm} - \tilde{G}_i = \sum_{\substack{i=1 \\ j=1}}^{nm} \tilde{y}_{ji} (\tilde{G}_{jcm} - \tilde{G}_{ji})$

$\tilde{W}_i (T_i, P, \tilde{y}_{ji}) = \tilde{G}_{cm} - \tilde{G}_i$

$\tilde{W}_{cm}(T, P) = \sum_{i=1}^{n} \tilde{Q}_l \tilde{W}_i$

$\tilde{Q}_l [\frac{kmol\ i-th\ fraction}{kmol}] \sum_{i=1}^{n} \tilde{Q}_l = 1$

The work is done due to the decrease in Gibbs energy of the *i*-th fraction:

$$\tilde{W}_i (T_i, P, \tilde{y}_{jcm}) = \tilde{G}_{cm} - \tilde{G}_l$$

Gibbs energy of the mixture of the *i*-th fraction $\tilde{G}_l$

Quantitatively, the composition does not change:

$\sum_{\substack{j=1 \\ i=1}}^{mn} \tilde{y}_{jl} = \sum_{j=1}^{n} \tilde{y}_{jcm}$ mass conservation law

$\tilde{G}_{cm} = \sum \tilde{y}\ cm\tilde{G}_{cm}$

$\tilde{G}_l = \sum \tilde{y}_{jl}\tilde{G}_{jl}$

$\tilde{G}_{jcm}(T, P, \tilde{y}_{jcm}) = \tilde{G}_{jcm}(T, P, \tilde{y}_{jcm} = 1) + \tilde{R}\ T\ ln\ \tilde{y}_{jcm}$ – Gibbs energy of the j-component of the mixture, which is subject to separation.

$\tilde{G}_{ji}(T, P, \tilde{y}_{jl}) = \tilde{G}_{ji}(T, P, \tilde{y}_{jl} = 1) + \tilde{R}\ T\ ln\ \tilde{y}_{jl}$ – Gibbs energy of the j-component of the *i*-th fraction after separation of the mixture. (cm. Fig. 3).

$\tilde{W}_i (T_i, P, \tilde{y}_{jcm}) = \tilde{G}_{cm} - \tilde{G}_i = \sum_{\substack{j=1 \\ i=1}}^{mn} \tilde{y}_{jl}\ \tilde{R}\ T\ ln \frac{\widetilde{y_{jcm}}}{\widetilde{y_{jl}}}$ the work of extracting the i-th fraction is carried out due to the decrease in Gibbs energy G_i of this i-th fraction

$\sum_{j=1}^{m} \tilde{y}_{jcm} = \sum_{\substack{j=1 \\ i=1}}^{m} \widetilde{y_{jl}}$ – mass conservation law

$\tilde{W}_i (T_i, P, \tilde{y}_{ji}) = -\tilde{R}T\sum_{\substack{j=1 \\ i=1}}^{m} \widetilde{y_{jl}}\ ln \frac{\widetilde{y_{jl}}}{\widetilde{y_{jcm}}}$ – work of extraction of the i-th fraction

It follows that, according to the amount of work $\tilde{W}_i$ spent on extracting the i-th fraction, the value of the extraction exergy of this function is determined, i.e. physical exergy. The magnitude of the physical exergy of extraction is identical to the magnitude of the work of separation (extraction) with the opposite sign.

Schematic diagram of the separation of a binary gas mixture by the low temperature method. An ideal binary gas mixture of a given composition in state 1 by HBC is compressed in a single-stage compressor 1.

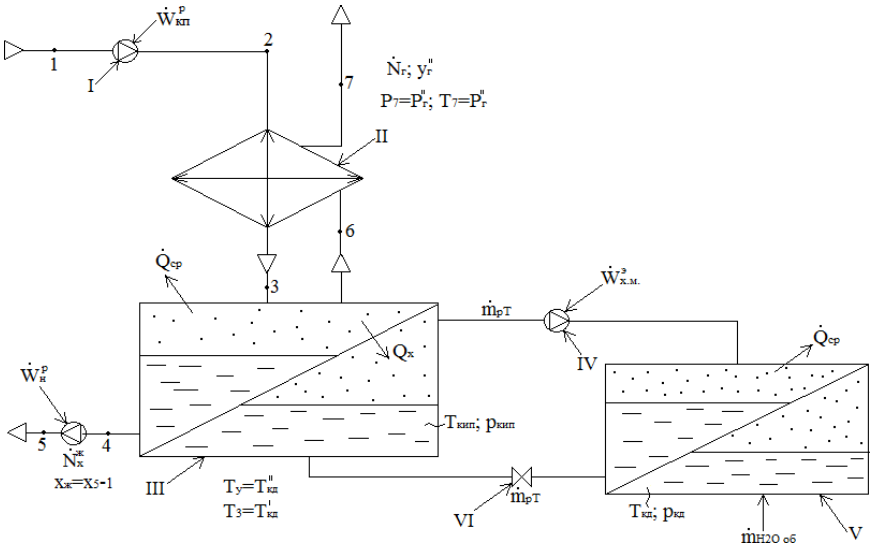

Fig. 2. Schematic diagram of the separation of ethane-ethylene mixture by partial condensation:
I – compressor installation II – pre-cooling heat exchanger,
III – evaporator,
IV – compressor installation V – air-vapor condenser,
VI – throttle device

The cooling effect is achieved in evaporator III due to the boiling of the working fluid (refrigerant). The vapors formed in III are compressed to the condensation pressure in compressor IV and fed into the air-vapor condenser V (Fig. 3). Hot refrigerant vapor from compressor 1 with temperature tTH1 enters the tube bundle 3, where it is cooled to temperature tTH2, and a mixture of vapor and liquid enters the linear receiver. In this system, the process water circuit is cycled and closed. Using the pump of the cooling circuit of the process water 8, water is supplied through pipes to the nozzles 4, from which atomized particles of water fall into the electrostatic field (ESF). The compression process is equilibrium, the process condition is X =T=const. (isothermal compression mode). A capacitor of this type is used for cooling capacities up to 350 kW.

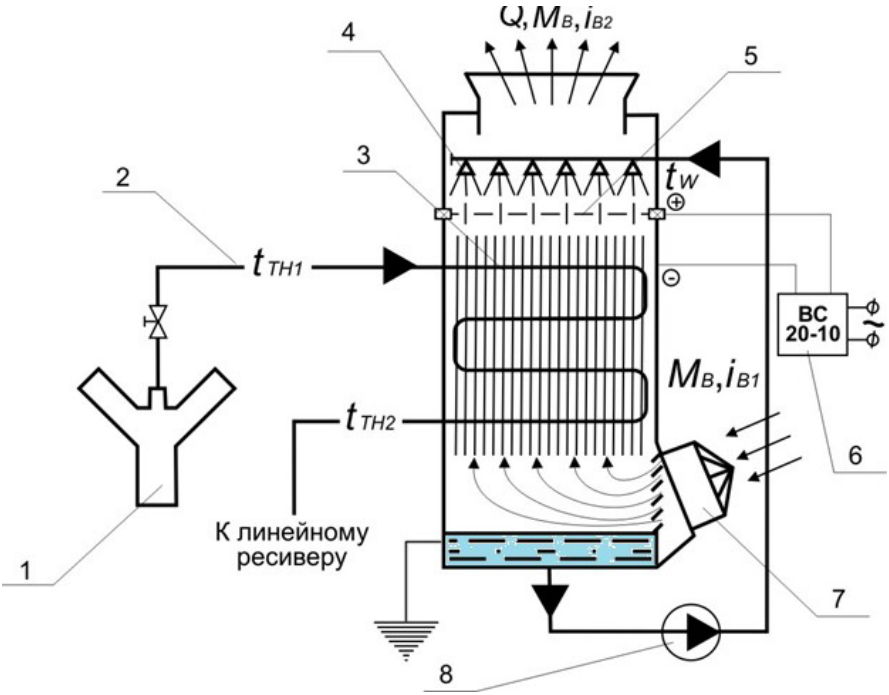

Fig. 3. Air-vapor condenser (patent RU 2246671 C1 of 05.20.2005): 1 – refrigeration compressor, 2 – heating pipe, 3 – tube bundle, 4 – nozzles, 5 – high voltage electrode, 6 – power supply, 7 – fan, 8 – process water cooling pump

Let us illustrate the calculation of the minimum heat and liquefaction work of a methane-ethylene mixture CH4-C2H4 :

At a temperature of $T_{cm} = 286$ K and a pressure of $P_{cm} = 8{,}5 * 10^5$ Pa and the mixture composition $\tilde{y}_{1,cm} 0{,}45 \ \frac{kmol\ component}{kmol\ mix}$ (ethylene - component number 1), as HBC.

$\alpha_1 = 0{,}795$ - degree of extraction due to imperfect equipment.

$$\theta_L = \alpha_1 * \tilde{y}_{1,cm} = 0{,}795 * 045 = 0{,}358 \ \frac{kmol\ 1(L)}{kmol\ mix}$$

$$\theta_g = 1 - \theta_L = 0{,}642 \frac{kmol\ 1(g)}{kmol\ mix}$$

$$\tilde{y}_{1,2} = \frac{\tilde{y}_{1,cm} - \theta_1}{\theta_2} = \frac{\tilde{y}_{1,cm} - \theta_1}{1 - \theta_1} = \frac{0{,}45 - 0{,}358}{1 - 0{,}458} = 0{,}1433 \ \frac{kmol\ component}{kmol\ mix}$$

$$\tilde{y}_{2,2} = 1 - \tilde{y}_{1,2} = 0{,}8567$$

$P_v(T_{CT}") = P_{n.p.} = P_1 * \tilde{y}_{1,2} = 8{,}5 * 10^5 * 0{,}1433 = 1{,}218 * 10^5$ Pa = 913,6 mmHg

$T_{CT}" = \frac{B}{A - \ln P_v(T)} - C$, where A=15,5368; B=1347,01; C=-18,15

$T_{CT}" = \frac{1347{,}01}{15{,}5368 - \ln 913{,}6} + 18{,}15 = 172{,}63$ K - methane condensation completion temperature

$\ln P = A - \frac{B}{T+C} = 15{,}5368 - \frac{1347{,}01}{286 - 18{,}15} = 10{,}51 \Rightarrow P = 3668$ mmHg = 48,9 bar

P'=$P_{cm} * \tilde{y}_{1,cm} = 8{,}5 * 10^5$ *0,45=3,825 bar = 2869 mmHg

$T'_{CT} = \frac{1347{,}01}{15{,}5368 - \ln 2869} + 18{,}15 = 196$ K – methane condensation start temperature

$\bar{T}_{CT} = \frac{T'_{CT} - T_{CT}"}{\ln \frac{T'_{CT}}{T_{CT}"}} = \frac{196 - 172{,}63}{\ln \frac{196}{172{,}63}} = 184{,}07$ K

$h_1 - h_2 == \Delta h = \int_{184{,}07}^{286} C_p dT = 3{,}809 * (286 - 184{,}07) + 0{,}157 * \left(\frac{286^2 - 184{,}07^2}{2}\right) - 8{,}355 * 10^{-5} * \left(\frac{286^3 - 184{,}07^3}{3}\right) + 17{,}565 * 10^{-9} \left(\frac{286^4 - 184{,}07^4}{4}\right) = 3694{,}77 \frac{Kj}{kmol}$

Watson's formula:

$h_2 - h_3 = \Delta h_v(T_{CT} = 184{,}07) = \Delta h_v(T_{nb}) \left[\frac{1 - T_{r_2}}{1 - T_{r_1}}\right]^n$

$T_{r_2} = \frac{T_{CT}}{T_{crit}} = \frac{184{,}07}{282{,}4} = 0{,}6518$

$T_{r_1} = \frac{T_{nb}}{T_{crit}} = \frac{169{,}4}{282{,}4} = 0{,}599$

$\Delta h_v = 3237 * \left[\frac{1 - 0{,}6518}{1 - 0{,}599}\right]^{0{,}38} = 3067{,}9 \frac{kcal}{kmol} = 12854{,}5 \frac{Kj}{kmol}$

1.) $Q_{Lq} = -[(h_1 - h_2) + (h_2 - h_3)] = -[3694{,}77 + 12854{,}5] = -16550 \frac{Kj}{kmol}$

2.) $\int_{T_{CT}}^{T_1} dS = S_1 - S_3 = -[(S_1 - S_2) + (S_2 - S_3)] = -85{,}61 \frac{Kj}{kmolK}$

3.) $S_1 - S_3 = -[(S_2 - S_3) + (S_1 - S_2)] = -85{,}61 \frac{Kj}{kmol*K}$

4.) $\bar{T}_x = \frac{\delta Q_{1-3}}{dS_{1-3}} = \frac{[(h_1 - h_2) + (h_2 - h_3)]}{[(S_1 - S_2) + (S_2 - S_3)]} = \frac{3694{,}77 + 12854{,}5}{15{,}78 + 69{,}83} = 193K$

5) $\tilde{W}_x = \tilde{Q}_x * \left[\frac{T_{av}}{T_x} - 1\right] = -16550 * \left[\frac{286}{193} - 1\right] = -7975 \frac{Kj}{kmol}$

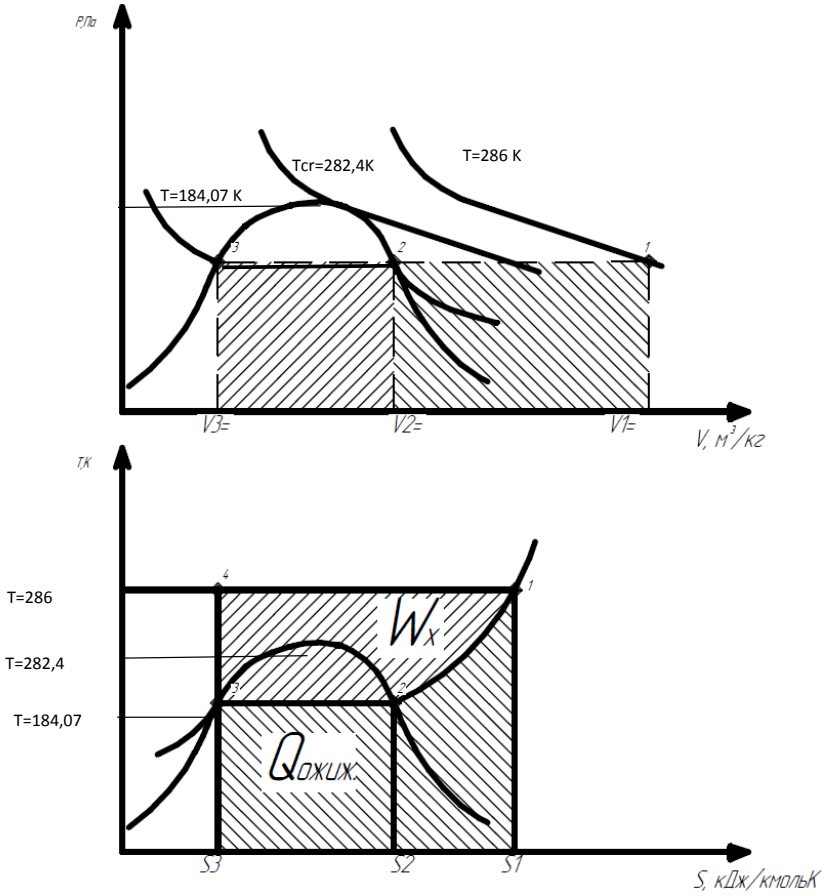

Fig. 4. Heat and work diagrams of ethylene liquefaction.

In all cases, the introduction of cold allows you to create new technological processes, to intensify production, to increase the yield and quality. In addition, it is possible to reduce the toxicity level of industrial emissions and create more comfortable working conditions. It should be noted that obtaining artificial cold is an expensive and energy-intensive process, in connection with which the issues of economic feasibility of technological processes using cold are very acute. Modern chemical industries are the largest consumers of cold. For the production of 1 ton of rubber, for example, it is necessary to use from 5000 to 7500 MJ of cold at Tx = 253 K. Obtaining 1 ton of caprolactam requires up to 8000 MJ of cold.

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TO THE THERMODYNAMICS OF COPPER-LEAD MATTE

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The article considers the behavior of iron and lead compounds and their effect on the oxygen content in copper-lead mattes. The substantiation is given for the statement that the consideration of copper-lead matte in the form of a quasi-triple Cu_2S – PbS – FeS system does not seem to be correct. When studying the thermodynamics of copper-lead mattes, it is necessary to take into account the oxygen content and the form of its presence in mattes. Such an approach allows the most comprehensive assessment of the behavior of copper, lead, arsenic and antimony in the process of converting copper-lead mattes.

The oxidation mechanism of iron and lead sulfide and their mutual influence on the formation of wustite and magnetite are shown based on the results of thermodynamic analysis. The Gibbs energy of the oxidation reactions of FeS and PbS was calculated.

Keywords: copper-lead matte, converting, iron sulfide, oxidation, oxygen, converter slag, Gibbs energy, distribution.

The phases coexisting in the pyrometallurgical units during matte smelting, converting, and slag depletion are sulfide (matte) or metal phase (rough metal), oxide melt (slag), and gas. The system that determines the formation of these phases is multicomponent. One of the main distinguishing features of the oxide-sulfide melts system are significant ranges

of variation in the values of the parameters that define the equilibrium state of the melts in the areas of their homogeneity. The values of the equilibrium partial pressures of oxygen can vary from 10^{-7} to 0.1 Pa, sulfur - from 0.01 to 10^4 Pa. The values of these characteristics of the state of the melts in each particular industrial unit vary in significantly narrower ranges, which is associated with the features of the optimal solution of individual physicochemical transformations carried out at various stages of the technological scheme. Knowledge of the thermodynamic characteristics of a system is a key task that describes a process of smelting close to an equilibrium state, converting under controlled conditions of P_{O2} and P_{S2}. The solution for the task can be used to improve the overall performance of the process.

The thermodynamics of the Cu–Fe–S system related to autogenous matte smelting and converting of traditional copper matte, as well as the behavior of metals under the conditions of these processes have been studied in sufficient detail by most authors [1–9].

The results available in the technical literature on the activities of components in sulfide and oxide melts made it possible to expand the boundaries of the theoretical basis of metallurgical processes. Thermodynamic models have been constructed that make it possible to predict copper losses in slags depending on various factors: matte and slag compositions, blast consumption, temperature, etc. Nevertheless, there is no consensus on the structure of sulfide melts. Thus, the authors of [5] believe that sulfides in liquid matte are largely dissociated into ions, and basically consist of iron, copper and sulfur containing homogeneous liquid phase. In article [6], the opinion is expressed that sibotaksis groups are formed in the sulfide alloy of two metals, one of which mainly consists of sulfur atoms and one of the metals, the other - the atoms of the other metal. In article [7], sulfur in molten matte is not bound to any specific metals in the form of sulfide molecules. The melts have an ionic structure and can be treated by electrolysis. This assumption found support in [8, 9].

As the analysis shows, despite the extensive available material on the activity of copper and iron sulfides in mattes, they cannot be used in thermodynamic analyzes of various systems, in particular, in the analysis of copper-lead mattes. This is due to the fact that in the conditions of converting copper-lead matte certain difficulties occur with obtaining high-quality blister copper with a minimum content of impurities, because of the high contents of lead, arsenic and antimony in the initial mattes. Moreover, the usual methods used in the processing of traditional copper

mattes for assessing the completeness of their removal are not suitable, since content of FeS and Cu_2S is several times higher than the concentration of ZnS and PbS. According to the results of the practice of converting copper-lead matte [10], the solution to the issue of increasing the extraction of copper into blister copper and improving the quality of the products is still open. In addition, the activity of sulphides of copper mattes was obtained by direct calculation of the activities of pure sulphides without taking into account the activity of FeO. As a rule, the presence of FeO in copper-lead mattes significantly changes the final values of the activities of sulfide components. In this regard, the description of the compositions of copper-lead matte in the form of a quasi-triple section Cu_2S - PbS - FeS seems not correct. This approach greatly simplifies its composition and cannot be taken as the basis for the description of the thermodynamics of copper-lead mattes. Lack of reliable method in the technical literature for determining the solubility and form of oxygen, their quantitative ratios in copper-lead mattes still complicates the final thermodynamic calculations of copper-lead mattes for lead smelting.

The industrial composition of the matte of lead smelting can be characterized by the complex multicomponent system Me-Fe-S-O-SiO_2 (Me–Cu, Pb, Zn, As, Sb). If insignificant amount of the slag component (SiO_2) and low concentrations of As, Sb, Zn in them are neglected, the industrial mattes can be represented (conditionally) in the form of a five-component system Cu–Pb–Fe–S–O. In this case, real mattes in composition characterize the compositions of final mattes consisting of sulfides of copper, lead, iron and iron oxide. Therefore, to calculate the activities of the components in the (Cu_2S+PbS)–FeS–FeO system, reliable data on the oxygen content in copper-lead matte is needed.

The present work did not have the goal of conducting a detailed analysis of the converting process; therefore, industrial results are discussed only from a general standpoint and applicable to the issue under consideration. The study of the thermodynamics of the complex multicomponent system Cu–Pb–Me–Fe–S–O in terms of assessing the behavior of iron compounds for overall mechanism and technological parameters of the process of converting copper-lead mattes arises particular interest.

Research methods

A study of the behavior of iron and lead sulfide compounds, as one of the main components in copper-lead mattes, was carried out on the basis of a thermodynamic analysis of the oxidation reactions of sulfides and wustite, as well as the reactions of the interaction of iron sulfides and lead with their oxides.

The states of pure liquid sulfide and pure liquid oxide were selected for the standard state of the substances involved in the analyzed reactions. Moreover, the well-known temperature dependences of the Gibbs free energy for solid FeS_s and FeO_s were converted to standard states of liquid sulfide (FeS_l) and liquid iron oxide (FeO_l).

The thermodynamic characteristics of the reaction of formation of FeS_l and FeO_l were determined taking into account the melting process (ΔH_{melt}) according to the equation:

$$\Delta G_{melt} = \Delta H_{melt} - T\Delta S_{melt} = \Delta H_{melt} - T\,(\Delta H_{melt}/\Delta T_{melt}) \quad (1)$$

Thermodynamic calculations for the oxidation reaction of lead sulfide were performed by summing the reactions with known Gibbs free energies.

The Gibbs free energy versus temperature for the reaction between lead oxide and iron sulfide was carried out according to the values of thermal effects (ΔH_{melt}) and the absolute values of the entropy of substances (ΔS_{melt}) involved in the reaction under standard conditions of components of pure liquid oxide and sulfide.

Discussion of Results

Thermodynamic analysis of the behavior of iron and lead compounds

The reactions accepted for analysis and the values of the Gibbs free energy change are shown in Table 1.

Table 1

Gibbs free energy calculation results

#	Reactions	ΔG_T, kJ/mol * K	ΔG_{1523K}, kJ/mol*K
1	$FeS + 7/4\ O_2 = 1/2Fe_2O_3 + SO_2$	– 679 369 + 185.75 T	– 396 472
2	$FeS + 5/3O_2 = 1/3Fe_3O_4 + SO_2$	– 609 390 + 144.98 T	– 388 515
3	$FeS + 3/2\ O_2 = FeO + SO_2$	– 506 321 + 107.55 T	– 342 522
4	$FeS + 10Fe_2O_3 = 7Fe_3O_4 + SO_2$	148 760 – 285.9 T	– 286 665
5	$FeS + 3Fe_2O_3 = 7FeO + SO_2$	339 142 – 246.4 T	– 36 125
6	$FeO + 1/6O_2 = 1/3Fe_3O_4$	– 103 097 + 37.5 T	– 45 984
7	$PbS + 3/2O_2 = PbO + SO_2$	– 496 011 + 141.6 T	– 280 354
8	$PbO + FeS = PbS + FeO$	37 725 – 67.44 T	– 64 986
9	$PbS + 3Fe_2O_3 = PbO + 6FeO + SO_2$	– 42 370 – 92.4 T	– 183 095

The change in Gibbs free energy from temperature (ΔG_7) for reaction (7) was determined by summing the reactions:

$$PbS = Pb + ½S_2 \qquad \Delta G_1 \quad (2)$$

$$½S_2 + O_2 = SO_2 \qquad \Delta G_2 \quad (3)$$

$$Pb + ½\ O_2 = PbO \qquad \Delta G_3 \quad (4)$$

$$PbS + 3/2\ O_2 = PbO + SO_2 \qquad \Delta G_7 \quad (5)$$

$$\Delta G_7 = \Delta G_1 + \Delta G_2 + \Delta G_3. \quad (6)$$

The Gibbs free energy ΔG_1, ΔG_2 and ΔG_3 are taken according to the data of [11].

The reactions of iron sulfide with magnetite and copper sulfide with iron oxides are not taken into account in Table 1 due to the positive values of the Gibbs free energy for them.

The high Gibbs free energy for FeS oxidation reactions (1) - (4) at a temperature of 1523 K for the conversion process indicates the highest affinity of iron for oxygen. Moreover, as shown by thermodynamic calculations, the occurrence of reactions (1) - (4) and (7) are equally probable.

The dissolution of oxygen in copper-lead mattes in the form of hematite (Fe_2O_3) is excluded due to the intense occurrence of reactions (4) and (9), as well as reaction (5). In addition, in the absence of a slag phase (SiO_2), wustite (FeO) can be oxidized to Fe_3O_4 by reaction (6). A slight discrepancy between the Gibbs free energy values for the oxidation of iron sulfide and lead sulfide at 1523 K indicates the possibility of predominant oxidation of lead sulfide to its oxide by reaction (7). The resulting PbO can interact with FeS by reaction (8). With a low FeS content in mattes, a high concentration of lead in the slags can be expected.

Thus, the possible presence of oxygen in copper-lead mattes in the form of wustite (FeO) and magnetite (Fe_3O_4) can be argued. Their quantitative ratio is largely determined by the course of reactions (2), (3) and (6) - (8). An increase of the content of copper and lead sulfide in copper-lead matte leads to a simultaneous decrease in FeS in them, and consequently, the content of FeO and Fe_3O_4. At elevated concentrations of lead sulfide in matte, oxygen anions bound to wustite (FeO) are replaced by sulfur anions associated with lead in the form of PbS. Oxygen bound to magnetite (Fe_3O_4) is practically not replaced by sulfur. The formation of Fe_3O_4 is determined by the course of reaction (2), and its reduction is determined by a decrease of the concentration of FeS in copper-lead matte. The occurrence of reaction (6) on the formation of magnetite will not have a significant effect due to the replacement of oxygen anions bound to wustite by sulfur anions closely connected with lead in the form of lead sulfide. Consequently, it can be argued that the process of converting copper-lead mattes is accompanied by a predominant growth of magnetite, the presence of which will have a significant effect on the redistribution of copper, lead and related metal impurities between the converting products in the direction of deterioration. In this case, high contents of copper and lead in the produced converter slag and their increased contents in blister copper are expected.

The obtained results fully confirm the assumption that the representation of the complex multicomponent Cu-Me-Fe-S-O system, related to copper-lead matte of lead smelting in the form of the quasi-triple Cu_2S-PbS-FeS system, as most authors consider, is simplified and not entirely correct. When conducting thermodynamic calculations of the final composition of copper-lead mattes, it is necessary to take into account both the oxygen content in the mattes and the forms of its presence, since the quantitative ratio of them is largely determine its final composition.

Analysis of industrial practice of converting copper-lead mattes

The converting of copper-lead matte at KazZinc Ltd. is carried out in horizontal converters with the addition of quartz flux of the following composition,%: 2-5 Fe; up to 2.0 CaO and 65-75 SiO_2. With incomplete loading of production capacities, about 60 tons of matte per day are processed in the converting stage. The process is conducted in 12-ton converters equipped with 10 tuyeres with a diameter of 38 mm each. Air consumption is 5000-10000 m^3/hr, the volume of exhaust gases ~ 75 thousand m^3/hr [12].

The first converting period includes loading of the matte, the supply of blast to the converter and the loading of flux, the discharge of slag and the collecting of white metal.

The second conversion period is to purge the white metal to produce blister copper.

The main losses of copper during the converting are accounted for converter slags, which are sent to a mine shaft furnace for depletion. The circulation of converter slag in the smelting-converting chain leads to the “smearing” of copper between the products of mine contractile smelting and converting. In addition, converter slags characterized by high concentrations of impurities, are the main source of accumulation of lead, arsenic and antimony in the technological flowchart, which, ultimately, determine the quality of the obtained smelting products. As a result, it is impossible to expect high recovery of copper and lead in the targeted products [10, 12].

The decrease in copper recovery is explained by the insignificant yield of blister copper, which can be seen from the results of the balance of material flows of converting products, shown in Fig. 1.

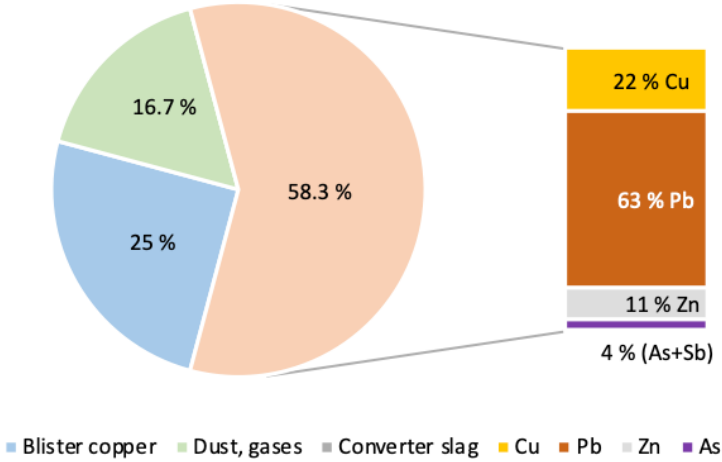

Fig. 1. The balance of material flows of converting products

The output of converter slag is significant and amounts to 42 tons or ~ 60% of the total initial loaded materials. The high values of the distribution of copper, lead, arsenic, and antimony to slag (of their total matte content), shown in Fig. 1, indicate that the solution to the issue of reducing copper losses with converter slag and removing impurities from the continuous circulation in the smelting-converting chain is one of the main for the industrial plants.

The detailed material balance of the process of converting non-ferrous metals and impurities between converting products and their distribution according to [10] is shown in Table 2.

Table 2

The material balance of the process of converting

Name of products	Q-ty, *t*	Cu			Pb			Zn			As			Sb		
		I	**II**	**III**	**I**	**II**	**III**	**I**	**II**	**III**	**I**	**II**	**III**	**I**	**II**	**III**
Loaded:																
Matte	60	35.3	21.18	100	25.9	15.54	100	3.4	2.04	100	3.8	2.28	100	0.7	0.42	100
Quartz Flux	12															
Total:	**72**		**21.18**	**100**		**15.54**	**100**		**2.04**	**100**		**2.28**	**100**		**0.42**	**100**
Produced:																
Blister copper	18	94.8	17.06	80.5	1.1	0.2	1.3	n.d.	-	-	0.9	0.16	7.0	0.6	0.11	26.2
Converter slag	42	7.46	3.13	14.8	21.1	8.86	57	3.86	1.62	80	1.19	0.5	22	0.36	0.15	35.7
Dust, gases	12	8.3	0.99	4.7	54	6.48	41.7	3.5	0.42	20	13.5	1.62	71	1.3	0.16	38.1
Total:	**72**		**21.18**	**100**		**15.54**	**100**		**2.04**	**100**		**2.28**	**100**		**0.42**	**100**

I – composition, %; **II** – quantity, t; **III** – distribution, %.

Up to 1.5% of lead goes into blister copper. Lead extraction to dust is low and amounts to 40%. Up to 60% of lead from its total amount is concentrated in converter slag, which is in full agreement with the results of thermodynamic analysis. During the conversion process, galena (PbS) present in matte is easily oxidized by reaction (7) with the formation of lead oxide and sulfur dioxide. Being a strong base, lead oxide is easily slagged by silica and forms fusible slags.

A detailed analysis of the distribution of copper, arsenic, antimony between the converting products is presented in [10, 12].

The established pattern on the redistribution of copper, lead, arsenic, and antimony between the converting products to the side of deterioration fully confirm the results of the thermodynamic analysis presented in [12], where the behavior of copper, lead, arsenic, and antimony compounds under the conditions of copper-lead matte converting was studied in detail.

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AUTOMATION OF A NUCLEAR MAGNETIC RESONANCE CONTROL SYSTEM OF THE SECOND-GENERATION ANALYZER

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The paper describes the automatic control system of a Nuclear Magnetic Resonance (NMR) Second-Generation Flow Analyzer using the STK500 programmer, with firmware in the assembly language in the ATmega8515 controller.

Key words: automated, control, electric drive, controller, programming, NMR.

Introduction

Development of an automated control system and power supply for electric drives for oil production processes, increasing oil recovery and oil preparation is a crucial task that one faces at a later stage of oil field development. Oil production and oil well fluid (OWF) preparation technologies require automatic control systems (ACS) based on flow-through express control of the quantity and quality of well products according to GOST 8.615-2002005 GSI. [1-4].

The aim of the work is to develop a second-generation NMR control system.

Second-generation flow analyzer (NMR II)

In 2008, we received the patent No. 74710 [5] for **NMR II** (second-generation analyzer). Figure 1 shows the analyzer's sampling system, and Figure 2 shows the electrical circuit diagram of the sampler's electric drive, which allows the branch pipe to be installed at the required level in the pipeline during the sampling for oil well fluid analysis. [6]

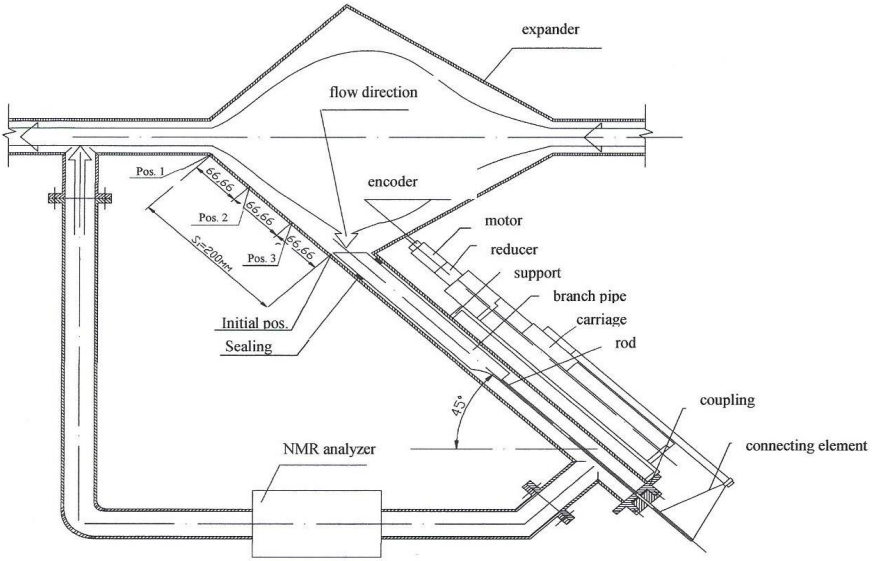

Fig. 1. NMR analyzer sampling system

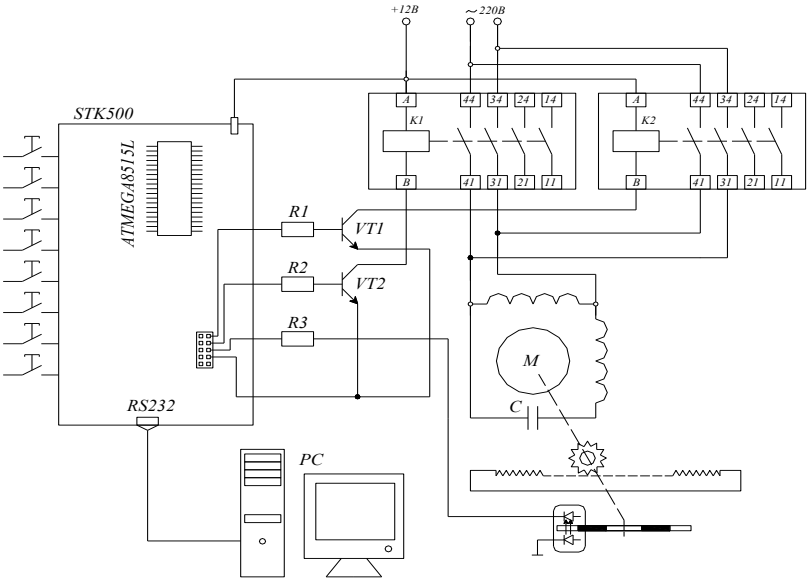

Fig. 2. Electrical schematic diagram of the electric drive of the NMR II branch pipe

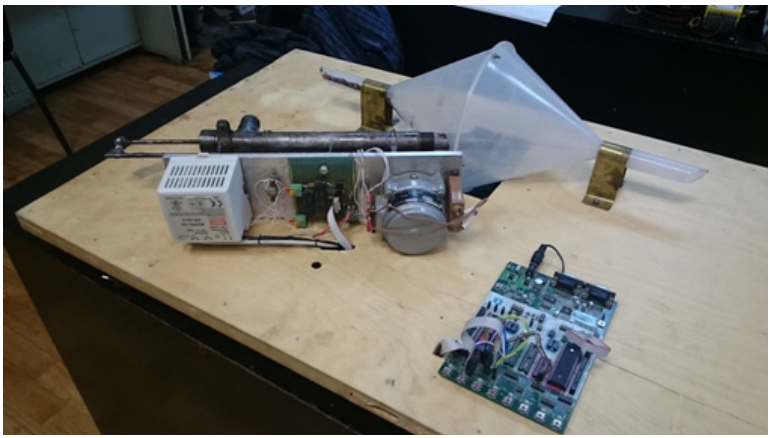

Fig. 3. Second-generation NMR stand

In order to increase the measurement range of the flow rate and sampling representativeness, the design of the new system is based on a device characterized in that the measuring part of the pipe (that is built into the main pipeline) has a conical extension, and sampling registered by the NMR relaxometer sensor is carried out by a branch pipe that can move along the cross section of the cone. [6]

For automated control of the electric drive of the NMR II sampling branch pipe (Fig. 3), we used a microprocessor control kit from the *ATMEGA* 8515*L* microcontroller; as for the development of the microprocessor, we used an *STK*500 development kit and design system for *Atmel AVR* flash controllers (Fig. 4), marked *SCKT*3000*D*3on the panel.

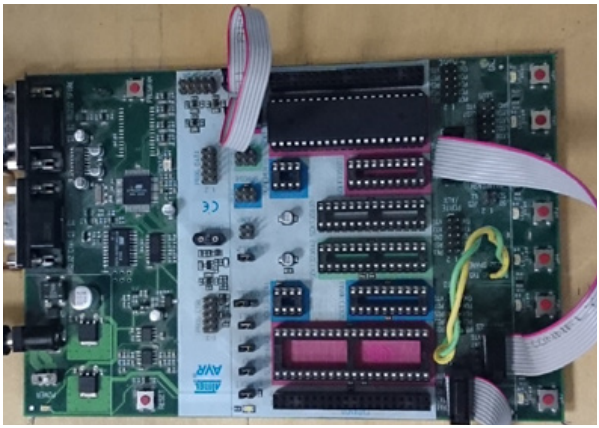

Fig. 4. Board STK500.

To program the controller, a connection must be made to the computer via the *COM* port, which can be used for process monitoring and local control.

There are two three-pin connectors designed to connect optical sensors to the

end position of the branch pipe on the power board (Fig. 5). The emitter and photo-receiver (simple or composite phototransistor) are securely fixed in the housing of the infrared reflection-type sensors; the optical axes of the emitter and photodetector intersect at a certain angle outside the housing. When the object to be detected is located at the intersection of the optical axes of the emitter and the receiver, the emitter signal reflected from the object is maximal in the receiving point. This leads to a sharp increase in the output current of the phototransistor, which, in turn, is fed to the terminals of the MC.

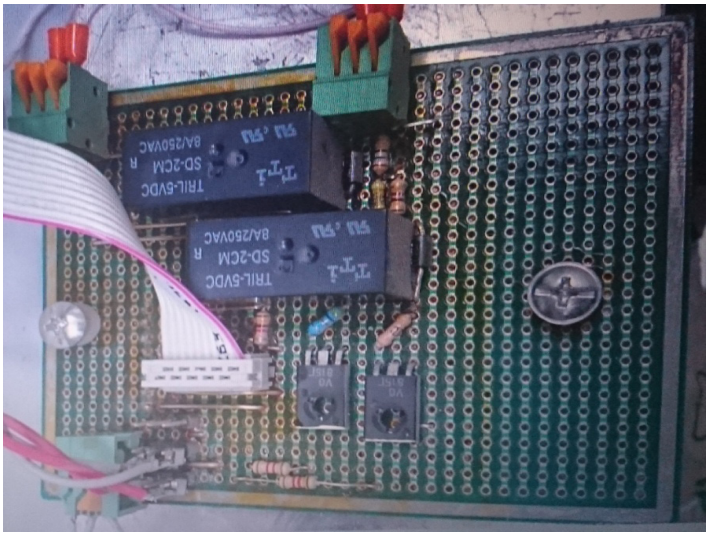

Fig. 5. Power assembly with the connection of a ten-wire cord to the relay.

The *ATmega* 8515 ensures the capacity of 1 mln operations/ second due to the fact most instructions during one machine operation cycle, thus allowing you to optimize power consumption by changing the synchronization frequency. The *AVR* core combines a large instruction set with 32 general-purpose working registers. All 32 registers are directly connected to the ALD (arithmetic logic device), which allows you to specify two registers in one instruction and execute it in one cycle. This architecture has more code efficiency and is 10 times better in terms of production capacity compared to *CISC* microcontrollers. It is supported by a set of tools and software for application development, including: C compilers, macro assemblers, debuggers/ simulators, in-circuit emulators, evaluation kits.

The *STK*500 requires an external 10-15V power supply to operate. After all the connections are made, ~ 220 V is to be connected to the *DR*-4515 voltage converter. When the LED indicator is red the power on; the LED status indicator will change from red to yellow and then to green. When the green LED is on the V_{CC} voltage (microcontroller power) is on.

The assembly language program in *ATMEGA* 8515*L* begins to perform the following operations: initialization of the microcontroller; initialization of ports *A* and *B*; timer/ counter 1, universal synchronous/ asynchronous transceiver (*USART*); going into the comparing routine of the accepted start-up code.

The MC receives the command and supplies the voltage of 5V, corresponding to the level of a logical unit, to the fourth discharge of port A, which, in turn, opens the transistor and supplies voltage to the relay coil, after which the drive comes into motion. After the "Forward" signal is produced, the controller carries out a delay slightly longer than an on-delay and conducts the polling of the fifth bit (in case of backward movement, it conducts the polling of the third bit) of port A connected to the second interlock relays.

When you press the *SW*4 button on the *STK*500 board, the branch pipe moves in the period. And when you press the button *SW*6 branch pipe moves back.

Conclusions

1. Controller programming allows you to diversify methods of control over magnetic resonance of a second-generation analyzer;

2. The methods, devices and model implemented for the measurement of the physicochemical parameters of oil well fluid using flow NMR analyzers have the following advantages according to our patents:

- The main pipe can be of any diameter, i.e. the upper range of flow measurement is almost unlimited, and the lower range will be $Q = 0$;

- The sample is supplied to the NMR analyzer by the differential pressure, which is regulated by the position of the branch pipe in the expander, thanks to which no pumps and valves are required, and you can "stop" the flow in the NMR sensor;

- The flow in the pipe is accompanied by following processes: preliminary determination humidity *W*, selection of the dependence of the relaxation rate on the flow corresponding to this *W* value from the computer database, measurement of the effective relaxation time, which can be measured with greater accuracy than the phase and amplitude of the signal and the flow velocity can be measured based on the relaxation rate.

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POSSIBILITIES OF AN OBJECT DIGITAL TWIN APPLICATION IN ORDER TO EXTEND AND PREDICT SAFE OPERATION RESOURCE

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Maintenance and repair of equipment is one of the most important stages of equipment operating cycle, but at the same time, it requires special attention. Large number of plants were placed into service in the 1950s, which indicates the availability of outdated equipment and requirement for careful control in order to reduce accidents frequency.

Currently, most enterprises of Russia use classic system of preventive maintenance based on planning and preventive focus, but this approach to maintenance is already outdated and not relevant. Its disadvantages are outdated standards, ignoring the actual working conditions and condition of equipment, quality of materials and spare parts, significant deviations of actual data from the planned operation.

Today, another type of maintenance and repair systems is attracting special attention - providing for equipment maintenance according to its actual condition. Such maintenance and repair system leads to increased responsibility in matters of ensuring safe operation.

Because of industry digitalization cyber physical systems are relevant, an example of which is digital twin. Its value is ability to control behavior and actual condition of an observation object, if necessary, to adjust a product, without high financial costs, to determine the most favorable operating conditions and modes in accordance with equipment state. These advantages, combined with situation in industry, makes the digital twin a promising method for maintenance and repair in order to extend and predict safe operation resource.

Keywords: digital twin, maintenance, safe operation, extension of operational resource, technological equipment

During all sages of equipment lifecycles, operational condition is one of the most important factor of correct, safe and efficient operation. Evalu-

ation of its actual technical condition and possibility of further work goes during maintenance and repair.

In Russian Federation, a large number of plants were placed into service in the 1950s, which indicates availability of outdated equipment and requirement for careful control in order to reduce accidents frequency. [1] The petrochemical and oil refining industry is characterized by use of a large number of aggressive environments, operation of equipment in conditions of high or low temperatures, high pressures and deep vacuum. Pipeline transport is also potentially dangerous due to possible leaks and possible hydrate formation on pipelines walls. [2] The definition and prediction of safe equipment life is important, because of impossibility of a simultaneous replacement of obsolete equipment.

In general, the technical condition of Russian oil refineries can be characterized by a rather high degree of deterioration, the use of outdated imperfect technologies, a lack of funds for updating, replacing equipment, and an outdated maintenance system. In addition, the issue of industrial digitalization and reduction of equipment repair and maintenance costs are relevant. [3]

During transportation of hydrocarbon feedstocks, the main factors leading to accidents are change in productivity over time, change of pressure during pumping, increase in damage amount, the presence of hydrogen sulfide and carbon dioxide, causing ulcerative stress corrosion, cracking and hydrogen stratification of pipes. [4]

Currently, most enterprises in Russia use classic system of preventive maintenance, which was developed in the USSR in mid-50s of the last century. The basis for development of preventive maintenance system was statistical data, according to which the need for equipment repair was determined by failure of 5% of tested equipment. The main features of this system are planning and preventive focus. The planning involves early determination, volume and frequency of maintenance and repair work, and the preventive focus implies performance of repair operations before equipment failure.

The system of preventive maintenance provides repair after working of equipment a certain number of hours. Currently, this system is outdated. Its disadvantages are outdated standards, ignoring actual working conditions and equipment condition, quality of materials and spare parts, significant deviations of actual operation conditions from planned operation [2]

Particular attention is drawn to another type of maintenance and repair systems, which provides equipment maintenance according to its actual condition. The most promising modern system is the area of equipment

maintenance system, known as TPM (Total Productive Maintenance), which was developed in Japan at the turn of the 60s and 70s, initially as a technique for increasing equipment efficiency. [2]

Compared with preventive planned maintenance, service by actual condition has several advantages:

- availability of constant information of units state covered by monitoring or a digital twin, allows to plan and perform maintenance and repair without stopping production and virtually eliminate equipment failures;
- possibility to increase production efficiency;
- forecasting and planning of maintenance and repair volumes;
- reduction of maintenance costs due to overhaul interval increase;

At the same time, transition to repair work on equipment actual condition leads to increased responsibility in matters of ensuring safe operation. There is a need for high-quality monitoring, diagnostics, in order to timely detect defects, malfunction and prevent its further development.

Analyzing statistics on accidents causes, as well as works of many researchers, one of the most common causes of an accident is equipment depressurization. In turn, depressurization occurs to corrosion, violation of installation, operation, the human factor. According to equipment lifecycle, and features of process, possible equipment upgrades, formation of thinning zones and stress concentrators are quite common. In addition, causes of accidents and negative situations can be malfunctions and breakdowns of sensors and signaling devices.

At the stage of world industry digitalization, the development and application of cyber physical systems - digital twins, is of particular relevance. These systems consist of real objects, virtual representatives and controllers, allowing to present everything in one object. [5]

The value of a digital twin is ability to track the behavior and condition of monitoring object, adjust a product with minimal financial costs according to market requirements, and determine the most favorable operating conditions and modes in accordance with actual equipment state [6].

Since the digital twin is more a means of solving practical problems, it is positioned as a pragmatic way of ensuring the interconnection of two worlds (physical and virtual).

In oil and gas industry, it is possible to use a digital twin for following purposes:

- to remote monitoring and control over processes course;
- for management of production processes;
- for production optimization;
- for detection of equipment breakdowns;

- for planning of repair work;
- for ensuring industrial safety;

A promising area of digital twin application is maintenance of facility throughout the entire life cycle. Managing of big data generated during product life cycle is the most important step that can provide insight and valuable information to guide production, maintenance, and repair issues. Despite the fact that now a large amount of information can be obtained through sensitive sensors, for example, with complex diagnostic monitoring, nevertheless, information at different stages is isolated [7, 8]. That is leads to not fully efficient use and correct assessment of the condition. At life cycle different stages, a virtual double is used to collect information in real time in various forms (tables, pictures, graphs, videos, and so on) and turns them into a single view, a digital asset.

With the help of a digital twin, each physical object has one unique digital replica, so-called digital shadow, in a very realistic three-dimensional form for a detailed description and analysis of its performance, which can provide real-time understanding of state, early warnings, forecasts and ideas for optimization.

Some companies plan to use digital twin at production stage to improve management efficiency. ARC Advisory Group estimated that an unplanned downtime can lead to losses of up to $ 1 trillion per year, but using a digital twin for maintenance and operation of equipment will help to change this situation. [9] Some advantages of using a digital twin:

- allowing better understanding of risk;
- facilitate detection of potentially dangerous emergencies;
- allowing predicting a possible operational resource;
- allowing easily and correctly planning of work;
- facilitate introduction of changes in design and construction;

Thus, development and use of a digital twin is a promising method for maintenance and repair in order to extend and predict the safe operation resource.

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