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**EVALUATION OF THE EFFECTIVENESS OF STATE FINANCIAL
SUPPORT OF SMALL AND MEDIUM-SIZED BUSINESSES IN THE
MAGADAN REGION**

Akulich Oksana Vladimirovna

Doctor of Economic Sciences, Full Professor
North-Eastern State University

Chapkina Nadezhda Anatolyevna

Candidate of Economic Sciences, Associate Professor
North-Eastern State University
Magadan, Russia

Abstract. The article analyzes the methods for assessing the effectiveness of state programs to support small and medium-sized enterprises (SMEs), proposed by domestic researchers, highlight their advantages and disadvantages. The authors have selected assessment indicators that allow, in their opinion, to reliably assess the effect of financial support for entrepreneurship in the region. The technique has been tested on the example of small and medium-sized businesses in the Magadan region.

Keywords: small and medium business, government programs, financial support, efficiency

Small and medium-sized businesses, creating an impulse for economic development, in turn, need support from the state. This fact is generally recognized both in Russia and in foreign countries. The Russian government spends significant financial resources on helping small businesses, but the real return from numerous government programs is often too small compared to the resources expended. Many works are devoted to the search for a simple and accessible methodology for assessing the effectiveness of government programs to support small and medium-sized businesses.

So, in the article [Kuznetsov, 2017], a detailed analysis of programs for supporting small and medium-sized businesses operating at the federal and regional levels is carried out. Based on the monitoring of the criteria for the effectiveness of state support presented in the development programs, the authors came to the conclusion that in most regional programs,

mainly qualitative criteria are used, which do not allow us to realistically assess the return on the resources spent. To assess the effectiveness of state support, the authors suggest using the following indicators: the number of enterprises that have benefited from support and operate in the region, an increase in tax revenues due to support; the share of innovative enterprises in the total number of enterprises that received support. In our opinion, the limitations of this methodological approach are due to the fact that such a narrow range of indicators makes it possible to assess the effectiveness of government programs, but it does not take into account the socio-economic component of the effectiveness of government support and makes it possible to assess its impact on the regional economy.

In the article [Kremin, 2017], all works devoted to methodological approaches to assessing the effectiveness of state support are divided into 5 groups:

1. Based on the establishment of the effectiveness of program documents aimed at supporting and developing entrepreneurial activity.
2. Based on the assessment of the development of entrepreneurship.
3. Based on the determination of the contribution of entrepreneurial activity to the socio-economic development of the region.
4. The resulting assessment is an integral indicator.
5. Based on the study of reducing administrative barriers in the field of entrepreneurship.

The author classifies the works of the authors reviewed by him, highlighting in each group the following criteria for evaluating methodological approaches

- assessment of socio-economic efficiency;
- assessment of the effectiveness of the activities of small businesses;
- assessment of the impact of small business on the development of the territory;
- ease of interpretation of the research results obtained;
- the presence of the empirical base of research in the public domain.

The author notes the lack of a unified methodological approach to assessing the effectiveness of state support for SMEs in the works analyzed by him. The author proposes to break all the assessment indicators into two blocks, one of which reflects the state's expenditures on providing support, the second block - the effect obtained from this. In each block, particular criteria are highlighted, which are then reduced to an integral indicator for assessing the effectiveness of state support. Agreeing with A.E. Kremin in terms of the particular evaluation criteria proposed by him, we are forced to note the drawback of this approach, which, in our opinion, is inherent in

all integral evaluation methods, namely: this technique, in general, allows us to evaluate only the dynamics of the studied efficiency indicator from the "increase - decrease" position. At the same time, it is difficult to draw unambiguous conclusions about the causes of certain dynamic changes on the basis of the calculated integral indicators.

The author of the following article proposes a methodology for assessing the effectiveness of state support for small innovative enterprises [Gamidullaev, 2012]. Among the evaluation criteria proposed by him are such as the indicator of the effectiveness of state information support for small businesses engaged in innovative activities; an indicator of the availability of existing state support programs; an indicator of the effectiveness of personnel support; an indicator of the effectiveness of financial and credit support and others. In our opinion, the disadvantage of this method is that it is not universal in nature, and in addition, it is based on expert assessments, and therefore cannot be completely objective, since entrepreneurs act as experts, and the opinion of representatives of structures regulating the state support is not taken into account.

Evseeva O.A., Babkin A.V. [Evseeva, 2014] propose to use a correlation-regression model of the dependence of financial support on various indicators, such as the number of SMEs, SME turnover in the total turnover of all enterprises and tax revenues of the consolidated budget of a constituent entity of the Russian Federation received from SMEs. Having calculated the coefficients of the model and comparing the value of the resulting indicator with 1, they determine the effectiveness of state support for SMEs. The disadvantage of the described method is, in our opinion, too narrow a set of evaluation criteria.

Drozdova D.I., Zaleshina V.V. [Drozdova, 2016] propose to adhere to the traditional approach and use two indicators in assessing the effectiveness of state support: the share of small enterprises in the total number of enterprises and the number of support programs operating in the region. This method, like the previous one, is based on a too narrow range of indicators, and the conclusion about the effectiveness of support programs based only on the number of programs operating in the region does not allow us to assess the real return on the resources spent by the state.

Morkovina S.S. and others [Morkovina, 2015] suggest using key indicators in the assessment to identify SMEs requiring support, which include: an indicator of the strategic importance of an export-oriented enterprise; an indicator of the internationalization of an enterprise; indicator of social performance; indicator of budgetary performance; indicator of non-primary exports in total exports. Next, an integrated indicator of the need for sup-

port is calculated, on the basis of which four possible options for the need to support an SME entity are determined (support is necessary, desirable, possible, not needed). This methodology is aimed at export-oriented enterprises, therefore, the indicators used in it are tied to exports.

Thus, a review of works devoted to methodological approaches to assessing the effectiveness of government programs to support SMEs shows that all the methods considered have the right to exist, are developed for specific research tasks and, with varying degrees of accuracy, allow us to assess the return on public financial resources.

In our opinion, the methodology for assessing the effectiveness of state support should meet the following requirements:

- be simple, and at the same time contain a sufficient number of indicators to allow assessing the economic, social and budgetary effects of the assistance provided by the state;
- be universal in nature, be applicable to all enterprises covered by the support, regardless of their industry affiliation;
- information for the assessment should be publicly available;
- the indicators of the methodology should have a comparable form, therefore, these should be relative indicators, thus, there will be an opportunity for interregional comparisons. Identification of regions with the greatest efficiency of state support will allow to extend their experience to other regions and adjust regional assistance programs.

We agree with the authors [Grazhdankin, 2009, Kremin, 2017], who argue that the overall effect of state support for small and medium-sized businesses consists of economic, social and budgetary effects, of which the economic effect characterizes the impact of SME development on the regional economy, social effect characterizes the impact of SMEs on the standard of living and social development of the region, the budget effect shows the return on budget funds aimed at supporting small and medium-sized businesses in the form of funds returned to the budget in the form of tax revenues.

Taking into account all of the above, we propose to include the following indicators in the methodology for assessing the effectiveness of state support for small and medium-sized businesses:

- 1) Indicators characterizing the economic effect of state financial support:
 - the contribution of SMEs to the region's GRP,
 - the share of SMEs in the total number of enterprises;
 - the share of income of the Ministry of Railways in the total revenue of enterprises in the region;

2) Indicators characterizing the social effect of state financial support:
- the share of people employed by SMEs in the total number of people employed in the region;

3) indicators characterizing the budgetary effect of state financial support:

- dynamics of financial support funds
- the share of taxes from SMEs in the regional and federal budgets;
- the share of enterprises receiving support in the total number of SMEs.

Of course, the assessment of the effectiveness of financial support for SMEs will be more accurate if only enterprises that are recipients of support are involved in the calculations. However, our task is to assess the impact of state aid programs on the situation in the region as a whole. Therefore, in the testing method we will use indicators that characterize the state of small and medium-sized businesses in the Magadan region in general.

On the territory of the Magadan region there is a state program "Economic development and innovative economy of the Magadan region", one of the subprograms of which is "Development of small and medium-sized businesses in the Magadan region." The activities of the subprogram are aimed, among other things, at the implementation of financial measures to support small and medium-sized businesses.

The organization authorized to bring state financial support to small and medium-sized businesses in the Magadan Region is the Magadan Regional Fund for the Promotion of Entrepreneurship. Table 1 shows the dynamics of financial support for SMEs in 2015-2019.

As follows from the table 1, there is an annual decrease in the allocated funds, the number of recipients of support, as well as the number of activities for which funds are allocated. Thus, the amount of financial resources decreased by 2019 by 22 times, the number of recipients of financial support - by 4.5 times, in 2019 only one event was financed "Subsidizing a part of the costs associated with the payment of interest on leasing agreements by an SME entity" against 14 activities foreseen in the Program. The share of financial support in the total volume of state support for SMEs is also decreasing. So, if in 2015 financial support accounted for 83% of the total funding of the state program, in 2016 - 70.2%, in 2017 - 35.6%, in 2018 - 5.6%, in 2019 - 2.2%. Such dynamics testifies to a shift in emphasis in the allocation of budgetary funds from financial support in favor of other areas of state support - consulting, property, educational.

Further, the indicators were calculated to assess the economic, social and budgetary effectiveness of state financial support for SMEs. The results are shown in Table 2.

Table 1
Financing of SMEs through the Regional Fund for the Promotion of Entrepreneurship of the Magadan Region in 2015-2019.

Event	2015	2016	2017	2018	2019	In total
	Thousand rub. / enterprises					
Submission of subsidies to individual entrepreneurs and legal entities to create their own business	1397,4/ 3	1000,0/ 2	2435,0/ 5	500,0/ 1	-	5332,4 /11
Subsidizing part of the costs associated with the payment of interest on loans attracted from Russian credit institutions	3572,6/ 9	1182,6/ 8	229,5/ 1	-	-	4984,7/ 18
Subsidizing part of the costs associated with the payment by the SME of interest on leasing agreements	5017,2/ 32	2976,9/ 21	1495,9/ 14	308,0/ 8	2100,0/ 22	11898,0/ 97
Subsidizing part of the costs of SMEs associated with the purchase of equipment	5766,6/ 5	3797,7/ 12	2829,1/ 3	493,8/ 1	-	12887,2/ 21
Other activities	32505,2/ 50	11859,1/ 17	725,0/ 3	-	-	45089,3/ 70
In total	48259,5/ 99	20816,4/ 60	7715,2/ 26	1301,8/ 10	2100,0/ 22	80192,9/ 217

Source: compiled from [Register of SMEs - recipients of support in the Magadan region in 2015-2019, www].

Table 2.

Indicator	2015	2016	2017	2018	2019	Change (+/-) 2019 to 2015
Economic efficiency indicators						
Share of SMEs in Gross Regional Product, %	39,1	35,9	21,9	34,8	35,9	-3,2
Share of SMEs in the total number of enterprises *, %	48,4	57,6	50,5	54,6	54,2	+5,8
Share of gross income of SMEs in corporate income, %	51,6	44,2	45,6	39,9	31,3	-14,3
Social performance indicators						
Share of the employed in SMEs in the total number of employed, %	17,2	17,8	17,6	16,3	14,6	-2,6
Indicators of budgetary efficiency						
Dynamics of financial support, million rubles	48,3	20,8	7,7	1,3	2,1	-46,2
Share of tax revenues to the budget from SMEs, %	4,63	3,77	4,11	4,11	3,98	-0,65
Share of recipients of support, %	3,9	2,1	1,1	0,4	1,0	-2,9

Source: calculated from [Magadan region in figures, www; Register of SMEs - recipients of support in the Magadan region in 2015-2019, www]

* - excluding individual entrepreneurs

Analysis of the data in the table shows that over the past 5 years, all indicators of the effectiveness of state support for SMEs in the Magadan region have decreased: a decrease in funds allocated for financial support for SMEs was accompanied by a decrease in the efficiency of this sector in the regional economy, the share of taxes paid, and the share of jobs created. Thus, the proposed methodology makes it possible to assess the effectiveness of government programs to support small and medium-sized businesses fairly objectively, taking into account the economic, social and budgetary effects on the region's economy.

The analysis of the dynamics and structure of state financial support allows us to draw the following conclusions:

1. In the state programs of support for SMEs implemented in the Magadan region in 2015 - 2019, the directions of support shifted from mainly financial to non-financial forms - educational, consulting, information. By 2019, the number of recipients of financial support was reduced to 1% of the total number of small and medium-sized enterprises in the Magadan region, so that its impact was somewhat noticeable. At the same time, the reorientation of aid programs towards other forms of support brings less cumulative effect than financial support, as evidenced by the calculated indicators for 2015-2016, when the level of this form of support was 70-80% of total funding.

2. In the forms of financial support themselves, priority is given to such areas as "Subsidizing part of the costs associated with the payment of interest on leasing agreements by an SME" (this area accounts for 44.7% of recipients of support in the Magadan region). In our opinion, the choice of this particular form of support is due to the fact that non-compliance by recipients with the conditions for the provision of subsidies is easily controlled and makes it possible to require the violator to return the amount of money to the budget in full.

In 2019, Russia adopted a national project "Small and Medium Enterprises and Support for Individual Entrepreneurial Initiatives", in which the emphasis of state support was shifted towards financial assistance. Moreover, the size of the allocated funds has grown tenfold. So, for example, in the Magadan region in 2020 in the direction of "Expanding the access of SMEs to financial support, including concessional financing" within the framework of the national project, 314.45 million rubles were allocated from the state budget. (in 2018, for comparison, funding for the program as a whole amounted to 23.5 million rubles). In addition, the focus is now on repayable forms of financial support, such as microloans, bank guarantees, loan guarantees.

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COMPREHENSIVE ASSESSMENT OF THE WELL-BEING OF AN INDIVIDUAL IN THE TERRITORY OF RESIDENCE: TAKING INTO ACCOUNT THE CHANGING INFLUENCE OF INDICATORS AND CORRECTIVE MODULES¹

Kuklin Aleksandr Anatolievich

Doctor of Economic Sciences, Lead Research Officer

Ural Federal University named after the First President of Russia B. N. Yeltsin

Pavlov Boris Sergeevich

Doctor of Economic Sciences, Lead Research Officer,

Institute of Economics of the Ural Scientific Center

of the Russian Academy of Sciences

Okhotnikov Sergey Aleksandrovich

Lecturer

Oxford Language Center

Abstract. The article discusses the generalizing characteristics of the well-being of the individual in the territory of residence, the assessment of indicators is carried out according to statistical data. The author's methodology was used, which allows in general to judge the changes and trends in the development of the regions. The constituent entities of the Ural Federal District (UrFD) were selected. As a result of the research, it was suggested that the use of this approach alone does not allow to fully capture the change in trends: often the presence of a particular indicator in a specific crisis situation does not always correspond to its actual / expected state. Therefore, the calculation of the generalized normalized assessment of the well-being of an individual in the territory of residence is adjusted for changes in the indices of economic development, potential and economic security. The authors made an attempt to consider in the analysis not only the population of the subject (the number of people), but also to assess the personality from the standpoint of moral development, the level of education, the available opportunities for spiritual development, the provision of benefits necessary to maintain life and the degree of satisfaction of the needs of the population.

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Keywords: well-being of the individual on the territory of residence, subjects of the Ural Federal District of Russia, socio-economic threats, economic potential, security, economic development.

Introduction

Over the past two and a half decades, Russia and its regions have experienced significant changes in the level of socio-economic development: from the default in 1998-99, the financial and economic crisis in 2008-09 and, finally, the coronavirus pandemic from 2020 to present time. An incorrectly chosen trajectory in socio-economic development (as a developing and catching up state) only aggravated the consequences. Development was characterized in some years by low GDP rates (no more than 1.5%), financing of education, science, health care and culture (only about 10% compared, for example, with European countries). The decline in population led even before the outbreak of the coronavirus to the so-called "Russian cross", when during the year more people died than were born.

A brief analysis of the well-being of the individual in the territory of residence.

Consider a generalized normalized assessment of the well-being of an individual in the territory of residence (subjects of UrFD). The choice of UrFD subjects as a testing ground is explained by their typical diversity (the Sverdlovsk and Chelyabinsk Oblasts are industrial territories with a high level of technological and technical development, the Khanty-Mansi Autonomous Okrug and Yamalo-Nenets Autonomous Okrug are oil and gas producing territories, agricultural production and industrial production).

The authors propose to consider the state of the subjects through the prism of the well-being of the individual in the territory of residence. Welfare (the author's definition) is a complex socio-economic category that objectively characterizes the provision of a territory with vital benefits and the degree of satisfaction of the needs of the population, and is expressed in:

for a person:

- full development of human abilities;
- providing benefits to maintain the vital activity of the body, its physical and mental health;
- creating conditions that allow the individual to strive for the all-round development of abilities;
- providing the population with the benefits necessary for life;

for the territory of residence:

- providing the necessary resources for the economic complex, including in the future;
- ensuring the stability of the political system of the state;
- organization and provision of the infrastructure component;
- a combination of market and non-market sectors of the economy, a reasonable opposition to the imperatives of economic efficiency and social justice.

This analysis was carried out on the basis of the methodology [1] and represents the processing of more than 80 indicators. Further, we will use the following levels of crises: N - relatively normal situation (0 and less); PK1 - initial stage (0.001-0.332); PK2 - developmental stage (0.333-0.665); PK3 - a critical stage threatening a transition to a crisis zone (0.666-0.999); K1 - unstable stage (1-1,399); K2 - threatening stage (1.4-1.799); K3 - emergency stage (1.8 or more).

For the period 2005-2019 (before the start of the coronavirus pandemic), it showed that the state of all UrFD subjects was in the pre-crisis (PK3) and crisis (K1) zones. UrFD subjects were faced with a situation where the number of deaths exceeded the number of births (the so-called "Russian cross"). The rate of natural increase decreased in Kurgan Oblast to -6.1 people per 1000 people, in Chelyabinsk Oblast to -3.2 people per 1000 people, and in Sverdlovsk Oblast down to 2.7 people per 1000 people. The level of registration of diseases increased: for tuberculosis (the worst territories are Kurgan Oblast and Sverdlovsk Oblast (respectively 212.1 people per 100 thousand people and 179 people per 100 thousand people); for viral hepatitis - Yamalo-Nenets Autonomous Okrug (YNAO) and Khanty-Mansiysk Autonomous Okrug (KMAO) (respectively 1847 and 1614 people per 100 thousand people); in terms of the spread of HIV infection - Sverdlovsk Oblast (about 2300 people per 100 thousand people). The highest level of registration of drug addicts was noted in Kurgan Oblast (279.4 people per 100 thousand people) [2].

In terms of living standards, almost all UrFD subjects were in the crisis zone (K1-K2). This was primarily due to the low ratio of per capita income to the minimum subsistence level. In terms of the ratio of the average pension to the subsistence level, all UrFD subjects were in the crisis zone (K3). The increase in spending on the purchase of food and alcoholic beverages in the total consumer spending of the population (more than 35%) and the share of expenses for housing and communal services in the average per capita income led to the fact that the position of UrFD subjects in terms of poverty was unstable: the worst YNAO (K2) and Chelyabinsk Oblast (K1).

Methodical tools

The determination of the well-being of an individual in the territory of residence, taking into account adjustments, was carried out in two stages:

1) Calculation of the correction factors for individual modules and the correction factor as a whole. This characteristic is calculated according to the formula

$$K(t) = 1 - \text{sign}(V_i(t)) * x_i(t), \tag{1}$$

where $\text{sign}(V_i(t))$ – speed sign in year t.

2) Calculation of a generalized normalized assessment of the well-being of an individual in the territory of residence, taking into account adjustments to potential, economic development and economic security.

$$PWBI(t) = WBI(t) * K_{\text{pot}}(t) K_{\text{dew}}(t) K_{\text{ES}}(t), \tag{2}$$

where $WBI(t)$ – the value of the personal well-being index in the territory of residence without adjustment per year t, $PWBI(t)$ – the value of the personal well-being index in the territory of residence, adjusted in year t, $K_{\text{pot}}(t)$, $K_{\text{dew}}(t)$ and $K_{\text{ES}}(t)$ – adjusting factors for economic potential, development and economic security, respectively.

Results obtained

The article presents the results in the most indicative periods of development: the financial and economic crisis of 2008-09, as well as stagnation and recession in the last 4 years (table 1). 2020, the year of peak loads from the coronavirus pandemic, only aggravated the socio-economic situation.

Table 1.
Generalized assessment of the well-being of an individual in the territory of residence (on the example of UrFD subjects)

Indicators \ Years	2008	2009	2010	2016	2017	2018	2019
	Sverdlovsk Oblast						
I. Personal well-being index in the territory of residence (according to statistics, normalized assessment)	1.12 K1	1.21 K1	1.01 K1	0.85 PK3	0.89 PK3	0.91 PK3	0.91 PK3

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Corrective modules:							
Economic potential (overall coefficient of adjustment)	0.77	1.19	1.23	1.19	1.21	1.23	1.23
Economic development (overall coefficient of adjustment)	0.90	1.06	0.84	1.11	0.88	1.10	1.11
Economic security	0.753	1.116	0.639	0.566	0.501	0.506	0.508
Overall adjustment coefficient	0.52	1.40	0.66	0.74	0.54	0.69	0.69
II. Personal well-being index in the territory of residence, taking into account adjustments	0.59 PK2	1.70 K2	0.67 PK3	0.63 PK3	0.48 PK2	0.62 PK2	0.63 PK2
Chelyabinsk Oblast							
I. Personal well-being index in the territory of residence (according to statistics, normalized assessment)	1.22 K1	1.31 K1	1.203 K1	1.059 K1	0.935 PK3	0.968 PK3	0.992 PK3
Corrective modules:							
Economic potential (overall coefficient of adjustment)	0.74	1.21	1.22	1.20	1.22	1.23	1.25
Economic development (overall coefficient of adjustment)	0.89	1.04	0.87	1.08	0.89	0.90	1.10
Economic security	1.013	1.309	0.914	0.947	0.731	0.781	0.783
Overall adjustment coefficient	0.67	1.65	0.98	1.23	0.79	0.87	1.07
II. Personal well-being index in the territory of residence, taking into account adjustments	0.82 PK3	2.16 K3	1.17 K1	1.30 K1	0.74 PK3	0.84 PK3	1.06 K1

Process Management and Scientific Developments

Khanty-Mansi AO							
I. Personal well-being index in the territory of residence (according to statistics, normalized assessment)	1.057 K1	1.163 K1	1.031 K1	1.107 K1	1.133 K1	1.13 K1	1.14 K1
Corrective modules:							
Economic potential (overall coefficient of adjustment)	1.22	1.22	1.22	0.78	0.81	1.18	1.20
Economic development (overall coefficient of adjustment)	0.89	1.07	1.08	0.91	1.08	1.10	1.11
Economic security	1.072	1.082	1.066	1.187	1.116	1.154	1.156
Overall adjustment coefficient	1.17	1.41	1.41	0.84	0.97	1.50	1.54
II. Personal well-being index in the territory of residence, taking into account adjustments	1.23 K1	1.64 K2	1.45 K2	0.93 PK3	1.10 K1	1.69 K2	1.75 K2
Yamal-Nenets AO							
I. Personal well-being index in the territory of residence (according to statistics, normalized assessment)	1.263 K1	1.304 K1	1.128 K1	1.199 K1	1.199 K1	1.167 K1	1.172 K1
Corrective modules:							
Economic potential (overall coefficient of adjustment)	0.82	1.17	1.17	0.78	1.21	0.78	1.20
Economic development (overall coefficient of adjustment)	1.01	0.97	1.02	1.03	1.05	1.08	1.10

Process Management and Scientific Developments

Economic security	1.249	1.241	1.122	1.219	1.153	1.048	1.05
Overall adjustment coefficient	1.04	1.41	1.34	0.99	1.46	0.88	1.39
II. Personal well-being index in the territory of residence, taking into account adjustments	1.31 K1	1.83 K2	1.51 K2	1.18 K1	1.75 K2	1.03 K1	1.62 K2
Tyumen Oblast (south)*							
I. Personal well-being index in the territory of residence (according to statistics, normalized assessment)	1.145 K1	1.245 K1	1.055 K1	1.016 K1	1.012 K1	1.102 K1	1.084 K1
Corrective modules:							
Economic potential (overall coefficient of adjustment)	0.72	1.25	1.27	1.32	0.64	0.66	1.30
Economic development (overall coefficient of adjustment)	0.36	1.53	0.39	1.12	1.13	0.84	1.11
Economic security	1.064	1.063	1.043	0.983	1.05	1.1031	1.1051
Overall adjustment coefficient	0.28	2.03	0.52	1.016	1.012	1.102	1.084
II. Personal well-being index in the territory of residence, taking into account adjustments	0.32 PK1	2.53 K3	0.55 PK2	1.48 K2	0.77 PK3	0.67 PK3 (borderline)	1.72 K2
Kurgan Oblast							
I. Personal well-being index in the territory of residence (according to statistics, normalized assessment)	1.267 K1	1.264 K1	1.267 K1	1.222 K1	1.178 K1	1.212 K1	1.214 K1

Process Management and Scientific Developments

Corrective modules:							
Economic potential (overall coefficient of adjustment)	0.79	0.82	1.10	0.85	1.12	1.14	1.21
Economic development (overall coefficient of adjustment)	0.97	0.95	0.93	0.96	1.03	1.03	1.05
Economic security	1.1	1.268	1.263	1.084	1.29	1.067	1.069
Overall adjustment coefficient	0.84	0.99	1.29	0.89	1.48	1.25	1.36
II. Personal well-being index in the territory of residence, taking into account adjustments	1.07 K1	1.25 K1	1.64 K2	1.09 K1	1.74 K2	1.52 K2	1.65 K2

^{*)} Note: The results for Tyumen Oblast are presented without taking into account the autonomous regions of KMAO and YNAO, which are considered separately.

For Sverdlovsk and Chelyabinsk Oblasts, due to the interaction, an improvement in the normalized score in comparison with the values of the statistics is characteristic. However, for 2008-2009 the situation was the opposite, the values of the normalized estimate based on the statistics are underestimated in comparison with the adjustment data. This was facilitated by the high rate of development of the indicator "The volume of overdue debt on housing mortgage loans in the total volume of issued housing mortgage loans." For KMAO, YNAO and Kurgan Oblast, due to adjustments, a deterioration in the normalized estimate is typical in comparison with the values of the statistics for the entire time interval (deterioration of the value by 15-45%).

Conclusion

1. Analysis of the behavior of the main indicators of the well-being of an individual in the territory of residence revealed the following types of interaction: positive, negative and neutral. For Tyumen Oblast (south) there was a change in the indicator by more than 2-3 levels of crisis.

2. A real picture of the personal well-being index in the territory of residence was obtained, which differs from the statistical data:

- according to Sverdlovsk Oblast, the crisis level corresponded to K2 (according to K1 statistics); from 2017 to 2019 there was an improvement

towards PK2;

- for the Chelyabinsk Oblast, the level of the indicator during the financial and economic crisis of 2008-2009 corresponded to the Sverdlovsk Oblast; in 2019, the indicator level worsened towards K1;

- according to KMAO and YNAO, as well as for Kurgan Oblast, a stationary process and the correspondence of the indicator to statistical data are characteristic;

- in Tyumen Oblast (south), the indicator deteriorated towards K3 in 2009 (according to the statistics, this corresponded to K1). Affected by a sharp change in the growth rate of industrial production compared to the previous period.

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**DRAWING UP AN EFFECTIVE BUSINESS PLAN AS A PLEDGE
OF THE RESULTIVE STRATEGY OF THE FUNCTIONING OF THE
ENTERPRISE**

Khakhina Alla Valeryevna

Lecturer of the highest category

Chataeva Alina Andreevna

Student

The Russian Presidential Academy of National Economy and Public Administration
Kazan branch, Russia

Abstract. Drawing up an effective business plan containing the main aspects of the activity with the analysis of the main problems and the proposal of the basic ways of their making decisions gives the opportunity to identify the causes of difficulties, to find out the ways of their elimination, and to evaluate the feasibility, prospects of the enterprise that is a pledge of the resultive strategy of its functioning.

Keywords: business plan, product, market of goods, service, consumer, sale, enterprise, profit, competitor, financial plan.

Business plans are required for all types of enterprises, because they contain all the main aspects of the activity with the analysis of the main problems and the proposal of the basic ways to make decisions. Such approach reduces the risk of business failures. Besides it the realism of a business plan is very important for investors, creditors and landlords.

If the content and the structure of business plans may differ then the content is unchanged regardless of the aspects of feasibility study of a new enterprise or the development of an existing one.

In preparing the resume, it should be kept in mind that creditors and investors pay close attention to the directions, areas of activity, the company's goals, as well as the peculiarities and convincing advantages of the project over others.

It is reasonable that future investors and creditors are also interested in the amount of project income and the amount of risk of losing money in an alternative case.

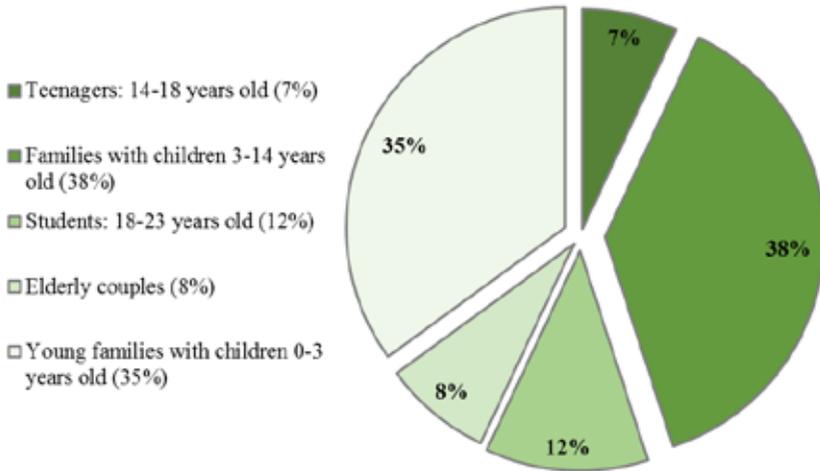
When describing a product (service), you should pay attention to the needs that they are designed to meet their useful effect and their differences from competitive ones. In characterizing the useful effect, it is necessary to emphasize the maximum satisfaction of market demands and to take into account the consumer properties of the product (service) and the price, which are decisive for the buyer and main for the competitiveness of the product (service). A visual image of the product and a sample of a product or the detailed description of the provision of services will give a clear idea of them, according to the characteristics of qualities, design, packaging and service. The expected profit based on the price of the product (service) and costs should also be reflected in the section «Description of the product (service)».

Special attention should be paid to researching of the market of goods or services. One of the most common reasons for business failures is the insufficient analysis of the market and potential consumers, their tastes, requests and funds. Therefore the entrepreneur should be made a sufficient amount of time to a thorough study of the market. It will lead to the determination of the range of consumers, the capacity of the market of goods or services and accordingly the volume of production, sale and required resources.

The implementation of a trial batch of goods or trial provision of services is given to the entrepreneur a valuable information about the market and the target audience of consumers: their categories, purchasing power, the amount of time spent on the sale of a product (service), the reaction of buyers to the price of products (service). Identifying the needs of buyers leads to the improvement of products (service), contributes to the taking and retention of certain niche in the market.

According to our sociological study of the target audience of the family cafe in the age segment the percentage ration is:

Diagram 1



When evaluating competitors it should be analyzed their business activities, paying attention to the stability of their state of affairs and the differences between their products (services) relative to competitive ones; advantages and disadvantages of their products (services), as well as the possibility of new competitors.

Building a competitive strategy, it is necessary to avoid the introduction to the oversaturated market of goods (services) and should be constantly analyzed the actions of competitors, emphasizing to the quality of products and services.

The main slogan of marketing is «to produce what is bought and not to sell what is produced». It is confirmed by studying the market and requests of potential buyers. The product (service) must be in demand arisen from the buyer's needs.

Quality and sales promotion are factors which are taken into account when choosing suppliers.

Attention should be paid to the scheme of distribution of the goods independently through wholesale organizations, stores, etc.; price formation: how the price of the product (service) will be determined, what profit is planned to obtain, to what extent the price can be reduced so that it will be given the opportunity to recoup expenses and make the sufficient profit; advertisement: how much money can be invested in it, in what form and what means to advertise the business; methods of stimulating consumers: how and for whose account to attract new buyers, to expand sales areas,

to increase production, to improve product (service), to provide guarantees or additional services, etc.; formation and maintenance of a good opinion of business: how and by what means the company will achieve a strong reputation of its goods (services) and the company itself.

The production plan contained in the production process is necessary for entrepreneurs engaged in the production of goods or services.

The company should confirm with calculations that it can produce a certain amount of products (to present services) of good quality, indicating an operating enterprise or a newly created one; a capacity, where, who, under what conditions raw materials, products and components will be purchased; whether production cooperation is implied; what equipment will be required and where it will be purchased.

An analogous sales plan is required in the case of creating a retail outlet, where the procurement of goods, the inventory control system and warehouse plan should be described and pointed out whether the appropriate premises for the store or the warehouse exist.

Possible costs and future changes should also be assessed.

One of the reasons for a business failure is an organizational confusion. Therefore, the organizational plan should be paid special attention, indicating partners whom the deal is organized and planned to establish its uninterrupted operation; specialists and conditions under which they will be employed for a full-time job under the contract or as part-time employees; how the work of each employee will be paid, on what principles and conditions the incentive will be implemented.

It should be noted that the employment of additional workers should be resorted if the profitability of the firm is increased and take in mind that the salary for employees belongs to the level of fixed costs, so strong confidence should be in their implementation.

The experience shows that entering business organizing own business should only with well-known, like-minded, initiative, striving for success people on whom you can rely on and entrust the solution to the issue of the joint venture. It is better if companions in different aspects of their activity will complement each other. It is the key to success of the company.

The financial plan summarizes in value terms the possible results of the earlier considered decisions taken. It includes: calculating of the value and determining the source of receipt of funds essential for the organization of the business, forecast the volume of sales, the balance of cash expenses and receipts, the table of income and expenses, the consolidated balance of assets and liabilities of the enterprise and the schedule for achieving the break-even point.

Resorting to a loan or investing own funds, it should be known what income money will generate. It is important to make sure that the profit from using the loan will be higher than the cost of its attracting.

The forecast of the volume of sales gives an idea of the share of the market that will be covered with the produced products (services).

The main task of the balance of cash income and expenses is the check of synchronism of receipt of cash from the sale of products and their consumption, i.e. the determination of adequacy of these funds at any one time.

The break-even schedule gives the opportunity to determine the volume of production whereby the company will begin to make a profit.

It should be kept in mind that unsuccessful decisions in the field of finance can lead to unfortunate results or loss of a part of a profit. It is advisable to resort to the services of a highly qualified financier to avoid such an undesirable option.

Thus, drawing up a business plan makes it possible to identify the causes of difficulties and to find out the ways of their elimination before they occur and to evaluate the feasibility and prospects of the enterprise that is a pledge of the resultive strategy of its functioning.

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**PRINCIPLES OF NOTARIES: COMPARATIVE LEGAL ANALYSIS
OF THE LEGISLATION OF THE RUSSIAN FEDERATION AND
FOREIGN COUNTRIES**

Kokoeva Luiza Tembolatovna

Doctor of Juridical Sciences, Full Professor, Head of Department

Esieva Fatima Kazbekovna

Candidate of Juridical Sciences, Associate Professor

North Caucasian Mining and Metallurgical Institute

(State Technological University)

Abstract. The institution of notaries is one of the most important systems of the legal system of any state. Despite this importance, various legal systems treat notaries in different ways: starting from the Anglo-Saxon system (which includes the USA, Japan and some other countries), where the approach to this activity is absolutely free, ending with the Latin system (Germany, Russia), where the notary acts as a precautionary "justice". In the presented scientific work, the institute of notaries in Russia is analyzed, the basic principles are highlighted and a comparative analysis is carried out with the notarial legislation of other countries.

Keywords: notary; legal system; principles of notaries, comparative analysis.

Russian notaries differ from similar representatives from other countries. Many countries use the Latin (free) notary system. This system differs from the Russian one in that a notary who carries out his public activities, having previously received an opportunity from government authorities, carries out such activities as a person of the free profession.

But also, many scientists who have studied the development of notaries in Russia draw attention to the fact that the principles that apply to Latin notaries were also in the system of Russian notaries. For example, referring to the sources of pre-revolutionary notarial law, namely the provision of April 14, 1866, it can be established that it legitimized some of the basic principles of the Latin system:

- for the first time, professional lawyers appeared who performed public functions;

- represented the interests of the state;
- but at the same time, this phenomenon was controversial, since the status of a civil servant was determined.

In general, the notary in Russia today is designed to protect those rights of citizens that are provided for by the Constitution of the Russian Federation and other legal acts.

But despite the importance of notaries for the entire system of legislation of the Russian Federation, not a single legislative act provides for the very concept of this institution. Based on this circumstance, different scholars offer a different interpretation of the definition of a notary:

- notary is a system of special bodies;
- notaries are special notarial acts, etc.

The Federal Law "Fundamentals of the legislation of the Russian Federation on notaries" only lists the concepts of notaries and notarial acts, without disclosing them as such.

Also, like any system-forming institution in the system of domestic legislation, the notary assumes the following basic principles [1]:

- The principle of legality.

This principle assumes that every lawyer performing notarial activities must strictly obey all the regulatory legal acts of the Russian Federation.

- Protection of the interests of persons who applied for a notarial act.

This principle means that a notary is obliged to provide services to individuals and legal entities in order to exercise their legal rights, as well as protect their legitimate interests. Also, the notary is obliged to provide advice to such persons in order to prevent harm to third parties.

- Compliance with the secrecy of the performed notarial actions.

This principle is similar to advocate secrecy: the law obliges a notary to keep secret all information that was obtained from a person in the course of carrying out notarial activities. The subject that can exempt from the protection of secrets is the court of the Russian Federation, otherwise the law provides for legal liability for unauthorized disclosure of such secrets.

- Compliance with the national language.

This principle means that notarial proceedings are conducted only in the language that is enshrined in domestic legislation, as well as in the legislation of the republics that are part of the Russian Federation. Otherwise, an interpreter must be provided to a person who does not know this language.

- Independence.

This principle means that a notary, carrying out his direct activities, must be guided only by the current domestic legislation of the Russian

Federation. The influence of any third parties on the exercise by the notary of his powers is excluded. This principle is also a guarantee for all notarial activities in the Russian Federation.

- Self-financing.

This principle means that all notarial activities should be carried out at the expense of the notary's funds. To implement the principle, the legislator has provided for special notary tariffs, reflected in the legislative framework of the Russian Federation.

- Dispositiveness.

This principle means that persons who are involved and interested in a certain legal outcome of the case have free and independent use of all funds belonging to them within the framework of notarial proceedings.

- Impartiality of a notary.

This principle intersects with the fundamental principles of the administration of justice, namely the equality of all participants before the law. In notarial activities, this means that a notary in the process of carrying out his activities is obliged to equally protect the rights of all participants in such legal relations. In other words, the notary's disinterest in any outcome of notarial proceedings should be ensured, only proceeding from the norms of legislation.

This principle characterizes the notary as one of the central systems that protect the legal rights of citizens. For this, the legislator has endowed with autonomy, independence and self-financing. But such conditions do not exist in all foreign progressive countries.

So, for example, in the USA there is another system of notaries [2]. One of the first differences that catches your eye in comparison with the notarial activity of the Russian Federation is that in the USA a notary does not have to be a qualified lawyer. Based on their notary public, a notary is a witness who enjoys a certain degree of trust.

Also, in the USA, due to their peculiarities of the legal system, each state determines its own legislation in relation to notaries. And in order to become a notary, you only need to reach the age of 18 and post a pledge. Unsurprisingly, the state of Florida has about 360,000 notaries, which equates to 1 notary for every 42 residents.

That is, such principles as the protection of the interests of individuals and the observance of notarial secrets in the United States do not exist due to the fact that a notary in America is just an honest citizen with a good reputation for fixing any oaths.

Interesting for analysis is the institution of notaries in France [3]. So, a French notary, together with his assistants, provide full support for the

service: they themselves are obliged to collect all the client's documentation, draw up it, negotiate with other persons and register any transaction. In other words, a notary in France is a private organization that transforms a transaction into a legally authentic form.

In the Netherlands and Switzerland, notaries have a mixed model [4]. A notary is also a qualified lawyer who carries out specialized activities. But before starting such activities, the notary is obliged to make a contribution to the public insurance service, which is a state fee.

Also, in case of any errors on the part of the notary in the execution and work with documents, he is responsible in proportion to the property registered for him. That is, on the one hand, in this institution of the notary there is a state principle, but the responsibility is personal and with all property.

The notary system in Germany is, according to the author, sufficiently developed and meaningful for the challenges of today. This German institute has some advantage over both foreign colleagues and Russian ones:

- notary in Germany is an institution of preventive justice. This is explained by the fact that the signature of a notary in court proceedings has more evidentiary force than the signature of individuals.

- execution of documents certified by the signature of a notary can be carried out without judicial participation.

- notarial secrets can only be disclosed in court and only with the consent of all parties, and not only by a court demand.

- a high threshold for acquiring the status of a notary. In Germany, in order to become a notary, you must have all the requirements of a "judge". The status of a judge is the status of a notary [5].

In conclusion, I would like to say that the institution of notaries in Germany is one of the best in the world system. The powers that are vested in notaries, in conjunction with the requirements that are presented to candidates, form a strong apparatus that can both facilitate the work of some state authorities and improve the practical component of notarial activities. One of the most favorable outcomes for the Russian notary system is the "adoption of experience" from German colleagues and subsequent optimization for domestic notarial legislation. This fact will make notaries in the Russian Federation, if not better, then on a par with German notaries.

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**TESTAMENT AS AN INSTITUTIONALIZED WILL:
PHILOSOPHICAL AND LEGAL ANALYSIS**

Shestakova Ekaterina Sergeevna

Postgraduate

Kutafin Moscow State Law University

Abstract. The aim of this study is to examine such a notion as will based on philosophical and legal approach and its institutionalization as a testament. Particular care is devoted to the analysis of free will and the difference between the internal will and a declaration of will and to the analysis of their influence on the consequences of transactions. The author also discusses the introduction of a new ground for inheritance such as mutual wills of spouses in the context of institutionalized will. The results of the consideration of the will show that the essential feature of such a kind of testaments is the interdependent declarations of will of each of the spouses that does not change legal nature of a testament as a transaction.

Keywords: will, inheritance, mutual wills, spouses, testament, testator

Such a complex and multifaceted category as will has been and still remains an important legal notion that requires careful consideration in the context of the analysis of a testament as one of the grounds for inheritance, expanded in recent years by the legislator through the introduction of provisions on mutual wills of spouses (Federal Law from 19.07.19 №217-FZ "On Amendments to Article 256 of Part One and Part Three of the Civil Code of the Russian Federation") (1). A testament, in fact, is a legally institutionalized will of the testator or testator-spouses, the posthumous implementation of which must be ensured. However, the expression "will", to a greater extent, is a universal category, is often used in legislation, legal literature, court decisions, and it cannot be called only legal. Consideration of this issue at the junction of such sciences as psychology, philosophy, jurisprudence is very important for identifying new opportunities and fruitful research on this issue.

Theorists hold quite various doctrines about will (2) that is explained by the uncertainty, confusion, as well as the depth of the essence of this

notion, which is an indivisible single mental process that includes certain mental components.

In meeting the objectives, a person goes through different stages of this process. Human behavior is a continuous chain of interrelated processes where goals are formed, a choice is made between them. It is impossible to exclude from it such components as memory and attitude, analysis of the situation, elaboration considering them and considering the cause of the program invariant (3).

The most significant in this chain is the traditional question of free will, which, with the term itself, was borrowed from doctrines that are not strictly legal, but was not perceived as a necessary for cognition of law.

An analysis of all points of view allows to conclude that the freedom of individuals and the freedom of their will are identic notions. Freedom draws the substance and the basic definition of will: a free is the will. Freedom is as sure as a will, as a subject. Will in law is a free will that corresponds to all the essential features of law and thus it is different from arbitrary will and opposes arbitrary behavior. The volitional nature of law is specifically due to the fact that law is a form of people's freedom, that is, the freedom of their will (4).

The problem of constitution and declaration of will for law as well as for philosophy is of great interest. Will is the main element of such a legal fact as a transaction, which gives rise to legal relationships, changes and terminates civil law relations.

The strong-willed nature of legal relations means not only their continuity with will and consciousness, the ability to respond to legal effect, but primarily the fact that these relations arise from the state will, expressed in legislation (3, p. 93). By means of will, within the legal provisions, relationships become legal relations.

The process of the constitution of a man's will aimed at making a deal (declaration of will) is a complex, multifaceted, unconventional psychological process that goes through the following stages: the emergence of a need and awareness of ways to satisfy it, method choice of satisfaction and a decision to effect a deal (5).

In the legal definition of the notion of a transaction, there is no indication of the volitional action of the participants in these legal relations, however, analyzing the legislation, we can say that the notion of will plays an important role.

A transaction as a strong-willed legal act is based not only on the desire to make a transaction, on informing all the participants about it, that is, consolidation, crystallization of this expression in the appropriate form

(otherwise it will not determine consistency and have legal consequences), but also on the full compliance of the internal will and declaration of will.

Therefore, it is so important to distinguish between these two notions, where will is a subjective moment, and declaration of will is an objective one. This distinction is very important for the further resolution of disputes and contradictions between will and declaration of will. Declaration of will is a recording of the psychological process, which makes it possible to understand the real desire, the choice of the subject's decision to conclude a transaction.

In the legal sense, the will and the declaration of will act as one, namely, if there is will, that is, the declaration of will, if there is no will, then there is no declaration of will: otherwise has no effect. They are essential elements for any civil transaction.

Even with a unilaterally authorizing or unilaterally binding transaction, which a testament is, there must be joining the will of another person for its realization, which, among other things, is reflected in the legislator's assumption of mutual wills of the spouses.

The testament is raised by the will of the testator. Without will, there is no declaration of will, and therefore, there is no testament. Even G.F. Shershenevich noted, analyzing inheritance law, that "the grounds for the devolution of property from one person to another can be: 1) a testament, 2) an agreement, 3) a law. In the first two cases, the inheritance is based on the will of the testator" (6).

In the Code of Laws of the Russian Empire, as well as in the current Civil Code of the Russian Federation, the chapter on inheritance by the testament is placed before the chapter on inheritance by law. This highlights that the legislator gives priority to the will of the testator and aims all efforts at protecting it after the death of the testator.

The Civil Code presumes conformity of will and declaration of will, but in some cases they may not coincide, and actions are performed not of their own free will, but under the influence of deception, coercion, or under threat. Accordingly, not every declaration of will can be made by a person of his own free will, and the true will will not correspond to the content of the testament due to the reasons mentioned above.

The inability of the person who made the testament to understand the meaning of his actions and to control them, which, at the same time, at the moment of the execution was considered legally capable, may also be associated with the defect of will while drawing it up.

It should be pointed out that the basis of a legally significant will is the possession of not only will in the actual sense, but also consciousness

- "will in the psychological sense". In this case, we are talking about the intellectual moment of legal capacity, which is not only the management of one's actions, but also the ability to be aware of their consequences, the result. Only having mental capacity of the subject we can equate volition with capacity. Hence the term "mature will", which means that the subject is ripe to understand and control his behavior. Here, we cannot talk about capacity without volition. In most cases, it goes beyond it, and a capable person may turn out to have a lack of will ability (3, p. 97-98).

Thus, once drawing up a testament, the intellectual capacity and volition of a person must coincide and act together. The will and desire should be emerged among the participating parties in normal conditions and coincide with the declaration of will.

Russian civilians have always stressed that a testament is a unilateral transaction involved the declaration of will of only one person (7).

A recent introduction into civil legislation of a new type of testaments, namely mutual wills of spouses, expanded the testator's ability of disposal of his property. It has to be emphasized that this kind of testaments have been successfully implemented for a long time in most countries worldwide. It has deep roots in the late 18th in common law, when it was established in *Dufour v Pereira* case. And now mutual wills is one of a range solution providing for a form of family property in common law jurisprudence (8).

In mutual wills, despite the appearance on the side of the testator of two persons - spouses, the legal nature of it as a transaction does not change, it remains a unilateral transaction that contains the interdependent declarations of will of each of the spouses.

This is the peculiarity of such testaments, without which it loses its essence. The problem of such testaments can be, as in other transactions, the dependence of the will of one person on another and thereby limiting the ability to the will declaration.

However, it can be assumed that the legislator had in mind that each of the spouses personally expresses his will, making a decision on the devolution of his property. Moreover, such a decision is mutual between the spouses (9).

Consequently, we can make a conclusion that a mutual will of the spouses is the result of an agreement between both spouses (common declaration of will), expressed in the determination of the conditions of the testament, which in this case is of the interdependent nature of instructions.

Examining the legislation in the area of inheritance, we can say that there is a clear regulation of the recording of the expression of will in the

transaction grounds of inheritance, the consequences of the discrepancy between will and declaration of will, as well as the consequences of the generating of will among the participating parties in unnatural conditions.

Such close attention of the legislator to hereditary relations, to their definition, is related with a large number of court proceedings in this area. The institution of the testament has become an urgent priority for the legislator also due to the fact that the state respects private will of the testator and its protection after his death. It is the institutionalization of the will of citizens, its regulation in the legal process for hereditary legal relations that plays an important role: it helps to implement the last will of a citizen or spouses and protect their rights.

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HIPPOTHERAPY AS A METHOD OF REHABILITATION FOR CHILDREN WITH DISABILITIES

Bulgakova Alina Anatolyevna

Master student

Moscow State Academy of Physical Education

Russian Federation, Moscow Region

Abstract. This publication is dedicated to one of the methods of rehabilitation of children with special needs, which is part of non-traditional medicine - hippotherapy. The article describes the essence and impact of this method on the rehabilitation of children with various forms of musculoskeletal disorders.

Keywords: hippotherapy; multi-sensory stimulation; rehabilitation; children's cerebral palsy; perception of language.

One of the main tasks of Russian medicine and politics in General is to nurture a healthy generation that can ensure the prosperity of the state in the future. The crisis state of society, a decrease in the birth rate and an increase in the death rate lead to an imbalance in society and, as a result, violations of state power in General. Another aspect that the state continues to improve the field of medicine and health care is the increase in the level of disability.

The very concept of disability can be defined as limitations in opportunities due to mental, physical or sensory abnormalities that lead to the emergence of social, legislative and other barriers that prevent the full integration of a person with disabilities into society.

According to statistics for 2020, the number of people with disabilities in Russia is 11875,000 people. These include both mental and physical abnormalities. The 8th place among them is the category of the population with cerebral palsy. [3]

One of the solutions for the education of children with physical and mental disorders is their integration into the conditions of inclusive education. But this decision is not always successful, since there are many children with disabilities today and schools cannot ensure the mass inclusion of children in the classes of general educational institutions. In this case,

it becomes necessary for parents to increase the intensity of rehabilitation manipulations.

Often, the path of rehabilitation for cerebral palsy takes place not only in the conditions of classical therapy for pathology of the musculoskeletal system, but also using the methods of complementary medicine. One of the ways of alternative medicine is to turn to zootherapy, which includes hippotherapy. This method is defined as a type of rehabilitation in which children practice gymnastic exercises on a horse. The benefits of using horses in rehabilitation were noticed in ancient times by Hippocrates, and nowadays it has been scientifically proven and is used in many countries. [1, 9] In Russia, as in some other countries, there is the National Federation of Adaptive and Equestrian Hippotherapy (hereinafter NF IAKS). In other words, it is a community of organizations and people promoting hippotherapy for the rehabilitation, habilitation and adaptation of patients. In addition to the interest of organizations in the development of training with horses for rehabilitation purposes, over the past few years, representatives of Russian science have become interested in this technique, who plan to introduce hippotherapy into traditional medicine, pedagogy and psychology, thereby approaching the issue of developing the technique from all angles of child development.

Speaking directly about horse therapy, it is necessary to understand the division of roles and emotional shades among the subjects and objects necessary for the successful completion of the rehabilitation process. The main feature of hippotherapy is the fact that both the subject and the object of the method should be in a harmonious relationship, which is built by the intermediary. In the course of rehabilitation activities, the owner of the horse is obliged to monitor the mood and behavior of the animal, thereby ensuring the safety of all participants. [2, 6]

The essence of the technique lies not only in the performance of gymnastic exercises on a horse, but also in direct communication between the patient and the animal, without which the continuation of the exercises becomes impossible. Emotional perception improves the psychological state of the child at the time of communication with the horse, stimulates the development of self-esteem and has a beneficial effect on the mental processes of the body as a whole. Only after reaching the necessary contact between both participants in hippotherapy will it be possible to proceed to gymnastic exercises. The positive effect of training with a horse is achieved due to several aspects: emotional attachment, together with physical activity and a special, for this type of therapy, rhythmic movement of the horse. This distinctive feature of therapy allows you to create a momentary state

that forces a child with a musculoskeletal disorder to keep balance and control the imbalance created by the horse's movements when moving. In addition, the child is given successive modifications that help correct the patient's postural control. Also, the process of riding a horse contributes to a continuous shift in the center of gravity and, as a result, postural adaptation of vestibular control. As a result of such manipulations, the child develops new somatosensory reflexes. Systematic training will allow the patient to develop the ability to control their own movements and, as a result, the movements of the horse, since the horse first listens to the impulses given by the person controlling it, and at first the owner of the horse acts as such a person in rehabilitation classes, and later the patient becomes under the control of the owner. [2, 9]

An experiment was conducted in Romania to confirm the positive effect of hippotherapy on children with musculoskeletal disorders. It was attended by 17 people with different levels of violation complexity. For the participants of the two groups, exercise systems were created with clearly defined goals and levels of difficulty depending on the degree of violation. After 2 months of experimental training, a secondary test was performed, which showed the following results for both groups:

Representatives of the group with an average level of violations showed improvements in static and dynamic balance and spatial orientation, an increase in sociability and a decrease in aggressive manifestations. No significant changes were found in the area of visual-motor coordination.

Among the representatives with a complex level of impairment, improvements were found in the field of behavioral and verbal communication, a partial improvement in paravertebral muscle tone and axial support of the head. In cases of severe muscle spasticity, relaxation was noted in the upper and lower extremities. In addition to positive changes in indicators, due to poor mental and physical endurance, symptoms of discomfort and shortness of breath were found. [4, 20]

Rehabilitation abilities of hippotherapy help to improve the condition not only among people with disorders of the musculoskeletal system, but also with intellectual disabilities, and manifestations of aggression and other mental disorders. At the same time, it is necessary to adequately assess the possibilities of hippotherapy and integrate them with therapeutic massages, speech therapy and psychological classes. In addition to additional rehabilitation actions, it is necessary to clearly understand the child's capabilities and readiness for close contact with the horse. Scientists confirmed that the greatest positive changes from riding were seen among subjects with mild or moderate levels of impairment. At the same time, it is difficult

for children with complex forms of disorders to keep on a horse due to severe musculoskeletal dysfunction. In such cases, hippotherapy should be performed in order to improve the psychological state, by introducing the child to communicate with the horse, to walk next to the horses, or even feeding the animal. To improve the emotional background, it is possible to combine several types of zootherapy.

Research in the field of hippotherapy is still being conducted. Scientists intend to improve the method of rehabilitation by integrating it with other areas of rehabilitation, including pedagogical and psychological technologies.

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FORMATION OF THE COGNITIVE INTEREST OF YOUNGER SCHOOLS IN MUSICAL ART

Lasitsa Anna Sergeevna

Student

Nizhnevarтовsk State University, Nizhnevarтовsk

Farkhutdinova Svetlana Gusmanovna

Candidate of Cultural Studies, Associate Professor

Nizhnevarтовsk State University, Nizhnevarтовsk

Abstract. In the era of innovative technologies, it is very important to promote the activation of the cognitive interest of junior schoolchildren in the music lesson for the development of an integral personality structure, as an integral part of modern society.

Keywords: primary school age, development of cognitive interest, music lesson.

From the point of view of psychologist E.R. Bern, a general education organization for primary school age, is a demanding and harsh world in which a child must be independently responsible for interacting with teachers and peers, is forced to face a demanding attitude towards himself and his actions. At this time, a new type of activity opens up for the student, which is referred to as educational activity.

According to V.A.Averin, the following fundamental factors should certainly be taken into account in the pedagogical process, namely, that the younger and middle school age is characterized by a slowdown in the process of physical development of children, an increase in the specialization of the cerebral hemispheres, a striking difference in the growth rates of muscle tissue and bones. In this connection, children have poor coordination of movements, the attention of students lends itself to rapid fatigue, there is a clear violation of posture. These spectra contribute to the depletion of students' forces, their increased fatigue, weakening of the processes of the nervous system, the manifestation of pronounced anxiety. And, as a consequence, the unconscious repression of previously acquired psychological formations.

The prerogative of the first days of finding students in school should be total control by parents and teachers. After all, the school for children

is a sharp change in the environment, which is still difficult for the body and psyche of younger schoolchildren. Therefore, it is important to create a favorable atmosphere, try to correctly involve younger students in the cognitive process [1, p. 243-244, 249, 256].

Numerous studies of psychological and pedagogical science believe that primary school age is such an age period, the leading role in the development of personality is played directly by the conditions of development. For children of this age, social conditions of life are important. In addition, the majority of a given age period of students have very different mental manifestations. In other words, in the same school, children of primary school age in different grades may have significantly different behavioral manifestations, which are mainly influenced by the social factor of the teacher, namely his communication style.

In primary school, the style of pedagogical communication between the teacher and the students is important. After all, it is communication that has a strong impact on the development of students' "ability to learn", on the development of cognitive interest, the manifestation of activity, the awakening of initiative in creative and constructive activities.

According to A.K. Markova, the following main styles of pedagogical communication should be distinguished:

- Authoritarian style, in which the student plays the role of an object of pedagogical influence. The teacher dictates his requirements to the students, establishes strict control over the implementation of his instructions, does not take into account the situations and opinions of students, does not substantiate his point of view about his actions. This style of communication repels students, contributes to the manifestation of aggression, the formation of low self-esteem. Pupils experience a decline in activity, interest in the pedagogical process, attention is activated only with the teacher's unquestioning command to fulfill his requirements. Undoubtedly, the assimilation of knowledge and the development of the personality of students with an authoritarian style is at a low level, psychological self-defense has an advantage.

- Democratic style. With this style of communication, there is a full-fledged cooperation of the teacher with the students. The teacher takes into account the opinions of students, gives students the opportunity to make decisions, approves the independence of reasoning, takes into account not only the degree of assimilation of knowledge, but also the personal qualities of students. This communication style is characterized by a favorable atmosphere, a state of calm satisfaction of students, the formation of their high self-esteem. The mechanisms of influence are

advice, an incentive to action, a request.

- Permissive style. This style of pedagogical communication is characterized by the absence of active teacher activity, relinquishment of responsibility for organizing the educational process, transfer of initiative to students and colleagues. Control and direct organization of the pedagogical process is carried out by the teacher without any formed system, the teacher shows indecision, as a result of which an unstable microclimate prevails, latent conflicts [2, p. 7, 84].

Due to the fact that a music lesson develops the spiritual and moral beginning of students, forms creative potential, musical culture, promotes self-expression, and most importantly, develops the child's personality, special attention should be paid to the development of cognitive interest in this subject in younger students. , because the elementary school is the most important foundation in which knowledge, skills and abilities, the foundations of the future personality, are just beginning to be laid.

According to psychologists, cognitive interest is the main, specific, internal motive for educational activity.

E. A. Baranova believes that cognitive interest contributes to the effective formation of a student as a subject of educational activity, because he is distinguished by incredible incentive and regulatory resources [4, p. 134].

The development of cognitive interest occurs with the direct cooperation of the teacher with the students. A benevolent interaction occurs when the teacher uses a democratic style of communication and nothing more. Since it is a favorable climate, respect for students, consideration of their opinions, encouragement that win over students and increase their cognitive interest in a music lesson.

An important aspect is the organization of work in small groups. Thus, V.F. Morgun revealed that recruiting students in groups is of great motivational importance. If, however, children with a neutral attitude to the subject are involved in joint work with students who do not like this subject, then the second, after the work done in the group, noticeably increases interest in the subject. If you combine children who love the subject with students who are neutral about the lesson, then the attitude of the latter remains unchanged.

An important study is V.F.Morgun's study, which shows that the motivational interest in the academic subject of students distributed into groups depends on group cohesion. That is, when recruiting groups, a significant role is played not only by the academic performance and general development of students, but also by taking into account the students' own de-

sires, which is taken into account only when using a democratic style of pedagogical communication. In other words, when assigning to groups, it is necessary to ask a question of this kind: "Who would you like to study with in music lessons in the same group?" The increased interest in small group interaction is facilitated by the fact that the priority is not the teacher-student relationship, but the cooperation between the students. In close-knit groups, students' interest in the subject under study has increased sharply. In the groups, in which there was no group cohesion, the attitude to the subject began to decline [3, p. 98-99].

Thus, we are convinced that it is very important to develop the cognitive interest of younger students in a music lesson. It is necessary to take into account the individual characteristics of younger students, their capabilities and abilities. The task of the teacher is to organize the musical and creative activity of schoolchildren, to create an atmosphere of trust and friendliness, in which the formation of cognitive activity of younger students, their initiative and desire for new knowledge of the world of music, will most effectively be revealed.

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FEATURES OF THE SEVERODVINSK PAINTING «BORETSKAYA» AND THE HISTORY OF ITS ORIGIN

Zakharova Svetlana Sergeevna

Undergraduate

Omsk State Pedagogical University

Abstract. The article describes the Boretskaya painting, its features and highlight the most important thing. In addition, tell about the peculiarities of the Boretskaya painting and the history of its birth with icon painting, as well as book miniatures; about compositional techniques, themes and manner, the study of traditions, preservation and research.

Keywords: Severodvinsk painting, folk art, Boretskaya painting.



Fig 1. On the map, the main villages along the North Dvina

Short description: The purpose of the article is to describe the Boretskaya painting, its features and highlight the most important thing. In addition, tell about the peculiarities of the Boretskaya painting and the history of its birth with icon painting, as well as book miniatures; about compositional techniques, themes and manner, the study of traditions, preservation and research.

Key words: Severodvinsk painting, folk art, Boretskaya painting.

Russian folk paintings are known all over the world. The murals were passed down from a family of craftsmen to a family. The followers, opening artels, passed on the skill of the folk fine applied art of painting. The most impressive among them are "Severodvinsk paintings". The term denotes

the general name for folk wood painting dating from the late 18th century in villages along the North Dvina River (Fig. 1). In Arkhangelsk Oblast in the North-West of Russia, craftsmen created wooden objects and decorated them with borets painting.

Geographically located in the Northern Dvina, Borok village. The work on typing in various areas in the North was carried out by the expedition of the Historical Museum. They began to study painting scientifically since the 50s, the organizer of the expedition was the Zagorsk Museum, which sent an expedition to the Northern Dvina. The most reliable sources are described in the works of Kruglova and Arbat. In the 16th century, the Northern Dvina was a large cultural and commercial center and a transport interchange, and the neighboring towns along the riverbed were its centers (Fig. 1). The painting was formed in the 18th -19th century in a natural way, under the influence of the posad culture in the 18th century. Products are created in the same style, which served as the basis for all peasant paintings and further developed the peasant culture of the north [1].

Boretskaya painting is colorful, it is impossible not to notice and look away. Her beauty inspired her to study motives, event plots, created by masters of folk painting, revealing her characteristic features and techniques. It got its name from the area in which it originated. Boretskaya painting has existed since the 18th century. Among the legends and legends, there is also a tale about the origin of painting. About 500 years ago, the prince from Moscow, Ivan III, occupied the local lands. Collected a quitrent from Novgorodians. The boyars, part of which was headed by the noblewoman with a strong-willed nature, Marfushka Boretskaya, rebelled against injustice. To deal with them, Ivan III sent an army, and he managed to occupy Novgorod. The noblewoman fled to the North Dvina, she settled on the shore, fenced off the area with a rampart. The name "Borok" is from the surname of the boyaryn. Martha's estate was located many miles away. Borok today is a marina. Sources on the study of painting describe that the settlers went to the village, were icon painters and miniaturists, book illustrators [3]. The nature of the products is varied: chests, spinning wheels, boxes, tues, household items and many other items (Fig. 4). The predominant theme was scenes of folk life and festivities in symbiosis with natural motives (Fig. 4). **Let's consider in more detail: Boretskaya painting** - one of the varieties of North Russian graphic painting. The name comes from the village in which it originated. Borok - the village arose on the banks of the Dvina when the Dvina region was settled by boyars from Novgorod. The choice fell on the boretsk painting, the brightest representative of the north.



Fig 2. The tree of Life



Fig 3. composition of boretz painting



Fig 4. Spinning wheels of the Amosovs

Description of the painting: The most elegant and richest is the Boretzkaya painting. The most famous products are Boretzky spinning wheels (Fig. 4). They consist of three compositional parts. A typical composition consists of a window located at the very top of a spinning wheel, a tree of life in the middle and below - young lovers on a sleigh or a coachman (Fig. 3). The compositions are inspired by folklore and folk songs. The most famous masters in this direction are the Amosov family. Their works have survived to this day (Fig. 4).

Characteristic elements: The set of technical and visual means of the artists corresponded to the rules of icon painting. The images did not have a play of light and shadow, there was no implied light source. The images are always two-dimensional, the space is infinite, and all the persons are either equally enlarged or of equal size in terms of their significance in a particular plot. The second plan is usually absent, the proportionality of scale and perspective is not always observed. A characteristic feature is the minimum of details, due to which all scenes acquire special expressiveness. The characters are facing the viewer. Painting is located on a thin layer of levkas or primer. The composition is limited by a frame, like an ark and an icon, separating reality from the painted plot. Recognizable element: shamrock, branch with berries, tulip, tree, birds, horses, geometric ornament. In the early works, the school of northern icon painting is noticeable, the trace goes into ancient Russian art. Borok's decorative art includes the moments of the census, book design, popular prints, northern writing of icon painting (clothes embroidered with pearls, hats, outerwear, bright coloring of painting, horseman). It is the composition of the spinning wheels that is compared with the iconostasis. The icon painting is inspired by the presence of some signs, while the painting itself is original. Instead of saints, various birds and rays of the sun are depicted. Lions and fairy unicorns are depicted in the windows.

Color spectrum: In addition to the traditional colors of the yellow and red palette, as well as green, gold is added to the painting, making it festive and elegant. The background usually remains white. The images are distinguished by the grace of lines and the whiteness of the background, the floral pattern stands out in color, gilding with gold leaf created a festive look and an elegant, expressive mood.

Compositional features and themes: The characteristic features of the painting of the spinning wheel are the patterns on its stem. The shamrock extends on a straight stem along the entire leg, ending with a rosette with a very rich tulip. In the uppermost compositional circle, a dove or a beautiful flower could also be placed. The legs had a certain shape: they were cut out in the form of 4, 5 circles, connected by waves. The compositions reflect the everyday scenes of the peasants of the north. A rider on a horse (from one to two) is characteristic, plant motifs - bushes with buds and curls, petal rosettes, solar symbols. On the prominent side of the spinning wheel is a wedding theme, a carriage of a guy and a girl in themed guise, a princess or a merchant's family. Red clothes with gold belts, with gold trim with pearls. For the paintings of the 17th and 18th centuries, the element of the tulip is characteristic, the heroes are dressed in beautiful boyar outfits - this is the influence of local schools in Novgorod. New compositions and a trace of old Russian themes are also emerging, each master introduces his own small character of painting, having fallen in love with depicting birds more and more solemn and with richly decorated tails. The symbolic "Tree of Life" with the image of birds was most fond of the folk masters of painting Bork. The symbol of the power of nature, the well-being of a happy life is depicted by a strong and at the same time graceful tree with roots - the "Tree of Life" (Fig. 2). This part of the spinning wheel is therefore called STAVO WITH WOOD. A favorite image - a village sleigh, transport, relevant at any time of the year and in any weather, for any holiday and fair, for a wedding - this object is present in all characteristic scenes.

Materials and tools: wood base, gouache, tempera, ink, brushes, feather, varnish, sandpaper and primer.

Conclusion: In the Boretsky paintings, everything is subordinated to the form of the object accompanied by a plot painting - both the decor and the painting are individually selected based on this rule. **Most of the masters tried to bring their own features into the painting, so the "Borok-Amos style"**, especially loved to gild the background, the contours of the horses according to a common stencil and used a compass to draw semicircles (from the research of Y. Arbat). [2]. Every piece of

Bork became a work of art. Old Russian art influenced the development of painting, monumental painting, miniature, icon painting, ornamentation of books can be traced in them. The populist masters transferred book motives and miniature techniques to painting. The principle and manner of depicting clothes, colors and characters in the drawing are laconic and simplicity. Techniques in composition are typical for icon painting and book miniatures (combination of composition and narrative scenes of different times [2].

Pigments and techniques are taken from the miniatures of Ancient Rus. We primed the product, painted with a contour, ink, then filled everything with color. The paints were diluted with egg yolk, only later they switched to dyes. Although it is borrowed from the influence of books, the nature of the painting is different. In the Northern paintings, plant motifs are visible among the components - a wriggling shoot with located sharp shamrocks and tulip-shaped flowers. Typical and popular compositions: sleigh rides, horseback riding, themed holidays and weddings, and in the center there was a fabulous bird or fish. The symbiosis of nature and man is inherently present in every plot. In the paintings, they created plot compositions in which everyday compositions, scenes with the image of hunters are common, everything is subordinate to symbols, it is especially noticeable in the composition of spinning wheels. In addition to a happy, prosperous life, wedding skating, scenes of peasant labor - scenes of the struggle of warriors, figures of horsemen, hunting scenes (Fig. 5). As an example, there is a hunting scene: the figure of the groom is the hunter, the bride is the bird. Confirmed by folklore research: before the wedding ceremony of lamentation, in words the bride compares herself to a bird, and the groom acts as a hunter [3].





Fig 5. Characteristic compositions

Images of a unicorn, lion, horse, deer, fabulous birds gamayun, sirina, peacock, swan, duck, chicken, herbs, flowers (tulips), bushes, berries, geometric signs and circles of the sun are frequent (Fig. 5). A separate symbol is the tree of life - a symbol of the power of nature, the well-being of mankind and happiness. The color palette consists of shades of red against a contrasting white background. The paintings are inherent in carpet compositions; in earlier samples they resemble arabesques. Shades of greenery and yellow palette sound like additional ones in the painting. A characteristic feature is the contouring performed with black pigment and fine goose feathers or fine hairs. Many artists painted household utensils and came from icon painting schools, participated in the painting of church walls and facades. The paintings are both traditionally pagan and have Christian content. Shows its relevance in the modern interior, household items find their place, thereby preserving the traditions of the craft. Boretskaya folk painting is a bright and distinctive art. Each master Borka brought some of his own specific character and style to the painting, worthy examples of art will always be relevant. The products have survived to this day, decorating the house and spinning wheels with paintings, by which it is possible to study the chronology of the Boretsk painting, glorifying Russia with its unique originality.

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CORRELATIONS BETWEEN AUTONOMIC REGULATION AND BLOOD PARAMETERS IN BURN TOXEMIA, DEPENDING ON AGE

Muhitdinova Hura Nuritdinovna

Doctor of Medical Sciences, Full Professor

Center for the development of professional qualifications of medical workers

Krasnenkova Marianna Borisovna

Associate Professor

Tashkent Medical Academy

Shomurodov Akmal Yangibayevich

Clinical resident of department

Center for the development of professional qualifications of medical workers

Abstract. On the first day, the level of the mesor of the circadian rhythm OBT was increased in all burned children in the first age group by 45-88%, in the second - by 49-70%, in the third - by 34-90%. During the first 10 days of burn toxemia, autonomic nervous regulation was in a state of hyperfunction, exceeding the physiological level of activity by 45-55% in infancy, by 45-90% in the preschool and school age groups. Restoration of normal red blood counts is one of the stress-limiting methods for correcting disorders of homeostatic systems in burn toxemia. The tendency to a hypersympathotonic reaction in connection with leukocytosis was observed in 1 and 2 subgroups of preschool age and in 1 subgroup of senior school age. In group 4, a negative influence of the growth of leukocytes on the activity of sympathetic influences was found. Revealed a direct stimulating effect of the growth of the number of stab cells on OBT in 1 subgroup of 1 group of children. The tendency of a negative relationship between the number of stabs in 1,2 subgroups of group 3, 4,5 groups in the first 10 days of the toxemia period is due to sympatholytics with insufficient effectiveness of anti-inflammatory therapy. The tendency to a sympathotonic response with an increase in eosinophilia in infants of the 3rd subgroup, toddlers, reflects a tendency to sensitization with a systemic inflammatory response. Correction of hypoalbuminemia provided some decrease in the hypersympatotonic response in groups 4 and 6 of burned adult patients in the first 10 days of toxemia. The aggravating effect of functional and anatomical immaturity was revealed during the

implementation of compensatory mechanisms of the hemocoagulation system in the first 10 days of burn toxemia in infants.

Keywords: autonomic regulation, burn toxemia, age

Relevance

The complex of psychophysiological and autonomic changes accompanying burn disease is reduced to an increase in autonomic tone to hypersympathicotonia. Considering that in the course of treatment, patients undergo both surgical interventions and a significant number of dressings, changes in the psycho-vegetative sphere become significant. These changes persist for years. Those who have been burned with different values of the Frank index have similar psychophysiological and autonomic disorders. On the other hand, in a particular patient, the ratio of the above indicators may differ significantly from the average, which requires targeted correction of the identified violations [1-4]. With a large volume of research results for burn shock, toxemia, septicotoxemia of burn disease, there is not enough information in the literature on the dynamics of autonomic regulation, violation of the circadian rhythm of the indicator in severe burns depending on age, which was the reason for studying the results of monitoring the indicator of general autonomic tone (GAT) and laboratory data homeostasis during toxemia.

Purpose of the work

To study and assess the correlations between autonomic regulation and blood parameters in burn toxemia, depending on age

Material and research methods

The studies were carried out in the following age groups: group 1 - 6 months - 3 years, group 2 - 3.1-7 years old, group 3 - 7.1-18 years old, group 4 - 18.1-40 years old, group 5 - 41- 60 years old, group 6 - 61-85 years old. We studied the data of hourly GAT registration and daily monitoring of indicators of conventional blood test methods (erythrocyte count, hemoglobin, hematocrit, platelets, leukocyte formula, total protein, albumin, urea, plasma creatinine, electrolytes, prothrombin index (PI), thrombotest (TT), fibrinogen, diastase, alanine transferase (ALT), asparagine transferase (AST). The research data were processed by the method of variation statistics using the Excel program by calculating the arithmetic mean values (M) and mean errors (m). To assess the reliability of the differences between the two values, the parametric Student's test (t) The interrelation of the dynamics of the studied indicators was determined by the method of paired correlations, the critical level of significance being taken equal to 0.05.

Table 1

Groups	men	women	age	total burn area,%	area of 3B degree,%	IF, units	days in hospital
1	15	7.0	18.1±7.5 months	33.6 ±10.1	9.0 ±6.5	42.1 ±16.6	22.2 ±9.6
2	11	9	4.8±1.0* years	50.8 ±14.9	25.8 ±11.6	88.7 ±36.8	46.3 ±18.4
3	14	4	12.1±3.0* years	50.7 ±12.7	11.7 ±6.5	76.3 ±19.1	34.3 ±18.2
4	13	2	27.1±4.8* years	58.2 ±14.1	20.2 ±12.0	112.3 ±35.6*	48.0 ±19.6
5	5	3	49.4±7.2* years	53.8 ±15.0	13.3 ±8.1	90.0 ±25.0*	26.5 ±13.4
6	5	3	70.1±6.4* years	35.7 ±10.6	20.5 ±7.8	77.3 ±30.2	41.6 ±19.3

*-deviation is significant relative to the indicator in group 1

As shown in tab. 1, there were 63 male patients, 28 female patients. Age, anthropometric differences were significant in the absence of significant differences in age groups in the total area of the burn, deep damage of grade 3B and the duration of inpatient treatment. A significant predominance of the Frank index (IF) in groups 4 and 5 was found, due to the aggravation of the condition by concomitant factors, such as combined injury, carbon monoxide poisoning, concomitant ischemic heart disease, burns of the upper respiratory tract.

Intensive therapy from the moment of admission was aimed at removing burn shock, adequate anesthesia and intravenous administration of crystalloids, volemic solutions under the control of hemodynamics, volume of urine output, correction of deviations in homeostasis indicators.

Results and discussion

Table 2
Dynamics of the GAT circadian rhythm mesor in childhood

Days	Group 1			Group 2			Group 3		
	6 months-3 years			3.1-7 years			7.1-18 years old		
	Sub-group 1	Sub-group 2	Sub-group 3	Sub-group 1	Sub-group 2	Sub-group 3	Sub-group 1	Sub-group 2	Sub-group 3
1	1.45 ±0.06	1.45 ±0.17	1.55 ±0.14	1.49 ±0.13	1.52 ±0.07	1.7±0.2	1.55 ±0.08	1.34 ±0.10	1.90 ±0.20*
2	1.36 ±0.05	1.37 ±0.09	1.53 ±0.10*	1.66 ±0.06	1.43 ±0.06	1.6±0.1	1.58 ±0.05	1.56 ±0.11	1.77 ±0.12*
3	1.36 ±0.04	1.43 ±0.11	1.30 ±0.09	1.52 ±0.05	1.53 ±0.05	1.8±0.1*	1.58 ±0.04	1.50 ±0.09	1.79 ±0.09*

Process Management and Scientific Developments

4	1.39 ±0.05	1.43 ±0.11	1.49 ±0.20	1.53 ±0.05	1.45 ±0.09	1.7±0.1*	1.56 ±0.07	1.50 ±0.08	1.69 ±0.10
5	1.45 ±0.05	1.52 ±0.20	1.45 ±0.18	1.56 ±0.05	1.53 ±0.07	1.7±0.1*	1.58 ±0.06	1.64 ±0.06	1.79 ±0.10*
6	1.52 ±0.05	1.49 ±0.09	1.44 ±0.20	1.58 ±0.06	1.55 ±0.08	1.8±0.1*	1.61 ±0.05	1.69 ±0.16	1.83 ±0.08*
7	1.54 ±0.06	1.34 ±0.24	1.40 ±0.09	1.68 ±0.08	1.68 ±0.08	1.7±0.1	1.58 ±0.07	1.71 ±0.09	1.76 ±0.08*
8	1.55 ±0.05	1.38 ±0.11	1.43 ±0.10	1.75 ±0.10	1.60 ±0.05	1.8±0.1	1.84 ±0.13	1.65 ±0.12	1.80 ±0.11
9	1.69 ±0.13	1.38 ±0.04	1.53 ±0.30	1.62 ±0.08	1.57 ±0.06	1.9±0.1	2.15 ±0.25	1.79 ±0.15	1.69 ±0.07
10		1.45 ±0.14	1.45 ±0.22	1.67 ±0.22	1.62 ±0.09	1.9±0.1		1.81 ±0.16	1.84 ±0.07

*-the difference is significant relative to the indicator in 1 subgroup

On the first day, the level of the circadian rhythm mesor GAT was increased in all burned children on average in the first age group by 45-88%, in the second - by 49-70%, in the third - by 34-90% (tab. 2). It draws attention to the fact that in the older school age, a significant difference in the degree of hypersympathotonic response was revealed in the 3rd subgroup relative to the first subgroup by 35% ($p < 0.05$), the second subgroup by 56% ($p < 0.05$).

In the dynamics during the first ten days of the period of burn toxemia, there was no significant change in the sympathotonic response in children of all age groups and subgroups of pediatric patients. According to the severity of burn injury, a significant increase in sympathotonic response was revealed on day 2 in subgroup 3 of group 1, on days 3-6 in subgroup 3 relative to subgroup 1 in preschool age, on days 1-7 in children of subgroup 3 of school age ($p < 0.05$, respectively). That is, despite the intensive complex therapy, with timely surgical intervention (early, delayed necrectomy), the autonomic nervous regulation was in a state of hyperfunction, exceeding the physiological level of activity by 45-55% in infancy, by 45-90% in preschool and school age groups.

Table 3
Dynamics of the GAT circadian rhythm mesor in adults

	19-40 years	41-60 years	61-78 years
Days	Group 4	Group 5	Group 6
1	1.31±0.05	1.42±0.16	1.21±0.10
2	1.37±0.07	1.17±0.06*	1.27±0.08
3	1.36±0.06	1.16±0.05*	1.37±0.09
4	1.59±0.04	1.39±0.08*	1.33±0.07*
5	1.55±0.06	1.47±0.07	1.21±0.11*
6	1.60±0.07	1.49±0.11	1.28±0.07*
7	1.67±0.07	1.49±0.08	1.37±0.06*
8	1.71±0.08	1.37±0.07*	1.25±0.07*
9	1.64±0.08	1.42±0.05*	1.29±0.11*
10	1.65±0.06	1.18±0.05*	1.26±0.13*

*-the difference is significant relative to the indicator in group 4

The hypersympathotonic response in adult patients (tab. 3) on the first day did not differ significantly from physiological values with a tendency to increase. Age differences were found, so in patients of group 5, GAT indices were found less than in 4 by 2.3.4 (by 15%, $p < 0.05$), 8.9.10 (by 20%, 13%, 28%, $p < 0.05$, respectively) day of the period of burn toxemia. In the oldest age group, a relatively less pronounced stress sympathotonic reaction was found relative to group 5 of patients on days 4-10 (by 16 -23%, $p < 0.05$, respectively). This was due not only to the age-related functional adaptive capabilities of old age, but also to a significantly smaller total burn area by 22.5% and a significantly lower IF index by 35 units (the reliability was not revealed due to the large spread of indicators).

Correlations between GAT and red blood parameters depending on age

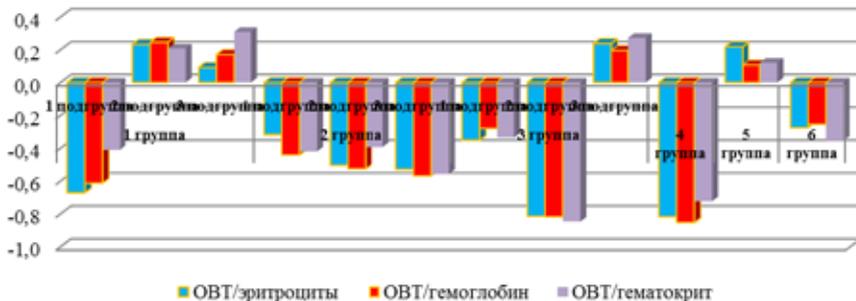


Fig.1

The predominance of negative correlations between the state of autonomic tone and the number of erythrocytes (fig. 1), the level of hemoglobin and hematocrit indicates that one of the factors contributing to the development of a hypersympathotonic reaction is a deficiency of blood parameters, that is, anemia in children of subgroup 1 of group 1, in all burned children of preschool age, 1,2 subgroups of senior school age, patients in 4 and, to a lesser extent, 6 groups. Thus, the restoration of normal red blood counts can be attributed to one of the stress-limiting methods for correcting disorders of homeostasis systems in burn toxemia.

The sympathotonic effect of the systemic inflammatory response is known under stressful influences on the body, including severe burn injury. Differentiated assessment of GAT correlations with leukocyte count parameters revealed some features depending on the age and severity of burn injury in childhood. Thus, a tendency to a hypersympatotonic reaction in connection with leukocytosis was observed in subgroups 1 and 2 of preschool age and in subgroup 1 of senior school age. In group 4, a negative influence of the growth of leukocytes on the activity of sympathetic influences was found.

Correlations between GAT and leukocyte counts

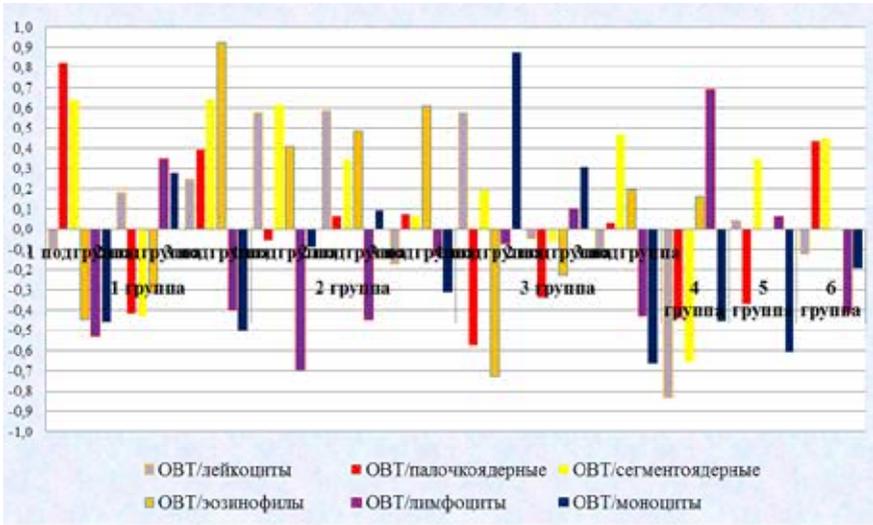


Fig. 2

A direct stimulating effect of an increase in the number of stab cells on GAT was revealed in subgroup 1 of group 1 of children, less pronounced in group 6 of patients. An interesting trend is the negative relationship between the number of stabs in 1,2 subgroups of group 3, in 4,5 groups in the first 10 days of the toxemia period, which is probably associated with the use of sympatholytic drugs with insufficient effectiveness of anti-inflammatory therapy (fig. 2). Confirmation of this assumption is the inverse correlation between GAT and segmented in group 4, moderate negative correlation between GAT and monocytes in 1 and 3 subgroups of infants, in subgroup 3 of senior school age, 4,5,6 groups of adult patients. A direct strong correlation between GAT and the number of monocytes in subgroup 1 of group 3 indicates a physiological hypersympathotonic response to the systemic inflammatory response of the body in the first 10 days of burn toxemia in schoolchildren, characterizing the insufficient effectiveness of anti-inflammatory therapy. The tendency to a sympathotonic response with an increase in eosinophilia is probably a feature of the physiological response of the autonomic nervous system to the systemic inflammatory response in infants of the 3rd subgroup, toddlers, reflecting the propensity to sensitization with a systemic inflammatory response in children of this age group (fig. 2).

Correlations between GAT and blood proteins depending on age

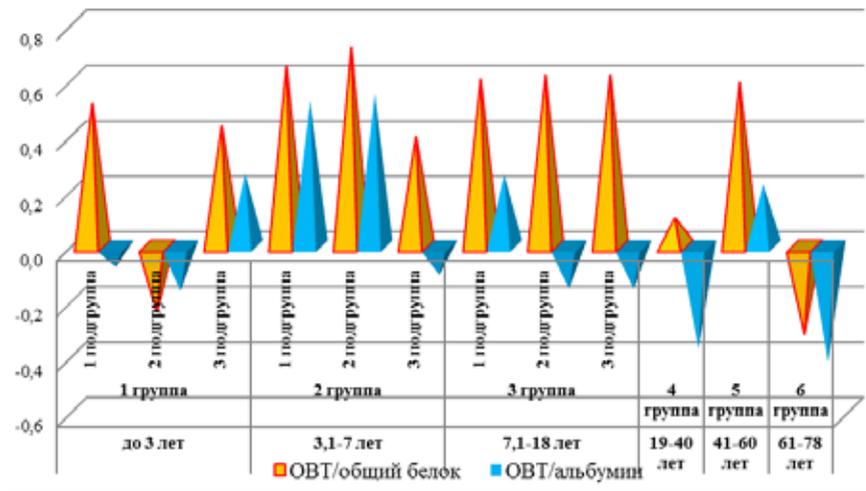


Fig.3

A positive effect on autonomic regulation of hypoproteinemia correction and restoration of plasma albumin concentration was revealed in patients in subgroups 1 and 3 of group 1, all children of preschool and school age, patients in groups 4 and 5 (fig. 3). Correction of hypoalbuminemia had a slight decrease in hypersympathotonic response in 4 and 6 groups of burned adult patients during the period of toxemia.

Correlations between GAT and blood enzyme indices depending on age

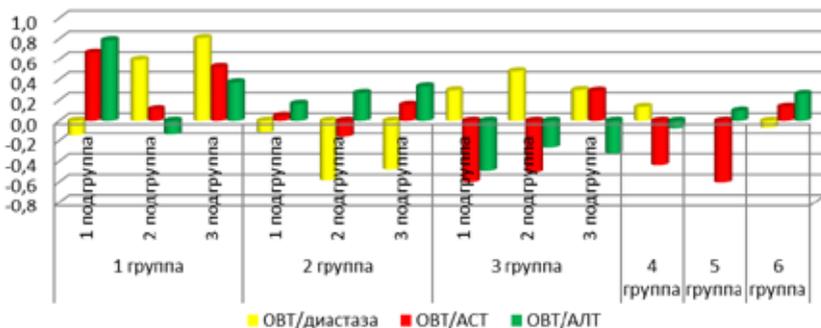


Fig. 4

As shown in fig. 4, the tendency of the hypersympathotonic response to an increase in plasma diastase was revealed in 2.3 subgroups of infants, in children of senior school age. In preschool age, insignificant stimulation of GAT was noted with a decrease in blood diastza. A significant direct correlation between GAT and ALT was found only in children of the 1st subgroup of infancy.

Correlations between GAT and parameters of the hemocoagulation system depending on age

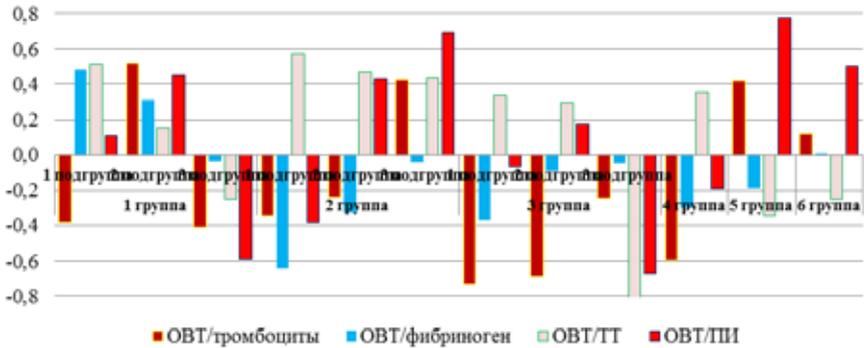


Fig. 5

Of particular interest is the correlation between the activity of autonomic regulation and the parameters of the hemocoagulation system under conditions of heparin administration with a complex of intensive therapy during the period of toxemia of burn disease, depending on the age and severity of the lesion in childhood (Fig. 5). Thus, a significant inverse relationship between GAT and the number of platelets in the first 10 days of toxemia in 1 subgroup of school-age children was found, as the injury worsened, this relationship weakened. That is, an increase in the number of platelets corresponded to an increase in sympathetic influences with a total burn area of $41 \pm 11\%$, grade 3B of $6.6 \pm 6\%$ and an IF index of 57 ± 11 units (-0.73). While in subgroup 3 of group 3, the degree of correlation significantly decreased with an increase in the severity of burn injury, an increase in the area of a deep burn 3B by 3 times to $22.5 \pm 6.6\%$, IF to 95.8 ± 19.1 units, despite almost half the total area of the burn, which was $25.8 \pm 11.4\%$ in subgroup 3 of group 3. Thus, on the basis of the obtained result, it can be concluded that the change in the number of platelets in peripheral blood during the period of toxemia is mainly influenced not so much by the total surface

damage, but the depth of the skin lesion, causing a violation of the compensatory mobilization of sympathetic influences with deeper damage to the skin surface. A reliably significant direct correlation between GAT and PI level was found in subgroup 3 of toddlers and in group 5 (aged 41-60 years), which corresponded to the concept of physiological hypercoagulation of phase 2 of coagulation in response to increased sympathetic activity during the period of burn toxemia. An unexpressed negative correlation between GAT and PI in subgroups 3 and groups 1 and 3 corresponded to the presentation of a breakdown of compensatory hypercoagulation to a sympathotonic response under conditions of a burn of 3B degree $6\pm 2.74\%$, IF 71.3 ± 8.4 units in infants and 3B degree $22.5\pm 6.6\%$, IF 95.8 ± 19.1 units in school-age children. It should be noted the aggravating effect of functional and anatomical immaturity of both the autonomic nervous system and the liver in the process of implementing the compensatory mechanisms of the hemocoagulation system in the first 10 days of burn toxemia in infants.

Correlations between GAT and blood electrolytes



Fig. 6

Timely correction made it possible to prevent significant deviations in the electrolyte balance, which manifested itself in the formation of insignificant compensatory GAT responses, although the prevalence of negative correlations in early childhood draws attention. Thus, there was a tendency towards an increase in sympathetic influences in hypokalemia in subgroup 1 of group 1, in all children of group 2. A direct correlation was found between the concentration of potassium in plasma and GAT, which is more typical for functional abnormalities of the urinary system in group 6.

Conclusions. On the first day, the level of the mesor of the circadian rhythm GAT was increased in all burned children in the first age group by 45-88%, in the second - by 49-70%, in the third - by 34-90%. During the first 10 days of burn toxemia, autonomic nervous regulation was in a state of hyperfunction, exceeding the physiological level of activity by 45-55% in infancy, by 45-90% in the preschool and school age groups. Restoration of normal red blood counts is one of the stress-limiting methods for correcting disorders of homeostatic systems in burn toxemia. The tendency to a hypersympathotonic reaction in connection with leukocytosis was observed in 1 and 2 subgroups of preschool age and in 1 subgroup of senior school age. In group 4, a negative influence of the growth of leukocytes on the activity of sympathetic influences was found. A direct stimulating effect of an increase in the number of stab cells on GAT was revealed in subgroup 1 of group 1 of children. The tendency of a negative relationship between the number of stabs in 1,2 subgroups of group 3, 4,5 groups in the first 10 days of the toxemia period is due to sympatholytics with insufficient effectiveness of anti-inflammatory therapy. The tendency to a sympathotonic response with an increase in eosinophilia in infants of the 3rd subgroup, toddlers, reflects a tendency to sensitization with a systemic inflammatory response. Correction of hypoalbuminemia provided a slight decrease in the hypersympathotonic response in groups 4 and 6 of burned adult patients during the period of toxemia. The aggravating effect of functional and anatomical immaturity was revealed during the implementation of compensatory mechanisms of the hemocoagulation system in the first 10 days of burn toxemia in infants.

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**PROSPECTS OF ARTIFICIAL INTELLIGENCE IN CARRYING
OUT THE ONCOLOGICAL COMPONENT OF THE MEDICAL
EXAMINATION OF THE POPULATION**

Cherenkov Vicheslav Grigorevich

Doctor of Medical Sciences, Full Professor
Institute of Medical Education

Veber Viktor Robertovich

Doctor of Medical Sciences, academician RAN, Head of the Department

Pasevich Konstantin Grigorevich

Candidate of Medical Sciences, Head of the oncological dispensary
Yaroslav-the-Wise Novgorod State University

Annotation. Creation of a robotic complex (RC) with a program for interviewing with illustrations (by the type of whether there are similar forms of pathology) of major tumors, a portable USB microscope built into a flexible hose and the body of the complex for transmitting pathological changes of visible localizations to the touch screen. To detect the activation of early signs of pigmented nevi and superficially spreading melanomas, they were stained with picrofuxin (Patent for invention No. 2716811 of March 16, 2020). The survey was conducted in 1638 patients with a trajectory for men and women on a touch screen. The use of RC allowed us to suspect the activation of pigmented nevi, tumors of the skin, oral cavity, thyroid gland, and enlarged lymph nodes in $9.03\% \pm 1.3$ patients, of which $31.08\% \pm 1.8$ were able to confirm oncopathology on further examination. In the presence of complaints from the stomach on an empty stomach, 107 patients underwent a "breath test" on a Helik@-Scan, built into the RC program. The color change in the "breathing tubes" was scanned with fixation on the touch screen, in 29 of them, Helicobacteriosis was detected above 10 units. with a load. 17 patients were diagnosed with grade 1 and 2 metaplasia, 4 with gastric ulcer, and 3 of them with malignancy. In 20 patients, type 2 diabetes mellitus was detected for the first time as a risk factor for the development of tumor diseases by a non-invasive method. The results of the examination by the program of the complex with recommendations were sent via an On-line connection to the general practitioner.

Keywords: robotic complex, survey with illustrations, "breath test", USB microscope, picrofuxin. diabetes mellitus

And although malignant tumors are extremely diverse and difficult to diagnose, a lot is known about the risk factors and mechanisms of cancer development, so that now in most cases, not only timely diagnosis and treatment, but also taking an active position in assessing the specific risk, successfully conduct prevention. The doctor should conduct a systematic examination of the patient not when something "hurts", but regularly, when nothing hurts, taking into account the risk groups, gender and age when contacting the doctor for any reason.

Early forms of cancer are preceded by a long period of carriage of oncogenic viruses, *Helicobacter pylori* and dysplasia, which can be established and cured. With a large flow of information during mass screening, asymptomatic signs of an early focus of developing cancer in organs and systems, the doctor's time limit, often limited to one question "What is Bothering you?". Naturally, asymptomatic pathological processes with this approach, against the background of concomitant diseases, go into the background. And this is the weakest link in primary diagnostics, which requires the creation and implementation of digital technologies that increase "oncological alertness" at the primary stage [1,2].

The goal is to find solutions to the problems of increasing the effectiveness of detecting oncological pathology and risk factors by using a robotic complex for a system survey-examination of the main localizations to reduce the time spent by the doctor prior to his appointment.

Material and methods

Robotic intelligence is a method that allows you to implement algorithms for multi-purpose and system analysis in the diagnosis. The study of the effectiveness of the robotic complex was carried out on the basis of the created system examination program with illustrations, a touch screen, magnifying diagnostics (including a portable USB microscope with an LED) of visual localities (skin, oral cavity), non-invasive determination of sugar, "respiratory urease test". Then an assessment was carried out, recommendations for further tactics were formed, and the results were transmitted to the doctor. Previously, a large-format digital television screen is installed in the waiting hall of the polyclinic, which is associated with the prevention program and explains the tasks of the need to pass the robotic complex (like a slide show). The survey program of the robotic complex is carried out on the touch screen. At the beginning, the passport data is filled in Fig. 1 (a).



a)

б)

Fig 1. Touch screen: a) keyboard for filling in passport data; b) Questions with illustrations of pigmented tumors

Then follow the questions on the main localizations with illustrations of (melanoma and non-melanoma) tumors (Fig. 2b), precancerous skin conditions, risk factors and other conditions, organ systems, lifestyle and habits

For example:

1. Do you have any skin problems (sores, cracks, or others?) formations that have recently:

1. Yes, it is possible to change the shape, color or size

2. Yes, there was a tumor spreading over the skin, in places with raised edges

other changes, sometimes itching

3. Yes, there is an ulcer on the skin that does not heal for more than 3-4 weeks*

4. Yes, there is a formation in the form of a skin-colored plaque with a depression in the center, raised shiny pearlescent edges

5. Yes, there are, but I do not know how to evaluate

6-Yes, there are several signs

7. No, nothing



Fig. 2. Precancerous changes and basal cell forms of cancer

2. Do you have a pigmented spot(s) in the area of the face, back, neck, including the nail bed (without bruising) or other places, including under magnification ?

o Yes o No

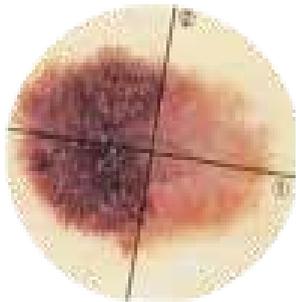


Fig.3. Do you have a pigmented spot(s) in the area of the face, back, neck, including the nail bed or other places, including under magnification?

Given the extremely high rate of advanced cases of oral cancer, we integrated a portable USB microscope with an LED into a flexible hose that enters the side of the body of the robotic complex to transmit pathological

changes in the skin and oral cavity to the touch screen. Suspicious areas can be zoomed in or out on the screen to detect signs of malignancy.



Fig. 4. Examination of the oral cavity (under the tongue)

On the front panel of the case, a ring is fixed for a container with disposable spatulas in sterile bags in order to displace the mucous membrane of the cheek and tongue for examining the hidden places of the oral cavity.

For the accuracy of the assessment of pigmented nevi, the magnifying magnifier and mirror were replaced with a USB portable digital microscope with pre-staining with picrofuxin for 7-10 minutes [3,4]. After absorption through the epithelium, allows detecting violations of the rhomboid shape of collagen fibers, the appearance of pigment globules, etc. identify the first signs of the transformation of the pigmented nevus into melanoma on the computer screen (Fig. 5).

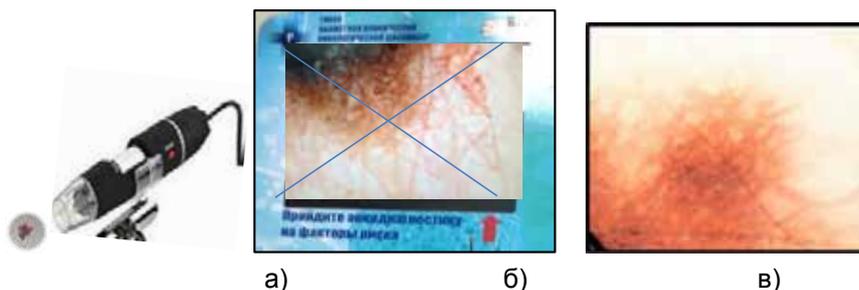


Fig. 5. Pigmented formations under a microscope with picrofuxin staining: a) USB microscope x 100; b) Fibers diamond-shaped depart from a simple nevus; b) collagen fibers depart chaotically with point inclusions

The survey organizer is a specially trained nurse operator or midwife of the examination room. which includes a robotic system and code registration. The nurse operator helps to answer questions, signs or factors that cause difficulties for the patient. The survey trajectory is based on gender and clarifying factors .

As you know, stomach cancer occupies a leading place among other malignant tumors. The proven cause of stomach diseases is the bacterium *Helicobacter pylori*. In the presence of the slightest complaints from the stomach and other digestive organs, it is recommended to conduct a sensitive "breath test" based on the "Helik®-Scan" (AMA company), built on the front panel of the robotic complex.

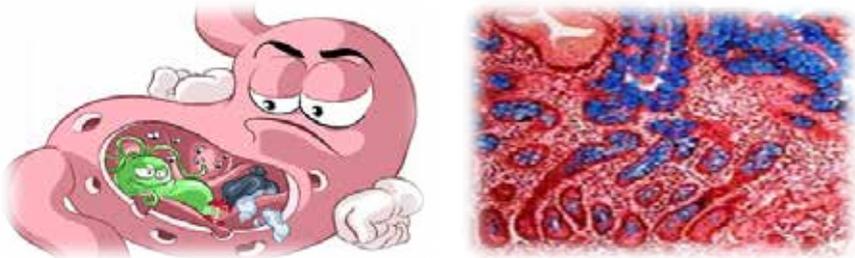


Fig.6. Stomach with Helicobacteriosis

Two "breath tests" were performed on an empty stomach : before taking urea (basal test) and after (with exercise). In case of infection with *Helicobacter pylori*, a second test (with a load of urea or urea) on the screen, the blue bar in comparison with the basal test significantly increased in proportion to the percentage of ammonia in the exhaled air. The program in the "on line" mode reflected the change the length of the second sample on the screen, respectively, is the infection of the stomach with *Helicobacter pylori*.

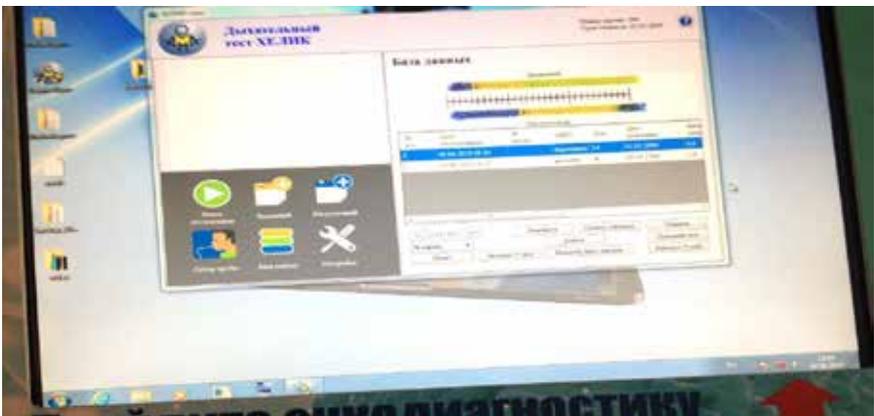


Fig.7. Results of patient P., 42 years old

In Figure 7 - On the right in the upper rectangle, two yellow stripes are visible (the upper one-one end turned blue after basal respiration -4.9 units; the lower one-after exercise-10.8 units).

Results. The studies were conducted in 1,657 patients who applied to the regional clinical oncology dispensary on the "Open Day" and after advertising exhibitions. The use of the robotic complex is suspected: tumors of the skin, oral cavity, thyroid gland, enlarged lymph nodes in (168 patients) 10.01%±1.3, of which (46 patients) 31.08%±1.8 with further examination, oncopathology was confirmed, including 3 patients with melanoma, 5 with basal cell carcinoma and in one case with thyroid cancer and in two with oral cancer. In addition, 8 patients were found to have melanoma-like nevi.

Table 1. Survey results with illustrations and chromo microscopy

Localization	Number of patients with suspected pathology	Installed	
		Precancerous changes, risk, milano-dangerous nevi	Malignant diseases tumors
Skin	16	8	8
Oral cavity	11	9	2
Lymph Nodes	19	19	-
Shields. iron	44	43	1
Moloch. iron	58	56	2
Diabetes mell	20	20	
Total	168	155 (9,3%)	13 (0,7)

58 patients with complaints of certain phenomena of stomach discomfort were given a "breath test" for 6 minutes the next day, 29 of them had helicobacteriosis above 10 units. with a load. All these patients underwent fibrogastroscopy (FGS) with biopsy for atypical cells and Helicobacter pylori for reliability. 17 patients had metaplasia of the 1st or 2nd degree, 4 had gastric ulcer and 3 of them had malignancy. In 20 patients type 2 diabetes mellitus was detected for the first time as a risk factor for tumor diseases by a non-invasive method .

All results of the RC program via the local Internet system and recommendations for further tactics should be sent to the attending physician, who, after the necessary additional examination of the patient, established the final diagnosis or referred to the necessary specialist.

Discussion

The RC and preliminary results described in this paper, taking into account the methods of targeted survey with illustrations used in the screening of persons who applied in terms of experimental examination, showed that the detection rate of malignant tumors was $0.7 \pm 1.2\%$, precancerous changes and melanoma-threatening pigmented nevi- $0,48.2 \pm 2.2\%$. For the accuracy of the assessment of pigmented nevi, the magnifying glass was replaced with a USB portable digital microscope with pre-staining with picrofuxin. Moreover, the melanoma can not be injured and perform a biopsy.

The use of a Helik®- scan in a complex digital program allows you to determine the causes of gastric discomfort. When the level of Helicobacter pylori infection exceeds 10 units, eradication and fibrogastroscopy are required, in which the detectability of grade 1-2 metaplasia and peptic ulcer disease was 7 пациентов, including malignancy in 3 cases.

Conclusions:

1. Conducting explanatory preventive work on digital television screens like a "slide show" in the halls of polyclinics increases the cancer literacy of patients, the purposefulness of passing their dispensary examination and the need for screening.
2. The results of the introduction of the robotic complex at the pre-medical stage allows you to save the time of a general practitioner for a systematic examination and identification of cancer risk factors and early forms of cancer ($0.79\% \pm 1.2$), precancerous changes and melanoma-prone pigmented nevi- $0,48.2 \pm 2.2\%$, the treatment of which is less expensive.
3. Digital technologies in the examination of patients are a real breakthrough in the primary diagnosis of risk factors and early forms of cancer, requiring their adaptation for each polyclinic and paramedic-obstetric stations with some improvement in the program and organization of the production of robotic complexes.

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EVALUATION OF THE QUALITY OF BACTERIAL BIOMASS BY TRANSMISSION ELECTRON MICROSCOPY

Gerasimov Vladimir Nikolaevich

Doctor of Biological Sciences, Head Research Officer, Head of Department
State Research Center for Applied Microbiology and Biotechnology

Abstract. Transmission electron microscopy can be successfully applied to quantitatively assess the quality of bacteria and microbial populations when studying the mechanism of cell inactivation at different stages of contact with disinfectants, antibiotics, biocins, including various stressful, damaging and lethal physical and chemical influences, as well as when debugging various biotechnological processes on stages of microbial cultivation, concentration and dehydration of biomass, etc.

This methodology is based on the technique of accelerated preparation of bacterial images for visualization of the fine structure of bacteria in an electron microscope and the technique of cytological analysis of the quality of bacteria in the biomass and quantitative assessment of the safety and damage of cells, diagnostics of structural disorders.

Keywords: transmission electron microscopy, bacteria, ultrathin sections, fixation of bacteria, cytological assessment of the quality of bacterial biomass, intact cells, bacterial cells with reversible damage, irreversible structural damage.

Evaluation of the effect of new disinfectants, antibiotics, biocins, physical and chemical agents on the fine structure of bacteria is carried out using the method of visualization in a transmission electron microscope of ultrathin sections, which makes it possible to reveal the features of the state of the ultrastructure of the cell both in normal conditions and after various stress and lethal effects. It should be noted that electron microscopy methods allow obtaining data both on a fairly representative sample of the population and on single cells, their structure and processes occurring in them. The method of ultrathin sections is one of the main methods of transmission electron microscopy of biological objects. With its help, the features of the fine structure of cells and supramolecular complexes are revealed, the fine structural bases of many biochemical, physiological pro-

cesses are revealed; mechanisms of pathological changes in cells.

When analyzing the material, this method, by changing the magnifications, allows one to find the most subtle violations of the ultrastructure (at high magnifications), at the same time, at low magnifications, it makes it possible to work with a fairly large sample of the microbial population.

The method consists in the fact that the biological material fixed and enclosed in a plastic mass is cut into thin sections and viewed in an electron microscope. In microbiology, the method has been most successfully applied since the last century, when, through the efforts of scientists Reiter and Kellenberger, a successful technique for fixing and dissecting bacterial cells was created, in which many of their features were taken into account. Let's list its main stages: the primary fixation of the material is carried out with a buffered solution of glutaraldehyde for 24 hours. The material is washed and embedded in agar. Additional fixation of samples is carried out for 4-16 hours in a buffered solution of osmium tetroxide (O_sO_4), washed and additionally contrasted in a solution of uranyl acetate. Dehydration of biological material is carried out in an ethanol concentration gradient. Then the samples are impregnated in several changes of solvent and epoxy resin, for 18-20 hours each and, finally, impregnated in pure resin. At the end of the impregnation, a two-stage polymerization is carried out: 24 hours at 37°C and 48 hours at 60-70°C. Traditional preparation of ultrathin sections of a particular sample takes 7-12 days [1-3, etc.].

However, in order to assess the quality of microorganisms at different stages of development and testing of technologies for the production of vaccine preparations, biological products, biologically active substances and drugs of microbial origin, it is important and urgent to include express methodological approaches for visualizing the ultrastructure of bacteria and quantitative methods for assessing the quality of cells and microbial biomass at any stage of the study of the damaging effect of disinfectants, antibiotics, biocins, or at different stages of the biotechnological process.

The purpose of this work - is to develop methodological techniques for express visualization of the ultrastructure of bacteria in a transmission electron microscope and methods for assessing the quality of cells and microbial biomass at different stages of development and pilot production of microbiological preparations.

Research results and discussion

To obtain high-quality sections, the implementation of the main steps of the ultrathin section method is mandatory. Attempts to simply shorten the timing of individual stages most often ended in a deterioration in the quality of the images. Unsuccessful preparation of a biomaterial simply closes the

possibility of conducting a high-quality ultrastructural analysis, therefore, any changes in the preparation technique must be justified and debugged. The traditional method of preparing ultrathin sections, albeit based on fairly accurate chemical concepts, was developed empirically and was polished in many laboratories. Taking the "working" method as a basis, we tried to get a faster way of preparing biological material.

The developed technique of accelerated fixation and preparation of cells is based on the same basic principles of material preparation: double chemical fixation of cells, their dehydration, impregnation and filling in plastic media. But if the usual process of fixation and preparation takes about a week, then with the help of the proposed method it is completed in a day with the receipt of sufficiently high-quality images. The essence of the described technique is that in order to reduce the time for preparing bacteria for analysis, fixation and staining of cells is carried out simultaneously, excluding the stages of washing and encapsulation in agar, and the time of impregnation and polymerization of the material is reduced.

The composition of the prefix mixture in% by weight is as follows:

25% glutaraldehyde	2.0 - 2.5
Uranyl acetate	0.5 - 0.6
CaCl ₂	0.11 - 0.12
Acetate-veronal buffer pH 6.0	all the rest

According to the accelerated technique, the bacteria are initially prefixed for 5-10 minutes in the specified mixture. Then to it add 3-4% solution of osmium tetroxide in a ratio of 1:1 (volume/volume) and carry out additional fixation for 55 minutes at room temperature. The microbial suspension is centrifuged and the sediment is dehydrated in an ethanol concentration gradient: 50% 10 minutes, 70% 10 minutes, 80% 10 minutes, 90% 10 minutes, 95% 10 minutes and 100% (absolute ethanol) 3 shifts of 20 minutes. The samples are impregnated in three changes of absolute ethanol and araldite, or propylene oxide and epon in ratios of 3:1, 1:1, 1:3 at 37°C for 1.5 hours each, then transferred into pure araldite (epon) and kept in vacuum (10^{-2-3} torr) 1.5 hours at 37°C. The samples are embedded in fresh resin and polymerized at 90 ° C for 14 hours.

Thus, the proposed method allows for 23 hours to prepare cells for ultrastructural analysis. Further operations - making sections, additional contrasting and viewing are carried out as usual.

Let us dwell only on the most important stage of the methodology, which required maximum practicing - fixation of the material. It is the optimal fixation that allows both preserving cells in a state close to their lifetime, and protects cells from damage inevitable during dehydration, pouring, and

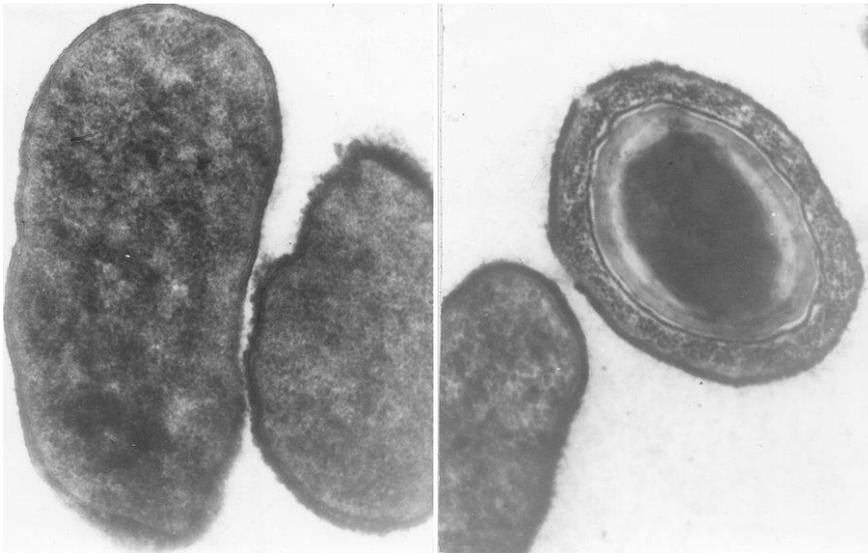
cutting on an ultramicrotome. We used a mixture of glutaraldehyde, uranyl acetate, and osmium tetroxide for fixation. Uranyl acetate is used more as a dye to enhance image contrast. However, it was shown that rapid pre-fixation with a mixture of glutaraldehyde uranyl acetate makes it possible to obtain fairly good sections [4]. Perhaps this is due to the fact that 0.5% uranyl acetate gelifies a DNA solution in a few minutes, preserving the DNA structure, which has always been a preparation problem. In our own research, we have repeatedly found a positive result of a brief pre-fixation of biomaterials in glutaraldehyde and used this moment here. It is essential that in the absence of laundering at the post-fixation stage, we have a mixing of fixatives. When mixed, these substances can react with each other to form components and complexes that have an additional preserving and fixing effect. It was found that the fixation of bacteria in the proposed mixture allows better visualization of the membrane structure and minimizes the extraction of nucleoid and nucleoplasm components. Note also that at the stage of impregnation of samples with resins, the best results were obtained using propylene oxide.

The study of "accelerated" sections in a transmission electron microscope showed that the fine structure of the cells under study is qualitatively preserved. To test the versatility of the technique, a number of gram-positive and gram-negative microorganisms were taken: *Escherichia coli* strain K 12; *Bacillus thuringiensis* strain 52; *Bacillus anthracoides* strain 250, etc. Fig. 1 shows micrographs of ultrathin sections of bacteria prepared by the method of accelerated fixation and preparation of cells. In the course of research, we were repeatedly convinced that the selected conditions make it possible to identify all the main elements of the ultrastructure of both vegetative and spore forms of microorganisms (fig. 1).

An important task of this study is also the introduction of a quantitative assessment of the information received. The traditional cytological description of the structure and level of preservation of microorganisms usually does not set itself the task of assessing the state of the cell population as a whole, limiting itself to visualizing individual cells and the smallest substructures. But for microbiological and biotechnological practice, a qualitative approach is clearly insufficient. In addition, a subjective moment is inevitable in assessing the state of microbial cells. Quantitative approaches to the analysis of the quality of biomass after various impacts are still lacking. Therefore, in front of us stood the task to develop an objective quantitative method for assessing the quality of biomass, which allows with a high degree of reliability to assess the level of viability of microorganisms in various biomass samples.

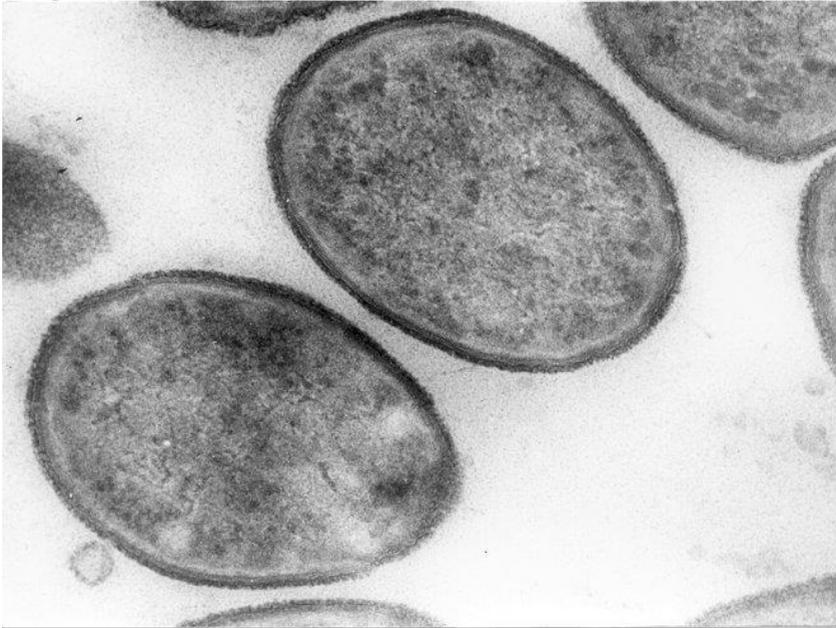
To find differences associated with different sensitivity of strains to a certain disinfectant or to visually represent the state of the population at different stages of processing, we could simply get images and describe them. But to describe the dynamics of the response of the microbial population to a specific drug, to compare the kinetics of alterations of different substructures, different strains, for different stress effects (antibiotics, biocins, disinfectants, etc.) was already impossible without a quantitative analysis of the material.

The proposed method of cytological analysis of the quality of cells was intended for quantitative assessment of the safety of cellular ultrastructures and diagnostics of their disorders. She proceeded from the division of the population using morphological criteria into 3 main groups based on morphological integrity.



A

B



C

Fig. 1. Electron microscopic images of ultrathin sections of bacteria obtained using an accelerated technique for preparing bacteria and spores for examination in a transmission electron microscope. A. Electron micrograph of the fine structure of bacteria *Escherichia coli* strain K 12, magnification 85000 times. B. Micrograph of bacteria *Bacillus thuringiensis* strain 52 at the stage of sporulation, magnification 70000 times. Fine structure of bacteria *Bacillus anthracoides* strain 250, an increase of 70000 times

The method of cytological analysis is based on viewing a certain number of images of microbes, when, based on cytostructural criteria, the state of individual cells and the biomass as a whole is assessed. Practical work with ready-made sections was carried out in the following way: ultrathin sections were viewed or photographed in a transmission electron microscope at working magnifications of 10-15 thousand times. From each sample, 15-20 random fields are photographed, which contain equatorial sections of 300-500 cells.

Hence, when visualizing the fine structure of bacteria, they are divided into three main groups of cells:

- intact or intact cells;
- cells with reversible damage;
- cells with irreversible damage, or destroyed cells.

Intact gram-negative cells are visualized with a clear, continuous, three-layer contour of the outer and cytoplasmic membranes. Intact gram-positive bacteria have one or a multi-layered homogeneous cell wall tightly adjacent to a three-layer continuous cytoplasmic membrane. For gram-negative and gram-positive bacteria in an intact state, the absence of a pronounced periplasmic space is characteristic. The cytoplasm of intact cells has a homogeneous, fine-grained structure of average electron density with a granule size of 15-30 nm, in accordance with the size of the ribosomal structures. The nucleoid has a fine fibrillar structure in the form of a compact zone of lower electron density relative to the surrounding cytoplasm. Distributed throughout the cell diffusely or centrally (fig. 2 A).

a) cells with changes in size and shape, for example, due to compression during temporary dehydration or swelling with temporary violation of permeability barriers;

b) a subgroup of plasmolyzed cells of a cell, where the main violation is the separation of the cytoplasm from the cell wall due to an increase in the osmoticity of the medium, this process can be accompanied by a partial thickening of the cytoplasm and a change in shape, but it is very important that the integrity of the membrane apparatus is fully preserved (fig. 2 C) ;

c) cells that have various violations of the cell wall in the form of ruptures of the outer membrane, or ruptures of the cell wall for gram-positive bacteria, but retaining the integrity of the cytoplasmic membrane and with an intact structure of the cytoplasm and nucleoid (fig. 2 B).

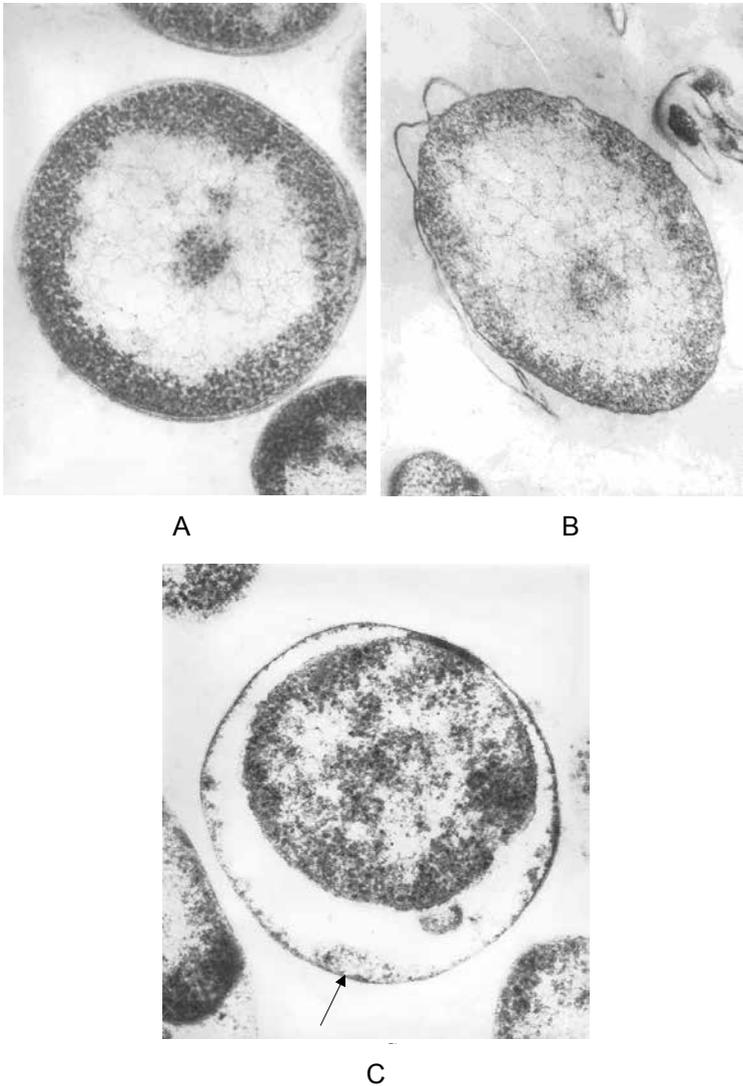


Fig. 2. Electron microscopic images of *Francisella tularensis* 15/3M bacteria with reversible ultrastructural abnormalities. A. Image of a cell with intact ultrastructure, magnification in the photo 120000 times. B. A bacterial cell with a ruptured outer membrane (arrow), magnification 100000 times. C. Image of the ultrastructure of the plasmolyzed cell (arrow), magnification 100000 times

All these cases refer to reversible violations of the fine structure of bacterial cells. With a variety of disorders in the area of the cell wall, the integrity of the cytoplasmic membrane and the safety of the intracellular compartment are observed.

Irreversible disturbances in the vital activity of cells inevitably occur when the integrity of the cytoplasmic membrane and destructive processes in the zone of the nucleoid or cytoplasm are disturbed. Accordingly, the group of bacteria with irreversible damage includes cells that have:

- a) rupture of all layers of the cell wall, which is usually accompanied by the release of cellular contents (fig. 3 A);
- b) cells with partial destruction of the cytoplasm and nucleoid (fig. 3B);
- c) cells with complete destruction of the contents, autolyzed cells (fig. 3C).

The quantitative data are then statistically processed. The result of the analysis is to determine the percentage of intact and damaged cells in the studied population. For cells with damage, the frequency of detection of each type of damage is determined.

Conclusion. Transmission electron microscopy can be successfully applied to quantitatively assess the quality of bacteria and microbial populations when studying the mechanism of cell inactivation at different stages of contact with disinfectants, antibiotics, biocins, including various stressful, damaging and lethal physical and chemical influences, as well as when debugging various biotechnological processes on stages of microbial cultivation, concentration and dehydration of biomass, etc.

This methodology is based on the technique of accelerated preparation of bacterial images for visualization of the fine structure of bacteria in an electron microscope and the technique of cytological analysis of the quality of bacteria in the biomass and quantitative assessment of the safety and damage of cells, diagnostics of structural disorders.

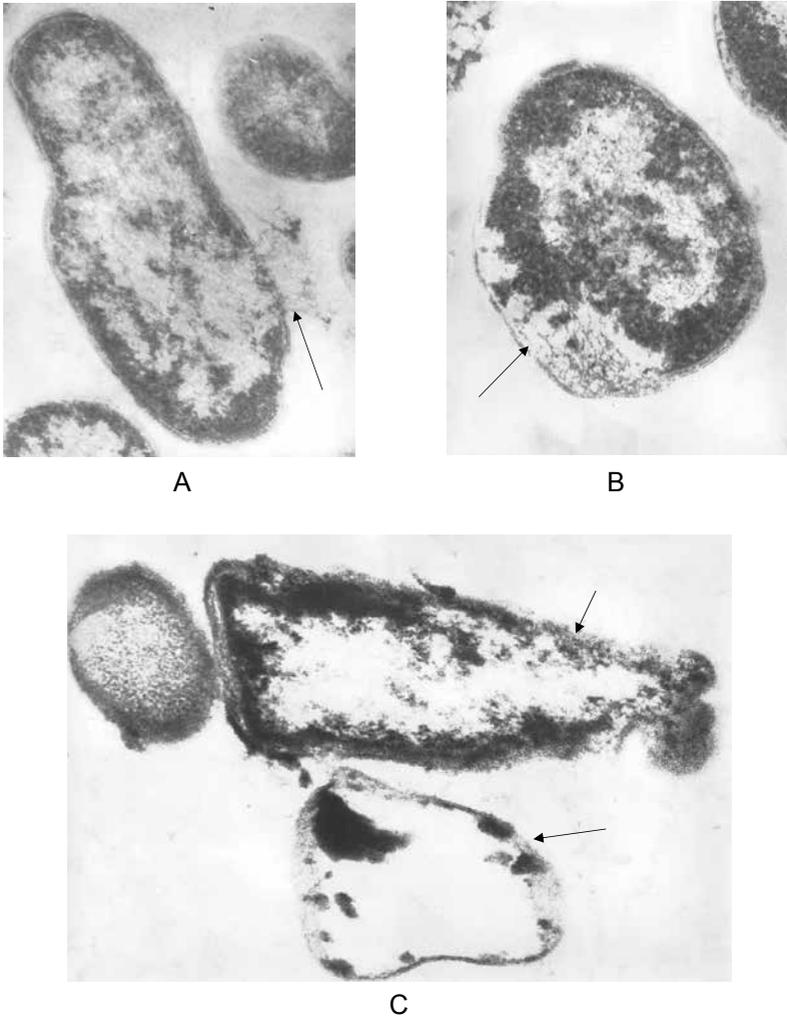


Fig. 3. Electron microscopic images of ultrathin sections of *Francisella tularensis* 15/3M bacteria with irreversible ultrastructural damage. A. Image of a cell with a rupture of the cell membrane and leakage of the cytoplasmic content (arrow), magnification in the photo 100000 times. B. Bacterial cells at the stage of destruction of the cytoplasm and nucleoid (arrow), magnification in the picture 100000 times. C. Bacterial cells at the stages of destruction and autolysis (arrow), magnification 80000 times

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DEPENDENCE OF SOFT WHEAT SPROUTS DEVELOPMENT ON FUNGICIDES AND VARIETY GENOTYPE

Beletskaya Ekaterina Yakovlevna

Candidate of Biological Sciences, Associate Professor,
Professor of the Russian Academy of Natural Sciences,
Omsk State Pedagogical University

Krotova Lyudmila Anatolyevna

Doctor of Agricultural Sciences, Full Professor,
Corresponding Member of the Russian Academy of Natural Sciences,
Omsk State Agrarian University named after P.A. Stolypin

Abstract. The effectiveness of fungicides as inducers of biological variability in populations of common wheat was studied. It is shown that the disinfectants have an unequal effect on the development of seedlings of different wheat varieties. It was found that, under the influence of fungicides, the range of variability in morphological characteristics significantly increased in conditionally mutant populations as compared to the control. Revealed a different response of varieties to the effect of fungicides, due to the differences in their genotypes. The Serebristaya variety showed greater lability of statistical indicators in response to the action of fungicides than the Pavlogradka variety, which showed a higher level of physiological homeostasis. When creating the initial material for breeding, it is recommended to use varieties with a higher capacity for neoplasms to enhance the mutation process in experimental lines of varieties under the action of fungicides.

Keywords: wheat, fungicide, cultivar, mutant, population, variability, genotype.

Introduction

According to the UN, by 2050, the world's population will reach 9 billion people, and the need for food will grow by 70%. At the same time, the potential of world agriculture is already under threat [10]. The main reason for the decrease in the productivity of crop production is the narrowing of the genetic base of agricultural crops [15]. The current loss of diversity poses a serious threat to the solution of the food problem for the entire world com-

munity. Therefore, at the present stage, the problems of conservation and rational use of plant genetic resources have become state, strategically important for each country [4, 15-17].

The problem of the genetic uniformity of cultivated varieties of cultivated plants is currently well known in the scientific community [2, 3, 17], its consequence is a colossal loss of grain yields due to the damage of crops by various phytopathogens [2-4, 12], and first of all - rust fungi, due to the similar reaction of varieties to pathogens [16]. One of the ways to overcome the current situation is the creation and use of new varieties and hybrids of grain crops that can provide a sustainable increase in crop productivity [13]. The most important in solving this problem belongs to soft wheat, with the future productivity of which is associated with ensuring the global food security of mankind [18].

In order to expand the genetic base of wheat, both the traditional method of chemical mutagenesis [8] and the search for new biologically active chemical compounds capable of inducing genetic changes in wheat populations [5, 7, 16] are used. When using chemical compounds, it is necessary to take into account not only the specificity of their impact, but also the potential mutability of crops and varieties, the biological specificity of the target itself [9]. The world achievements of induced mutagenesis in relation to different crops clearly indicate the role of the genotype in the mutation process: crops are classified as highly and low stable. Low stable are rye, oats and durum wheat, and highly mutable - barley, rice and soft wheat [14]. The genotype of the variety significantly affects the sensitivity to the mutagen, the frequency and spectrum of visible mutations. When studying the role of the genotype in induced mutagenesis, it was found that the ability of an organism to variability depends on its genetic characteristics, the number and size of chromosomes, age, ploidy, and other factors [11].

In recent years, there has been an increasing interest in fungicides as inducers of changes in genotypes associated with the emergence of new traits and properties that increase the productivity and adaptability of the crop. Such studies are already being carried out quite widely [1-3, 5, 7], however, the contribution of a biological object to the induced variability of populations is not sufficiently highlighted in the scientific literature.

Purpose of the study

In the process of studying the effects of the influence of biologically active chemical compounds of a new generation of decomposable fungicides AltSil and Alkasar on the biological properties of plants, to study the effect of fungicides on the growth and development of plants in the early stages of ontogenesis; features of the manifestation of phenotypic variabil-

ity of seedlings of spring wheat varieties Pavlogradka and Serebristaya, depending on their genotypic differences.

Material and methods

In 2017–2020 the seeds of wheat varieties Serebristaya and Pavlogradka were treated with AltSil and Alkasar fungicides: Each of the fungicides was used in two concentrations: at a dose recommended for grain production (n) and a double dose (2n) to enhance the formative process and assess the damaging effect on cellular and organismic wheat plant systems [1].

Germination of seeds was carried out in rolls, observing the methods and requirements of GOST for seed organizations [6]. In the discussed series of experiments, 10 variants of the experiment, 60 seeds in each roll, were laid. The test objects were seedlings of the Pavlogradka and Serebristaya spring soft wheat varieties, the seeds of which were not exposed to fungicides. The experiment was carried out according to the following scheme (tab. 1):

Table 1.
Experiment scheme

№	Experiment variant	Fungicide and active ingredient
1	Spring wheat variety Pavlogradka	control, without seed treatment
2	AltSil (Pavlogradka) - AIP(n)	AltSil: tebuconazole
3	AltSil (Pavlogradka) - AIP(2n)	AltSil: tebuconazole
4	Alkasar (Pavlogradka) - AkP(n)	Alkasar: difenoconazole+cyproconazole
5	Alkasar (Pavlogradka) - AkP(2n)	Alkasar: difenoconazole+cyproconazole
6	Spring wheat variety Serebristaya	control, without seed treatment
7	AltSil (Serebristaya) - AIS(n)	AltSil: tebuconazole
8	AltSil (Serebristaya) - AIS(2n)	AltSil: tebuconazole
9	Alkasar (Serebristaya) - AkS(n)	Alkasar: difenoconazole+cyproconazole
10	Alkasar (Serebristaya) - AkS(2n)	Alkasar: difenoconazole+cyproconazole

Results and discussion

In our experiment, disinfectants containing various active ingredients had an unequal effect on the morphometric parameters of Pavlogradka seedlings. AltSil at a concentration (n) caused accelerated plant growth,

forming a longer coleoptile, and a double dose (2n) delayed the development of this trait, however, the shoots were thicker in thickness and with a more developed root system. In addition, the leaf blades of the shoots were wider and more intensely colored. The Pavlogradka cultivar forms more developed shoots (\bar{x} = 128.4 mm), but with a narrower range of variability (Cv = 10.1%) than in mutant forms (Cv = 19.2-21.2%, tab. 2). The action of the fungicide Alkasar caused an increase in the range of variability in the length of the sprout at both concentrations (n and 2n) with a significant decrease in the level of development of the sprout. Conditionally mutant populations of the Serebristaya cultivar fluctuated in a wider range, both in terms of mean values and range of variability. This cultivar probably has a greater potential for variability under the influence of both fungicides than Pavlogradka, which has a higher physiological homeostasis.

Table 2
Statistical characteristics of the original varieties and their mutant populations

Population		AltSil (n)	AltSil (2n)	Alkasar (n)	Alkasar (2n)	Control, no processing
Sprout length						
Pavlogradka	$\bar{x} \pm S\bar{x}$	108.6 ±0.38	98.9 ±0.33	98.4 ±0.34	98.3 ±0.31	128.4 ±0.22
	Cv (%)	21.2	20.1	21.0	19.2	10.1
Serebristaya	$\bar{x} \pm S\bar{x}$	108.9 ±0.30	97.5 ±0.41	113.8 ±0.23	98.6 ±0.42	139.6 ±0.24
	Cv (%)	16.8	24.5	12.3	25.6	10.3

In addition to the analysis of statistical parameters of populations, the ratio of the proportion of normally developed seedlings and the proportion of plants with deviations from the norm was assessed (fig. 1-6).

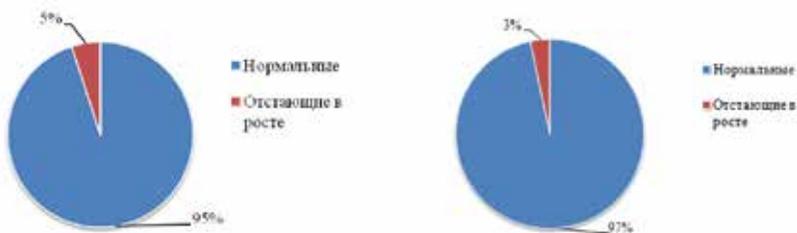


Fig. 1. Serebristaya, no treatment

Pavlogradka, no treatment

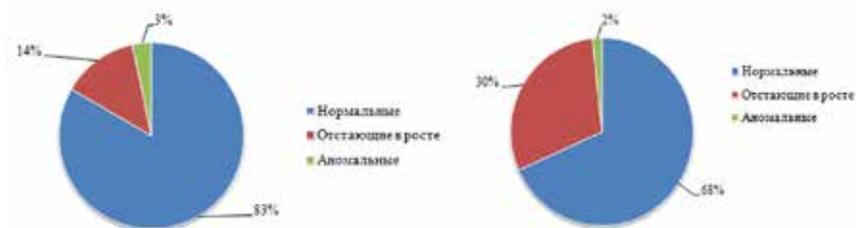


Fig. 2. Serebristaya, AltSil (n)

Pavlogradka, AltSil (n)

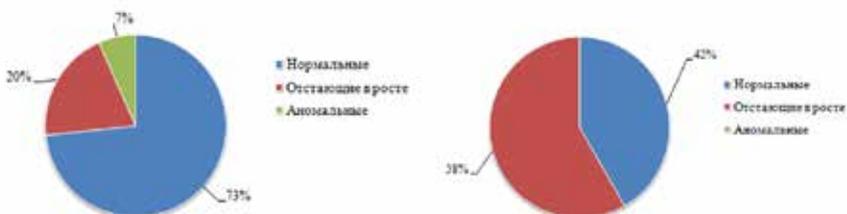


Fig. 3. Serebristaya, AltSil (2n)

Pavlogradka, AltSil (2n)

The seedlings of the variety Serebristaya, without treatment, did not have abnormal plants, the proportion of seedlings lagging behind in growth was 5%. (fig. 1). This is caused by a disease of three plants affected by mold because their kernels have not been treated with fungicides. The distribution diagrams of normal, stunted and abnormal plants show that in both treatment options (ALS –n and ALS-2n), normal plants predominated (Fig. 2, 3). Lagging plants in the first variant accounted for 14%, abnormal - 3%. The doubled dose of the fungicide had a more pronounced inhibitory effect, therefore, the proportion of seedlings lagging behind in growth increased to 20%, abnormal - to 7%.

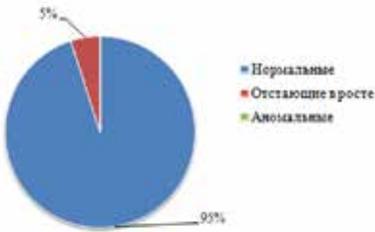
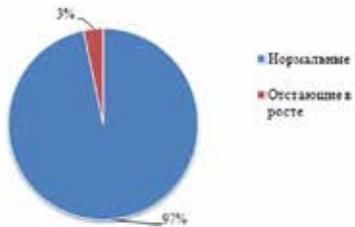


Fig. 4. Serebristaya, no treatment



Pavlogradka, no treatment

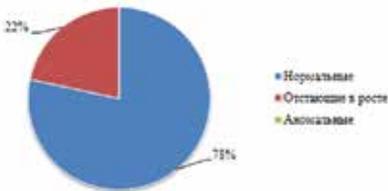
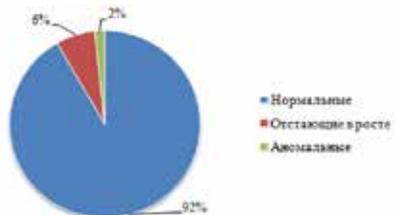


Fig. 5. Serebristaya, Alkasar (n)



Pavlogradka, Alkasar (n)

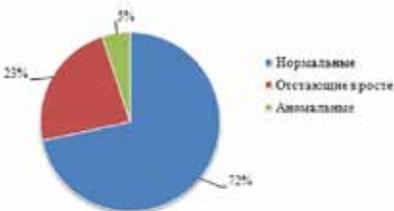
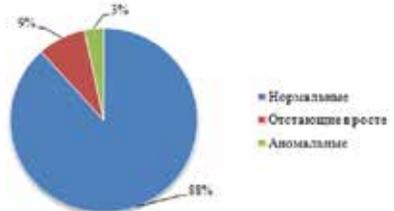


Fig. 6. Serebristaya, Alkasar (2n)



Pavlogradka, Alkasar (2n)

The Pavlogradka cultivar without treatment formed more normal plants than the mutant forms (97%), and did not have abnormal seedlings, but the proportion of those lagging behind in growth was 3% (2 grains were affected by Fusarium). In the populations of Pavlogradka treated with a single dose of the fungicide AltSil (AIP –n), normal plants prevailed, the proportion of seedlings lagging behind in growth was 30%, abnormal plants - 2%. The doubled dose of the fungicide had a more pronounced inhibitory effect, therefore, the proportion of plants lagging behind in growth increased to 58%, without abnormal seedlings (fig. 3).

In both variants of the treatment of the Serebristaya cultivar with the

fungicide Alkasar (AkS - n and AkS-2n), normal plants prevail, with a single dose (78%, and without abnormal seedlings), and with a double dose - 72% of normal seedlings (Fig. 4, 5). A double dose of Alkasar exerted an inhibitory effect to a greater extent, as a result of which the proportion of seedlings lagging behind in growth increased to 23%, and abnormal plants appeared, accounting for 5% of the total population (Fig. 6). The effect of the fungicide Alkasar in a single dose shows that in the experimental populations, normal plants predominated 92%, lagging behind in growth with a single dose of the fungicide was 6%, taking into account abnormal plants (2%). The doubled dose of the fungicide had a more pronounced inhibitory effect, so the proportion of plants lagging behind in growth increased to 9%, and abnormal ones - up to 3%.

Conclusions:

1. The multidirectional effect of various disinfectants and their consumption rates on the morphometric parameters of seedlings was established: fungicides AltSil and Alkasar inhibited the development of seedlings of the Pavlogradka variety, reducing the average values of the trait by 15.4-23.5%.

2. The largest average value of the sprout length was observed in the control line of the Pavlogradka cultivar (128 mm), AIP (2n), AKP (n) and AkP (2n) were at the same level, - 98 mm, which showed an inhibitory effect on the development of seedlings, and the line AIP (n) - 108 mm (tab. 2) had a somewhat advanced development of shoots in comparison with them.

3. All mutant populations (CV within 20%) showed an average level of variability of the sprout length and a coefficient of variability close to it (CV within 20%), and only control - Pavlogradka had a low coefficient of variability (10%), from which we conclude that the fungicides we used increase the level of genetic diversity in populations of soft wheat treated with fungicides.

4. The lag in the development of seedlings of the Serebristaya variety was more significant (by 18.5-30.2%) than that of the plants of the Pavlogradka variety. The effect of the fungicides used on the level of population variability was revealed: the coefficients of variability of the shoots of mutant lines of the Pavlogradka cultivar in comparison with the control (Cv = 10.1%) increased to 21.2%, and the lines of the Serebristaya cultivar (Cv = 10.3%) increased to 25.6%. In general, the values of the coefficients of variability of the traits of the Serebristaya variety varied in a wider range than that of the Pavlogradka variety. The influence was exerted by both the

type of fungicide and its dose, and varietal differences of plants (tab. 2).

5. AltSil in a single dose (AIP - n) showed weak stimulation of individual plants, AltSil in a double dose (AIP - 2n) and Alkasar - inhibition.

6. The mutant populations of the Serebristaya cultivar fluctuated in a wider range, both in terms of the mean values and the range of variability. This cultivar probably has a greater potential for variability under the influence of both fungicides than Pavlogradka, which has a higher physiological homeostasis.

7. When creating a source material for breeding, it is recommended to use varieties with a higher capacity for neoplasms to enhance the mutation process in experimental lines of varieties under the action of fungicides.

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SYNTHESIS AND PROPERTIES OF NANOSTRUCTURED MATERIALS OF THE CARBON-METAL SYSTEM

Zherebtsov Dmitry Anatolevich

Doctor of Chemical Sciences, Senior Research Officer

Tolstoguzov Dmitry Sergeevich

Postgraduate

South Ural State University

Abstract. As a result of the research, new nanostructured metal-containing materials were synthesized. The phase composition and microstructure of materials have been studied. The regularities of the formation of metal compounds in a carbon matrix have been studied.

Keywords: carbon matrix, phenol-formaldehyde resin, nanocomposite, metal.

Currently, there is growing interest in the creation of nanostructured metal-carbon composite materials. The real interest is associated with the manifestation of surface effects on particles of a nanosized dispersed state.

Obtaining nanostructured metal-carbon composites is a multistage process. The most common methods for obtaining metal nanoparticles on the surface of a carbon matrix are vapor deposition (CVD), pyrolysis, electron beam exposure, carbonization [1–3]. However, the available production methods either require complex hardware and are therefore expensive.

One of the methods for the synthesis of nanostructured carbon materials of the Me - C systems is synthesis in a polymer matrix by pyrolysis [4]. The scheme of the method is shown in Figure 1 [5].

The main polymer matrices for the synthesis of nanocomposites are polyvinyl alcohol, polyacrylonitrile, polyvinyl chloride, etc. [4, 6].

Nanocomposite metal-containing materials are used as electrodes for chemical current sources and water purification devices, high-capacity capacitors, catalysts, gas sensors, drug carriers, MRI, fuel cells, etc. [6 - 8].

The purpose of our work was to synthesize and study the structure of glassy carbon metal-containing composite materials obtained from phenol-formaldehyde resin and carboxylates of transition metals Co, Ni, Cu.

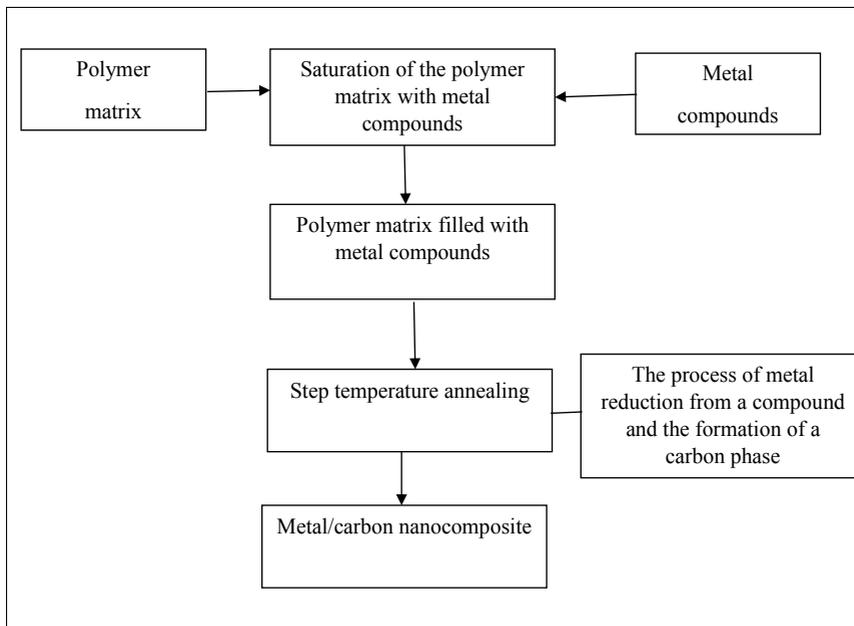
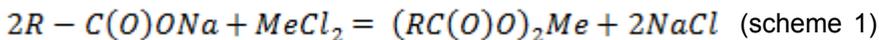


Figure 1. Scheme of obtaining metal-carbon nanocomposites

To obtain a composite material, phenol-formaldehyde resin and 8-hydroxyquinolines, benzoates, salicylates, phthalates and N-phenylanthranilates of Co, Ni, and Cu were used. The synthesis of metal carboxylates was carried out by ion exchange reactions between sodium salts of organic acids and chlorides of Co, Ni, Cu (scheme 1).



The binding material for composite materials in our case is phenol-formaldehyde novolac resin, fillers are introduced organic metal salts. Ethyl alcohol was used as a solvent for phenol-formaldehyde resin and metal carboxylates.

The synthesis was carried out according to the method [9]. In our case, the product yield was 70 - 75%. According to the method, water-dioxane solutions of organic acids (8-hydroxyquinoline, benzoic, salicylic, phthalic, and N-phenylanthranilic acids) and a 20% aqueous solution of sodium hydroxide NaOH were used. For the synthesis of Co, Ni, Cu carboxylates, the solutions were heated to 80 - 90°C. When aqueous solutions of sodium carboxylates and transition metal chlorides were mixed, precipitates of

transition metal carboxylates precipitated. The resulting substances were purified from impurities of sodium chloride $NaCl$.

The synthesized transition metal carboxylates in a ground powder state were mixed with a ground phenol-formaldehyde resin. to the resulting mixture was poured 95 vol. % ethanol. The resulting mixture was subjected to stepwise thermolysis (figure 2).

As a result of thermolysis, an opaque, glassy porous black shiny material was obtained.

Scanning electron microscopy, X-ray phase analysis, and X-ray microanalysis were used to study the synthesized composite materials. The structure and chemical composition were determined by electron microscopy using a Jeol JSM-7001F electron microscope. The phase composition of the composites was determined using a Rigaku Ultima IV X-ray powder diffractometer.

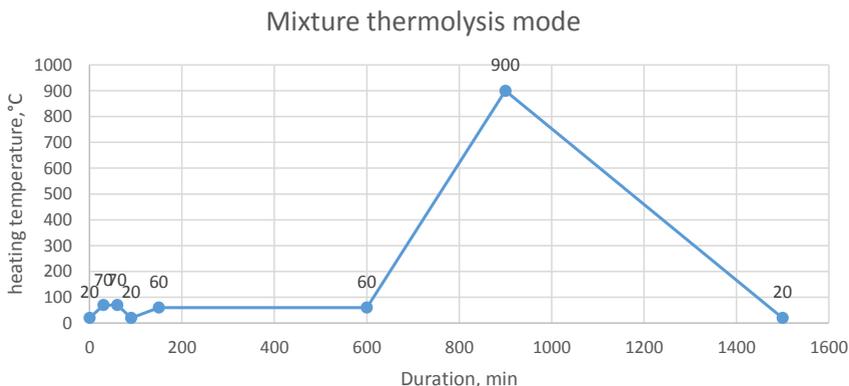


Figure 2. Graph of the heat treatment mode of the mixture

X-ray phase analysis of organic salts made it possible to confirm the formation of only a few compounds: $Cu(HPhal)_2 \cdot 2H_2O$, $Co(HSal)_2 \cdot 4H_2O$, $Ni(HSal)_2 \cdot 4H_2O$, $Cu(HSal)_2 \cdot 4H_2O$. The rest of the connections do not yet have a resolved structure. The assumption about the existence of new synthesized carboxylates was based on a comparison of X-ray diffraction patterns of the synthesized product and reagents.

When studying the composites, the morphological characteristics of the samples, their local and average chemical composition, and the uniformity of metal distribution in the glassy carbon matrix were evaluated. In this case, two samples were taken from the sample - from its upper and lower

parts. This made it possible to estimate the solubility of transition metal compounds in the total solution by the ratio of the average metal content in the upper and lower parts of the sample, since incompletely dissolved particles of these compounds settled in the lower part. It can be assumed that in samples containing similar amounts of metal in the upper and lower parts of the sample, the solubility of the salt is higher.

The homogeneity of the composite can be estimated as the ratio of the measured metal concentrations indicated in the table as a fraction, in which the numerator indicates the concentration at the top and the denominator at the bottom of the composite (table 1).

Table 1 – Metal concentration in the composite, wt. %.
The numerator indicates the concentration in the upper part, and the denominator - in the lower part of the composite

Cation	Anion					
	8-hydroxyquinolinate	Benzoate	Salicylate	Phthalate	N-phenyl anthranilate	
Co	5.20/15.44	0.67/-	2.46/-	5.10/22.94	3.31/3.61	
Ni	4.50/4.72	-/11.43	2.19/-	4.02/7.56	3.78/16.52	
Cu	2.66/4.10	^a 1.24/-	^b 0.76/-	2.13/-	3.94/5.73	1.17/4.08

a – DMF washed, b – recrystallized from DMF.

Analysis of these data indicates that nickel (II) 8-hydroxyquinolinate, copper (II) phthalate, and cobalt (II) N-phenylanathanilate had the best dissolution in phenol-formaldehyde resin, and during heat treatment they retained high dispersion. This indicates that, firstly, the listed anions formed a strong bond with the phenolic rings, and, secondly, the listed cations exhibit a high coordination number. As a result, they coordinated the electrons of the phenolic rings on themselves. It follows from this that the formed coordination structure remained strong during thermolysis. This ensured that during the heating process, metal particles retained their position in the resin structure, and then in glassy carbon.

The sizes of metal particles observed using electron microscopy are summarized in table 2. In more than half of the cases, the sizes differ by one or two orders of magnitude, and in many of these cases a bimodal distribution can be noted. In some cases, the irregular particle shape may suggest that the large particles are agglomerates of smaller crystallites. To estimate the average crystallite size, the sizes of the coherent scattering regions were determined, calculated from the half-width of the X-ray

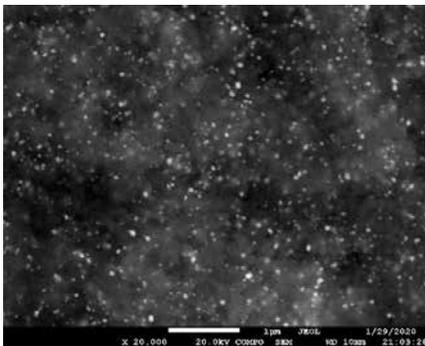
reflections (table 3). Among other salts, salicylates are smaller and have a narrower particle size distribution.

Figure 3 shows the typical morphology of a cobalt nanocomposite in a glassy carbon matrix prepared using cobalt phthalate. The images obtained in the reflected electron mode show a dark glassy carbon matrix and light inclusions of a heavier element (cobalt). Obviously, in the lower part of the material, the concentration of metal inclusions is higher, which indicates that cobalt phthalate particles settle in the alcoholic solution of the resin. Cobalt particles are finer in the upper part of the sample (20 - 100 nm) compared to the lower part of the sample (100 - 250 nm).

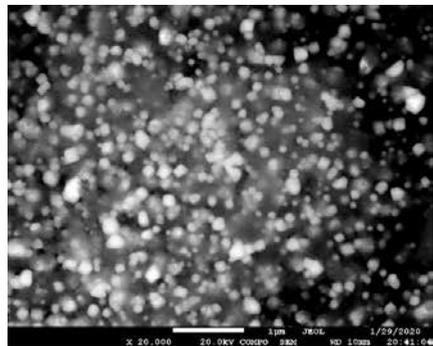
Table 2 – The size of metal particles in the composite according to microscopy data, microns. The numerator shows the size at the top, and the denominator - at the bottom of the composite

Cation	Anion					
	8-hydroxy-quinolinate	Benzoate	Salicylate	Phthalate	N-phenyl anthranilate	
Co	0.01 – 0.7/ 0.02 – 0.7	0.01 – 0.2/-	0.02 – 0.03 /-	0.02 – 0.07/ 0.07 – 0.2	0.02 – 0.5/ 0.03 – 1.0	
Ni	0.02 – 0.4/ 0.01 – 0.3	-/0.01 – 0.3	0.01 – 0.1/-	0.03 – 3.0/ 0.01 – 0.3	0.05 – 0.5/ 0.05–1.0	
Cu	0.1 – 2.0/ 0.04 – 1.0	^a 0.07- 1.0/-	^b 0.7- 1.0/-	0.7 – 1.0/-	0.02 – 0.40/ 0.02 – 3.0	0.05 – 5.0/ 0.03 – 4.0

a – DMF washed, b – recrystallized from DMF.



a)



b)

Figure 3. Morphology of Co/glassy carbon nanocomposite obtained using cobalt phthalate: a) in the upper part, b) in the lower part of the sample

Table 3 – Size of areas of coherent scattering of metal particles in the composite according to X-ray phase analysis, μm.

Cation	Anion				
	8-hydroxy-quinolinate	Benzoate	Salicylate	Phthalate	N-phenyl anthranilate
Co	0.079	0.094	0.004	0.070	0.085
Ni	0.038	0.028	0.026	-	0.072
Cu	0.046	0.5/0.050*	0.050	0.063	0.080

*in the numerator – DMF washed, in the denominator – recrystallized from DMF

According to these data, it can be concluded that the particles are in a nanostructured state. Moreover, the smallest size is possessed by nickel and cobalt nanoparticles in the case of 8-hydroxyquinolinate, benzoate and salicylate anions for nickel and salicylate for cobalt. This indicates a high solubility in phenol-formaldehyde resin.

X-ray phase analysis was used to obtain data on the phase composition of the obtained composites (table 4).

Table 4 – The content of metal (in the numerator) and graphite (in the denominator) in the composite according to X-ray phase analysis, wt. %.

Cation	Anion				
	8-hydroxy-quinolinate	Benzoate	Salicylate	Phthalate	N-phenyl anthranilate
Co	28/72	17 ^a /27	47 ^e /20	40/60	40/60
Ni	100/0	100/0	95 ^h /2	0 ^d /0	40/60
Cu	97 ^c /0	27 ^b /0 (10 ^g /0) *	45 ^f /0	97/3	100/0

Notes to Table 4: *without brackets – salt washed with DMF, in brackets – salt recrystallized from DMF. Together with the metal phases, the composite material also contains oxide phases: a – 29 % CoO, 28 % Co₃O₄, b – 73 % Cu₂O, c – 3 % Cu₂O, d – 20% Ni₃S₂, 80% Ni₉S₈, e – 10 % Co₃O₄, 23 % CoO, f – 55% Cu₂O, j – 70 % Cu₂O, 20 % CuO, h – 3% NiO.

As a result of the data obtained, it can be concluded that the phase composition of the obtained materials is different. In addition to the phases

of the reduced metal and graphite, metal oxides are formed from the thermolysis of the anion. This is due to the strength of the bond between the metal cation and the acidic anion. As a rule, the resulting multicomponent residue consists of a mixture of nearby oxides or a mixture of elemental metal and its lower oxide.

As a result of the research carried out, the following conclusion can be drawn. First, a new technique was developed for the synthesis of new carbon nanocomposite metal-containing materials. These materials have been received. Secondly, the composition and structure of the obtained materials were studied. Based on these results, assumptions were made to explain the homogeneity and heterogeneity of the material in terms of volume and the composition of the phases that form the material.

From the study of the obtained composite materials, it can be concluded that the most uniform distribution of metal particles over the volume of the composite material was observed in the case of using Ni (II) 8-hydroxyquinolate, Cu (II) phthalate, and Co (II) N-phenylanthranilate. During the thermal decomposition of metal salts in the phenol-formaldehyde matrix, mainly metal particles were formed in the case of the use of Co (II) and Cu (II) 8-hydroxyquinolates, Ni (II) benzoate, Co (II) and Cu (II) phthalates, and Co (II), Ni (II) and Cu (II). In this case, the largest particle size of the reduced metal (more than 2 μm) was observed in the case of using Cu (II) N-phenylanthranilate and Ni (II) phthalate, and the smallest particle size (about 10 nm) - in the case of using Co 8-hydroxyquinolates and benzoates, Ni, salicylate and Ni phthalate. Analysis of the results showed that salicylates Co, Ni, Cu give composites with the most monodisperse and fine metal particles. Phthalates follow, the rest of the salts close the row.

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UDC 543.421

**STUDY OF THE EFFECT OF HUMIC SUBSTANCES ON
THE POSITION OF CALIBRATION GRAPHS IN THE
DETERMINATION OF SILICON IN WATER BY HIGH-RESOLUTION
ELECTROTHERMAL ATOMIC ABSORPTION SPECTROMETRY
WITH A CONTINUOUS SPECTRUM SOURCE**

Shtin Tat'yana Nikolaevna

Head of department

Ekaterinburg Medical Research Center for Prevention and Health Promotion
of Industrial Workers, Rospotrebnadzor

Neudachina Lyudmila Konstantinovna

Candidate of Chemical Sciences, Head of Department

Ural Federal University named after the First President of Russia B. N. Yeltsin

Shtin Sergei Anatolievich

Candidate of Chemical Sciences, Associate Professor

Ural Federal University named after the First President of Russia B. N. Yeltsin

Abstract. The paper considers the influence of natural compounds, humates, on the position of the calibration curves when determining the mass concentration of Si (IV) ions in water by high-resolution electrometric atomic absorption spectrometry with a continuous spectrum source. The analysis of the results obtained using the calibration dependences $A_{\text{int}}=f(C_{\text{Si}})$ in various systems: Si (IV) ion - water; Si (IV) - HA ion at a silicon resonance line of 251.611 nm and a decision was made about the possibility of determining the dissolved forms of silicon in the presence of humic substances with an acceptable error.

Keywords: spectrometry, ETAAS, silicon, calibration curve, water, continuous spectrum source.

In the course of the natural cycle, natural waters come into contact with a large number of various minerals, organic compounds and gases, dissolving them. Therefore, the chemical composition of natural waters means the entire complex of dissolved gases, various mineral salts and organic compounds [1]. The binding of Si (IV) ions in an aqueous medium with dissolved organic substances, humic (HA) and fulvic (FA) acids refers to natural processes occurring in natural (surface and ground) water. The

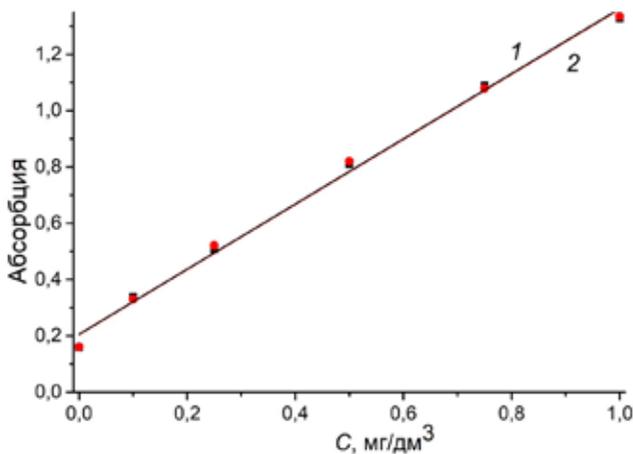
relevance of studying the effect of natural compounds, humates, on the determination of silicon in water by high-resolution electrometric atomic absorption spectrometry with a continuous spectrum source (HD CS ETAAS) is beyond doubt.

To study the effect of HA in the determination of silicon by the HD CS ETAAS method, the calibration dependences $A_{\text{int}}=f(C_{\text{Si}})$ in water and an aqueous solution of HA were studied. The research methodology consisted in the determination of silicon in natural surface waters using the calibration dependences $A_{\text{int}}=f(C_{\text{Si}})$ in various systems. The following solutions were used as such systems: Si (IV) ion - water; Si (IV) - HA ion.

The silicon concentration in the calibration solutions was varied in the range from $3.56 \cdot 10^{-6}$ to $35.60 \cdot 10^{-6}$ mol/dm³ (or 0.10-1.00 mg/dm³), the HA concentration was kept constant at 5 mg/dm³. The concentrations of silicon and HA in the model solutions corresponded to the average content of these components in natural waters of the Sverdlovsk Oblast (Russia) in the summer period of the calendar year.

The study of the influence of the matrix components of water on the determination of silicon was carried out on a high-resolution atomic absorption spectrometer with a continuous spectrum source of the ContraA® 700 model with an electrothermal technique for atomization of samples, manufactured by Analytik Jena AG, Germany. The temperature-time program and instrumental parameters for the determination of dissolved forms of silicon by the HD CS ETAAS method are published in [2].

The effect of humic substances on the position of the calibration curves in the determination of silicon in water by the HD CS ETAAS method is shown in fig. 1.



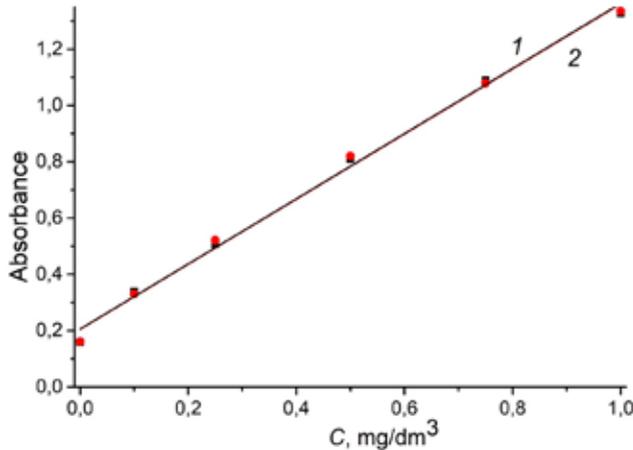


Fig. 1 – Influence of humic substances on the position of the calibration curves in the determination of silicon in water by the HD CS ETAAS method: 1) Si (IV) - HA ion; 2) Si (IV) ion - water. The concentration of HA is 5 mg/dm³.

The mass concentration of silicon (X , mg/dm³) in a single sample was calculated by the formula:

$$X = (C_{\text{Si(IV)}} - C_{\text{blnk.}}) \cdot \eta \quad (1)$$

where $C_{\text{Si(IV)}}$ – mass concentration of silicon in the analyzed water sample, established by the calibration characteristic, mg/dm³;

$C_{\text{blnk.}}$ – mass concentration of silicon in the blank sample established by the calibration characteristic, mg/dm³;

η – dilution ratio.

A comparative assessment of the results of determining silicon in natural surface waters is given in tab. 1.

Comparison of the results obtained by the calibration dependences $A_{\text{int}} = f(C_{\text{Si}})$ in various systems shows that the found concentration values are in good agreement with each other within an error of up to 3.41%, while the index of intralaboratory precision (reproducibility) does not exceed the previously established value in the method [3].

Based on the results of the studies obtained, it can be concluded that it is possible to determine the dissolved forms of silicon in the presence of HA by the HD CS ETAAS method with an acceptable error.

Table 1

Determination of silicon by HD CS ETAAS in natural surface water

Sample name	Mass concentration of silicon, ($X_{av.} \pm \Delta$), mg/dm ³ at P = 0.95	
	Calibration characteristic in the system:	
	Si (IV) – HA ion	Si (IV) ion - water
Water from the Volchikhinsky reservoir, Sverdlovsk Oblast, Russia	2.45±0.22	2.39±0.22
Water from the river Istok, Sverdlovsk Oblast, Russia	0.51±0.09	0.52±0.09
Water from the Bobrovka River, Sverdlovsk Oblast, Russia	7.76±0.70	7.50±0.68

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**THE ROLE OF THE MILITARY VETERINARY SERVICE IN
ELIMINATING THE CONSEQUENCES OF THE CHERNOBYL
DISASTER IN 35 YEARS**

Yushkova Lilia Yakovlevna

Doctor of Veterinary Sciences, Professor

Donchenko Nikolay Aleksandrovich

Member of the Russian Academy of Sciences, Doctor of Veterinary Sciences,
Head of Structural subdivision

Donchenko Alexander Semenovich

Academician

Siberian Federal Scientific Center of Agrobiotechnology of the Russian Academy
of Sciences,
Novosibirsk, Russia

Abstract. An analytical review of the publications of scientists, for the outlook of colleagues. The article is of cognitive interest and new scientific knowledge about the Chernobyl disaster and the role of the military veterinary service in its elimination, which are necessary for the implementation of radiation control measures. accidents at Chernobyl nuclear power plant. [1].

Keywords: About the accident at Chernobyl on April 26, 1986 and its consequences.

One of the first requirements for radioactive contamination of the area is the control of the content of radionuclides in food products in order to prevent the introduction of radioisotopes into the human body over permissible amounts. When dividing heavy nuclei of uranium-235, plutonium-239, about 200 different isotopes are formed, having their specific physico-chemical characteristics: type of radiation, energy of radiation, life span. (half-life).

The most dangerous isotopes, in biological terms, include radioisotopes: iodine-131, strontium-90, caesium-137, which have the greatest biological activity, it is due to the fact that iodine is a micronutrient necessary for the body, and strontium and caesium, chemical analogues of

the most important elements of mineral nutrition, respectively, calcium and potassium. In the composition of radioactive substances that fell after the Chernobyl disaster, up to 50% of the activity was iodine-131, which entered the human body with local milk and greens, which was concentrated in the thyroid gland and selectively irradiated it. The half-life of its 8 days, the period of iodine hazard lasted within 80 days.

Since 1987, strontium-90, and caesium-137 with a half-life of 28.6 and 30.2 years, respectively, began to pose a danger, which migrated along the chain of soil - plant - animal - people. Strontium-90, an analogue of calcium, is deposited in bone tissue, comes mainly with milk and products of plant origin, cesium-137, is deposited mainly in muscle tissue, liver and kidneys and enters the body with milk, meat, fish and wild plants (mushrooms, berries, medicinal herbs and plants).

The beginning of the organization of veterinary radiation control of food in peacetime is associated with measures to eliminate the consequences of the Chernobyl disaster. Vast areas of the Russian Federation contaminated with radioactive emissions as a result of this disaster (49 thousand km² in 19 subjects.federation), determined the long-term tasks of the veterinary and sanitary service to ensure the radiation safety of food in the Armed Forces of Russia.

The elimination of the consequences of the Chernobyl disaster is a set of measures carried out in a short time, of such importance and magnitude that it can be estimated only after a few decades. When all sources of information are fully available to researchers, the long-term consequences of the effects of accident products on the human body and animals, as well as the natural environment, will become clear, and specialists will be able to analyze and assess the real extent of the economic damage caused. Therefore, at present, the characterization of the activities of all special services in the disaster zone is of great importance.

Radiological groups in the services were established to carry out radioactive environmental control; meteorological, sanitary-epidemiological, veterinary and agrochemical. By decision of the head of the military veterinary service of the USSR Ministry of Defense on April 28-30, 1986, an inventory was carried out of all dosimetric and radiometric devices of the service, including those contained in long-term storage. At the same time, in the military veterinary institutions of the districts and fleets, classes were held with personnel, as well as military personnel called up for training fees for training in working with radiometric devices.

The military veterinary service of the Kiev, Belarusian and Carpathian Military District was involved in the work to eliminate the disaster from the

very first days, by the heads of these services. In early May 1986, a preliminary assessment of the volume of work was carried out and priority measures were planned to preserve the health of the personnel of the troops and their families, in terms of military veterinary service. The specialists of the service were entrusted with the organization of a system of veterinary radiation control and veterinary and sanitary examination of food products received by military personnel and members of their families, as well as assistance to the state veterinary service for the organization of radiation control in the field.

So, on May 4, 1986, at a meeting of the Supreme Council of the Byelorussian SSR, a decision was made to ensure the radiation safety of animal and plant-based food supplies to the population. In pursuance of this decision, work was carried out to remove radiometric devices from storage in the inviolable reserve of the military veterinary service of the district DP-100 and equip them with industrial enterprises of the republic producing food products. Three groups of troops from military districts were involved in providing measures to eliminate the consequences of the disaster. At different times, more than 200 thousand people worked in these groups, taking into account the rotation. At the first stage (April-August 1986), the work was organized by involving specialists from service institutions of the Kiev and Belarusian military districts and officers of toxicologists from other districts (a total of 38 radiologists were involved). During this period, there was a lack of information on the radiation situation and veterinary and sanitary assessment of the consequences of the accident, there were no regulatory documents establishing permissible levels of radionuclides in food products, feed, as well as contamination of the skin of animals upon their admission to meat processing plants and slaughter stations. In early June 1986, the first field veterinary institution was formed (275 veterinary laboratory), stationed in a 30-kilometer zone. It provided radiometric control and veterinary and sanitary examination of food entering the troops involved in the Chernobyl industrial site and the adjacent contaminated territory of the Kiev Military District.

In July 1986, the creation of a veterinary and sanitary radiation control system was mainly completed in the territory of three military districts subjected to radioactive contamination. This system was further developed at the second stage (from August 20, 1986).

The provision of food to military units that took part in the elimination of the consequences of the Chernobruisk disaster was carried out according to a single scheme, using the example of the troops of the Belarusian Military District: a district food warehouse (Mr. Bobruisk) - a separate storage

department of this warehouse (Gomel) - a mobile department (p. Rudakov)
- individual military units and units.

Through military trade: 210th (Gomel), 300th (Mogilev) and 603rd (Kalinkovichi). According to the following scheme; military trade enterprises - a warehouse for the military trade department of the BVO (n. p. Rudakov)
- mobile points of military trade.

A similar radiometric control system was uninterrupted in two other sectors, the Kiev and Carpathian Military Districts.

At all stages of food supply, veterinary radiation control was carried out by 23 stationary and 11 mobile veterinary radiometric laboratories, which determined the area of responsibility, as a rule, for two dozen military units and institutions, in the territory of two or three administrative entities.

Veterinary laboratories (except for inpatients) were equipped with: two veterinary doctors, a radiologist and a veterinary and sanitary expert, a laboratory assistant and a driver, while standard technical means of service were used: a field veterinary laboratory, based on the Zil-157 and a sanitary and bacteriological laboratory, with a set of RLU-2 based on the Gaz-66. Taking into account the work carried out and the experience gained, the military veterinary service prepared a directive establishing the following procedure and periodicity of radiological control:

1. In district food bases and warehouses for the reception of food products, including products contained in packagings that protect them from contamination with radionuclides (sealed metal and glass containers, containers duplicated with polymer inserts), as well as products produced by enterprises from contaminated raw materials, harvested, transited or stored in contaminated territory;

2. On mobile offices of district warehouses, warehouses, bases of the back and offices of field Voentorg - at reception and a holiday, except for the products which are in a tight container and with results of the radiological control which is carried out at the previous stage of transportation;

3. At food warehouses of formations and military units - 2 times in 2-3 days of storage and before use to provide troops, at the same time it was prescribed to carry out the examination of food products according to the main physical and chemical quality indicators, monitor compliance with veterinary and sanitary requirements to protect them from radionuclide pollution during transportation and storage in contaminated areas.

From the experience of work, it was clear that up to 65% of food pollution occurred during loading and unloading operations, transportation, loss of container sealing and culinary processing of products. The main reason was the ingress of radionuclides together with dust at field feeding stations,

as a result, the strictest "dust suppression" regime was observed everywhere, especially in the summer. The organization of food safety control is shown on the example of the work of 225 district veterinary laboratory, which carried out measures from the first days of the disaster.

To strengthen radiological control, veterinary officers were called up from the reserve, who for a week, under the guidance of laboratory specialists, mastered dosimetric and radiometric control techniques. After completion of the training, radiological groups were organized, which were located at food bases, meat processing plants, dairy plants and other enterprises, supplying food to the troops.

During the first 3 months after the disaster, three radiological control posts were deployed at meat processing plants:

1st post at the bases, cattle maintenance for dosimetric examination of animals coming to slaughter;

2nd post on cutting lines for express dosimetry of treated carcasses, semi-carcasses and by-products. They were also entrusted with determining the gamma background in the territory and in the production premises of the meat processing plant.

The 3rd post was in the laboratory of the meat processing plant.

At the post of radiation control of the base, livestock content, all incoming livestock were subjected to dosimetric control before these animals were put on the base for external and radioactive internal infections using the express method. The rapid method of dosimetry of animals, as well as carcasses and organs was carried out using SRP-68-01 and DP-5A devices. Animals that were infected above permissible values were not allowed to kill. If infection of carcasses is detected above the norm at the radiation control station, samples were taken from them and sent to the laboratory of the meat processing plant, where they were subjected to a total B-activity study. When obtaining results exceeding 2-3 times the VDU-86, the carcasses of animals were sent for exposure to separate refrigerators. When heavily infected, carcasses were destroyed. Meat quality control was also carried out at the slaughter stations of the military units of the district. Radiation control posts at slaughter stations of military units and as well as at meat processing plants carried out pre-slaughter dosimetry, and after slaughter, infections of carcasses and by-products were determined. For radiation monitoring, SRP-68-01 and DP-5A were used. In dubious cases, samples were taken and sent for radiometric examination to the veterinary laboratory of the Belarusian Military District. The posts of radiation control were also entrusted with monitoring the condition of animals of military units. For the first time three months after the accident,

the animals of military units were subjected to dosimetric control at least once a week, especially cattle located on pasture. Control of radioactive contamination of cattle was carried out using dosimetric devices SRP-68-01 and DP-5A. The method is based on determining the volumetric radioactivity of the animal's body. Radioactivity measurements were performed in gluteal muscles and muscles located at the top edges of middle part of humerus. For the calculation, the average value for the two measurements in the specified areas was taken. The time of detection of radioactive contamination of muscle tissue of one animal is about 1 minutes. This method was used as an express method in determining the volumetric contamination of carcasses and organs, dairy products, etc. At the dairy plants of the BVO (Minsk, Gomel, Volkovyssk, etc.), supplying milk to the troops, military trades, as well as at meat processing plants, radiation control posts were deployed - the 1st at the acceptance of milk and the 2nd at the output of finished products. The post at the reception of milk was established by the pollution of milk locomotives, when contamination was detected, the cars were sent back to the farms. In the absence of external contamination of milk locomotives, the radioactivity of milk was determined directly in the tank. For which they took samples and examined for radioactivity in the laboratory. The radiation monitoring post at the output of the finished dairy products also determined milk contamination by rapid methods. If the content of radioactive substances in dairy products is higher than the permissible values from this batch, samples were taken and examined in the laboratory of the dairy plant. Radiation control of milk from cows of military units was carried out systematically, 1-2 times a week by the veterinary institutions of the district, and in remote garrisons by specialists of regional veterinary laboratories. Radiation control of food at food bases and military units of the district was carried out by specialists of the veterinary laboratory, as well as specialists of veterinary institutions and heads of laboratories of district food bases. Radiation control was carried out as food arrived at the district food bases and food depots of military units. In the initial period, radiometric studies of food and water were carried out, which was then supplied with a ДП-100 plant, the sensitivity of which in some respects did not correspond to ВДУ-86. Then, 225 laboratories, as well as other veterinary institutions of the district received KRVP-ZAB, slightly later KPK-1, RKB-4-1eM, whose sensitivity is much higher than that of ДП-100. These devices made it possible to sufficiently accurately detect the presence of radioactive substances in the food delivered. As these devices became available for the supply of services, the amount of food not allowed increased markedly by radiometric indicators. In addition to food

research, the laboratory provided guidance on food radiation control to other veterinary institutions in the district. Thanks to the painstaking work of specialists of the veterinary laboratory and other institutions of the district during 1986-90, there were no cases of personnel damage through food supplies received for troop allowance. In May 1986 alone, 7 officers with a degree, a candidate of veterinary sciences, were called up to the veterinary laboratory. It was a huge intellectual force of service, which made it possible to quickly navigate in that difficult environment, in the full sense close to combat. The reliable forecast carried out by the first state test site for spectrometric analysis and the air laboratory of the entire contaminated area was completed only by the fall of 1986. The nuclear disaster has already quietly and quietly claimed the health of tens of thousands of people. Unnecessary classification of information, from its own population, caused harm to the people much more than its dosing, which would undoubtedly play a positive role. In all 89 veterinary and epizootic units and in more than 20 veterinary laboratories subordinate to the military veterinary service of the center, special units were created - radiometric control departments. Military veterinary specialists took an active part in the preparation of VDU (temporarily permissible levels of radionuclides in products) and the development of regulatory and legal documentation for the overexposure and use of meat and meat products obtained from slaughter of animals in contaminated territories [1]. The model created by military veterinary radiometric control and supervision was transferred to the veterinary and phytosanitary supervision bodies of the State Military veterinary science has taken a leading and undeniable position in ensuring the radiation safety of food products to the population of the affected areas and the country as a whole, among similar structures and services.

For the first time, the veterinary service successfully used radiation control devices that were not previously in service with the veterinary and medical services, such as: KRVP-ZAB, KRK-1, RKS-01, RUB-01Pb, RAM-12, RAM-63, SRP-68 -02, etc. The officers of the laboratory were represented by experienced reserve officers who had theoretical and practical training in their civilian specialty. The tasks of radiometric control by the laboratory were carried out not only on the territory of the Republic of Belarus, but also on the territory of Ukraine. The laboratory performed various tasks: radiometric assistance to scientific institutions, radiometric food control of military units, radiometric control of decontamination facilities, radiometric control of landfills and firing ranges, radiometric control of food of the civilian population. The laboratory coped with the tasks, this was facilitated by the correct organization of the administration of the USSR

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Ministry of Defense vertically and executive subordination. There were 11 stationary groups in the laboratory, for which certain military units were assigned, as well as radiometric control areas. The unit included one officer and a private, which were equipped with both stationary and portable radiometric devices. The duty group was at the combat post for a month. To accommodate stationary groups, a convenient place was chosen or a house after decontamination there. Radiometric measurements of the area were carried out and after which tents were installed: sleeping; operating, for sample storage. Accumulated samples after radiometric studies were taken to burial places. The level of radioactive contamination in the area of the veterinary laboratory was from 0, 6 to 1.5 mg/h. Daily information on the results of the radiometric study was received at the central post of the laboratory, where the data were summarized, analyzed and submitted to the central veterinary laboratory of Chernobyl and the veterinary service of the Belarusian military district. The officers of the chemical service of the task force, checking the radiometric control logs, made their adjustments. The greatest danger to the participants in the liquidation of the accident was radioactive dust, which entered the body through the respiratory organs. A metal taste in the mouth, pharyngitis, often manifested by personnel, caused alarm among subordinates. The main means of protection against radioactive dust were petal respirators, which often the personnel did not use the complex of measures for "dust suppression," that is, total tide of roads and locations and ve discipline in roads with regular water from tanker trucks. The working day in the laboratory began with decontamination of rooms and equipment, not timely removed radioactive dust at workplaces introduced errors in the studies. Dogs and cats left by the fleeing population inside the 30-kilometer zone began to pose a health hazard in themselves - the Soviet Ministry of Agriculture feared outbreaks of rabies and plague. The Ukrainian Ministry of the Interior appealed for help to the Republican Society of Hunters and Fishermen, calling on 20 groups of local residents to distribute the contaminated territory among themselves and begin to eliminate all abandoned animals that they would meet. In yards and gardens, the upper layer of the earth was removed and collected in heaps - they were covered with a layer of clay and sown with grass. The most polluted soil was removed and buried in excavated pits. Many settlements were deactivated twice or three times, houses that could hardly be deactivated were demolished. Over time, entire villages were demolished by bulldozers and buried, they are reminiscent of only triangular metal signs with a trefoil - a symbol of radiation danger. Military chemists did everything they could to remove radionuclides from buildings and soil:

soldiers prepared a solution of polyvinyl alcohol in field kitchens - they treated the walls, drying out, he captured contaminants and turned into film that could be removed from the walls. The roadsides were filled with bitumen to stick dust to it, and - kilometer after kilometer - laid new asphalt where the pavement of the highway could not be cleaned. Large barrels of glue were installed on Mi-8 helicopters and sprayed to capture radioactive particles on the ground. Specialists of the Scientific Research and Design Institute of Installation Technology of the Ministry of Social Development (NIKIMT) searched all enterprises of the Union for any means of binding dust, - if only they were cheap and available in large quantities. Throughout the summer, everything from PVA glue to bard - pulp from beets and wood-working waste - was delivered by cars to the perimeter of the zone and sprayed from helicopters like thick, dark rain. Radiation threatened rivers, lakes and reservoirs of Ukraine, and Soviet engineers and hydrologists showed extreme ingenuity. Called to the zone from Moscow and Kiev, from the first days after the explosion they fought so that the fallout did not fall into Pripyat, so that they did not leak into the groundwater, so that the pollution that had already entered the river did not take the current to Kiev and the huge reservoir that supplied the city with drinking water. Brigades of the military and builders of the Union Ministry of Reclamation and Water Management built 131 new dams, dug 177 drainage wells and began work on creating an underground wall of clay - 5 km long, up to 1 m thick and 30 m deep. The wall was supposed to prevent contaminated water from entering the river [4]. Collective farm fields plowed deeply, turning the upper layer of the earth and moving radionuclides deeper into the soil. Scientists brought about 200 species of plants, trying to establish which of them better absorb radiation. The fields were filled with limestone and other types of calcium in the powder to chemically bind strontium-90 in the soil and prevent it from moving along the food chain. Experts gave an optimistic forecast that agriculture in the zone could be resumed in a year.

At that time, it was revealed: only at six large meat processing plants of the republic, more than 17 thousand tons of meat, with an extremely permissible level of radioactive pollution, not counting five thousand tons of milk.

By the enormous amount of work performed by military veterinarians, one can judge only by such figures. More than 5 tons of zinc phosphide (the strongest mineral poison) were spent on all deratification measures and more than 750 km of square meters were treated. The epidemic and epizootic situation in the floodplain of the Pripjat and Dnieper rivers, which had a dysfunctional natural focus on tularemia and other infectious diseases, was thoroughly studied and predicted.

And about the number of destroyed rodents, we can call an approximate figure of tens of hundreds of thousands of individuals, since, on this account, there is its own method of counting.

Thus, against the general background of radioactive contamination of the area, the military veterinary service, together with the anti-epidemic bodies of state and military medicine, ensured the epidemic and epizootic well-being of the Gomel, Mogilev, Chernihiv, Zhytomyr and Kiev regions in a number of infectious diseases. In particular tularemia, brucellosis, tuberculosis during the following 1987-90) [1].

Conclusions

Military veterinary science is a special combat support service designed to fulfill multifaceted tasks to preserve the health of military personnel and members of their families in the conditions of the use of WMD, during the liquidation of the Chernobyl disaster, was able to:

1. Reorient its work to a completely new way of its military use, namely, ensuring the radiation safety of food products and fulfilling non-peculiar national economic tasks.

2. Provide and conduct veterinary and radiometric examination, with mass slaughter of farm animals and obtain from their slaughter, benign livestock production (total meat and milk, about 57 thousand tons)

3. To create a slender system of veterinary radiometric and phytosanitary control and supervision at the facilities of the Ministry of Defense, processing enterprises of the meat and dairy industry and in the agricultural sector of production. (Taking into account the state veterinary service, 68 veterinary and radiometric groups functioned in contaminated areas of Belarus).

To remember what such consequences lead to.

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**SOCIO-GEOGRAPHICAL AND GEOECOLOGICAL FEATURES OF
WATER SUPPLY IN THE CENTRAL ASIAN REGION**

Mavloni Mehrubon Subhonkulzoda

Candidate of Geographic Sciences, Senior Lecturer
Zhuhai University (China)

Mavloni Subhonkul Rakhmonkulzoda

Candidate of Geologo-Mineralogical Sciences, Senior Research Officer
Institute of Geology, Earthquake Engineering, Seismology of the National
Academy of Sciences of Tajikistan

Abstract. The article makes an attempt to highlight the issues of water resources management in the Aral Sea Basin (ASB), the problems arising on the way to their solution, or minimization from the standpoint of environmental sustainability and balanced nature management, as well as the problem of regional cooperation.

Keywords: Amu Darya, Syrdarya, transboundary rivers, water salinity, ecology, Central Asia, irrigated areas.

The state independence acquired by the countries of Central Asia contributed to the rupture of economic and interstate relations between them. The problems facing the Central Asian states of finding ways that will help them approach economically and technologically developed countries require finding new ways of integration, mutual understanding, especially in the area of water resources distribution.

The territory of the Central Asian states occupies a total area of about 4 million km². It covers the subtropical zone and the southern outskirts of the temperate latitudes and in the geographical aspect is a vast closed drainage area of the closed Aral-Caspian basin. Being in the zone of inland deserts and remoteness from seas and oceans, it is characterized by a purely continental climate.

According to forecasts of international research organizations, the next 20 years may become a turning point for the development of world civilization due to the threat of water shortage. In the states of Central Asia today, the "water issue" has become a serious factor in interstate relations and regional security. With high rates of population growth and a low level of

economic development, the labor market now and in the future will experience significant demographic pressure. A significant increase in the demographic potential of the region with an underdeveloped economy can exacerbate the problems of employment, labor migration, and increase social tension. Analysis of available sources on this issue [3, 4] and our own calculations [1,2] allowed us to reach the next level of generalization.

Features of the planned socio-economic development of the countries of Central Asia and the region as a whole are largely determined by the availability of water and energy resources (WER), which are extremely unevenly distributed throughout the region. The main sources of water supply for the region - the Syrdarya and Amu Darya rivers, are mainly formed in Kyrgyzstan and Tajikistan.

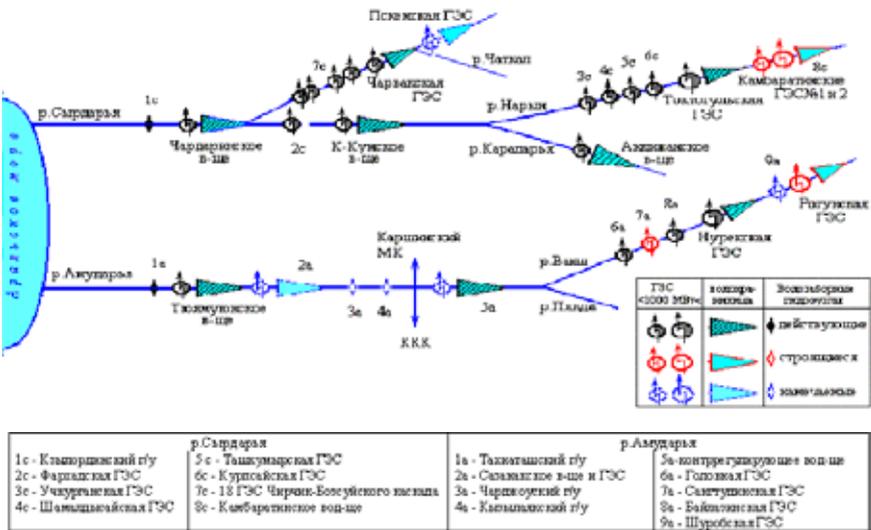


Fig. 1. Simplified linear diagram of the Syrdarya and Amudarya river systems (according to Starikov N.P., 2006, funds of the SHC "Barki Tojik")

These states today do not have the technological capabilities to discover commercial reserves of oil and gas, although, according to experts' forecasts, there are industrial reserves of hydrocarbons in the depths of these republics. For Kazakhstan, Turkmenistan and Uzbekistan, this ratio develops in the opposite way, and they are the largest regional exporters of hydrocarbon raw materials. In the structure of energy production in

upstream countries, over 80% is accounted for by hydropower, while about half of their domestic needs for primary energy resources they have to meet through imports from downstream countries. The presence of SER in the runoff formation zone and the absence of technologically and economically accessible industrial reserves of organic fuel there dictate the need to develop the hydropower potential of rivers. The problems of further development of the SER countries of the region, the maintenance of water facilities require their resolution, taking into account the emerging economic contradictions and the need to develop mechanisms for economic integration. The destruction of stable ties that operated within the framework of the previous water-energy scheme, economic and financial difficulties, deterioration of the technical condition of the water-management and energy infrastructure, the different periods of economic reform in the countries of the region, the resource-absorbing style of management predominantly determine the ineffective use of SER, the deterioration of the technical condition of the water management and fuel and energy infrastructure of the countries of the region.

The measures taken to control the state and use of water resources of transboundary rivers, accounting for water intake and making forecasts of water resources are insufficient. Existing intergovernmental agreements on the procedure for the use of SER, weaken the economic, energy and environmental security of the region. Of the two components necessary for agriculture in these conditions, it is possible to note the availability of free land reserves (tab. 1) and the fact that all countries in the region, to one degree or another, plan to use them in the future (tab. 2).

Table 1
Availability of free land reserves

Country	Area, ha	Suitable for processing	Worked area	Actual irrigated area
Kazakhstan	34440000	23872400	1658800	786200
Kyrgyzstan	12490000	1570000	595000	422000
Tajikistan	14310000	1571000	874000	719000
Turkmenistan	48810000	7013000	1805300	1735000
Uzbekistan	44884000	25447700	5207800	4233400
ASB	154934000	59474100	10140900	7895600

Table 2.
Past and forecasted data on the areas of irrigated land, thousand hectares

Year	Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan	Total
1990	782	410	706	1329	4222	7449
1995	786	416	719	1736	4298	7955
2000	786	415	719	1714	4259	8101
2010	806	434	1064	2240	4355	8899
2025	815	471	1188	2778	6441	11693

This table shows that a relatively small increase in the area of irrigated land is predicted in Kazakhstan, Kyrgyzstan and Tajikistan. However, in countries with the largest area of irrigated land (Turkmenistan, Uzbekistan), a significant increase in the area of irrigated land is expected by 2025 and, accordingly, an increase in water consumption in the agricultural sector of the region's economy, which will significantly increase the shortage of water resources in it and increase competition for water, both inside countries and between them. At the same time, the ecological allowable volume of water use in -5 Central Asia should be at least 78-82 km per year. Cotton, undoubtedly, remains the leading export item for the future, and the countries of the region will increase its production. The first three countries predict that the increase in the average annual yield by 2025 will be 3.0 t/ha. This figure is 10% higher than in 1990. In Turkmenistan and Uzbekistan, the projected yield for 2025 is significantly higher and will amount to 4.7 and 5.0 t/ha, respectively, which is almost twice the current level of production and the level of production in 1990 (Table 3)

Table 3
Gross production (thousand tons) and average annual yield * (t/ha) of cotton in Central Asia and their forecast

Year	Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan
1990	323 2.7	218 2.7	377 2.8	927 2.3	4900 2.8
1995	154 2.2	88 2.3	314 1.4	1.035 2.2	3.438 2.6
2000	296 1.9	91 2.6	330 1.4	1.407 2.2	3.280 2.2

2010	320 <i>2.8</i>	107 <i>2.9</i>	810 <i>2.8</i>	<i>3.000</i> <i>4.5</i>	4.500 <i>3.2</i>
2025	330 <i>3.0</i>	140 <i>3.0</i>	1.050 <i>3.0</i>	<i>3.600</i> <i>4.7</i>	7.250 <i>5.0</i>

*** Average annual yield data are shown in italics.**

At the same time, agriculture itself also does not have sufficient funds to expand production. The yield of the main crops in the Central Asian countries is very low. Naturally, such agricultural production is unattractive for external investors as well.

The region is characterized by population growth [tab. 4]. There are various estimates of the region's population in the near future and their incorrect application, for example, underestimation of labor migration processes [33, 62], can significantly affect the choice of strategic approaches to the parameters of sustainable development.

Table 4
Population of Central Asian countries, million people

Year	Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan	Total
1990	16.7	4.3	5.4	3.7	20.3	50.4
1995	16.0	4.6	5.9	4.6	22.9	54.0
2000	14.9	4.9	6.1	5.4	24.3	55.6
2016	17.9	6.0	8.7	5.5	31.85	69.3
2025	25.9	8.4	9.0	13.1	40.3	96.7

Forecasts for 2025 for all five Central Asian republics show a gross population growth in the region compared to 2016 in the amount of 18.9 million people. Based on these data, it follows that by 2025 the size of the entire population of the region will increase with the rate of average annual population growth, in the amount of 1.9%.

In addition, the situation is aggravated by the constantly progressing salinization and degradation of lands, primarily irrigated ones. The area of irrigated land in the ASB, where the salinity of the top 1 meter soil layer is classified as moderate or severe, accounts for about 35% of the total irrigated land in the basin.

An important role in the deterioration of water use in transboundary rivers of the macroregion is played by the quality of water in these water basins. Using data from the United Nations Economic Commission for Europe (UNECE), the Central Asia Region Environmental Center (CAREC), an analytical report on water quality in the Amu Darya and Syrdarya river basins can be compiled. The analysis showed that an important role in the

deterioration of water quality in these water basins is played by collector-drainage waters with an increased content of salts of sulfates, magnesium, nitrite nitrogen, fluorides, and pesticides. In addition to oxygen starvation of rivers, these components lead to the degradation of their biological components, and the ionic and biogenic composition of water deteriorates. Using published statistics on the chemical composition of the river. Syrdarya, the authors provide data on the influence of collector-drainage waters on the total salinity of water in this river basin from the source to the mouth (tab. 5).

Table 5

The influence of collector-drainage waters (CDW) on the total salinity of the river. Syrdarya in modern conditions

Water management area	CDW volume, million m³/ year	Average mineralization, g/l	The volume of salts entering the river, million tons/year
Syrdarya from the source to the Toktogul hydroelectric complex	190	0.75	0.143
From Toktogul hydroelectric complex to Kairakkum reservoir	8680	2.205	19.139
From the Kairakkum reservoir to the Chordara reservoir	3360	3.005	10.097
From the Chordara reservoir to the mouth	1860	3.20	5.952
Total: on the river Syrdarya	14090	9.16	35.331

This table shows that due to the inflow of more than 14.0 million m³/year of collector-drainage water into the Syrdarya river, the average salinity increased to 9.16 g/l, and more than 35 million tons of mineral salts. Kazakhstan is already sounding the alarm about the incompliance of the water composition of the Syrdarya river with environmental requirements. In particular, the maximum permissible concentration of a harmful substance per unit volume of water (MPC) for chlorine is 0.7 g/l. In fact, this figure is 1.5-2.0 g/l. An important "merit" is also borne by mining and processing enterprises located in the immediate vicinity of this river, which extract tin, lead, tungsten and other heavy metals. It is long overdue to consider the ecological aspects of the atmosphere together with the problems of respect for the ecology of water basins.

All the above-mentioned problems of water supply and lack of respect for the ecological aspects of water resources are becoming a problem not only economic, but also social. The resources of irrigation and the agricultural production based on them in Central Asia have practically exhausted themselves today and cannot further serve the goals of sustainable economic development of countries and the region as a whole.

It can be seen from this table that due to the flow of more than 14 million m³/year of collector-drainage water into the Syrdarya river, the average salinity increased to 9.16 g/l, and more than 35 million tons of mineral salts enter this river per year. Kazakhstan is already sounding the alarm about the incompliance of the water composition of the Syrdarya river with environmental requirements. In particular, the maximum permissible concentration of a harmful substance per unit volume of water (MPC) for chlorine is 0.7 g/l. In fact, this figure is 1.5-2.0 g/l.

It is necessary to determine the approaches that control the directions of transformations of the socio-geographical and ecological-demographic positions of the territories neighboring Tajikistan, and to identify the peculiarities of their influence on the socio-economic development of not only Tajikistan, but also neighboring states.

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**GEOCHEMISTRY OF DIAGENESIS OF SAPROPEL SEDIMENTS
OF SMALL LAKES IN SOUTHERN WEST SIBERIA AND EASTERN
BAIKAL**

Leonova Galina Alexandrovna

Doctor of Geological and Mineralogical Sciences, Leading Researcher

Maltsev Anton Evgenyevich

Candidate of Geological and Mineralogical Sciences, Researcher

Sobolev Institute of Geology and Mineralogy, Siberian Branch,

Russian Academy of Sciences

Abstract. Organogenic sediments (sapropels) in lakes are characterized by a recovery type of diagenesis, during which organic compounds are decomposed, the chemical composition of the pore waters is modified, and authigenic minerals (first of all, pyrite) are formed. Pyrolysis data indicate that organic matter undergoes radical transformations already in the uppermost sapropel layers, and the composition of this organic matter is principally different from the composition of the organic matter of the its producers. The sapropels contain kerogen, whose macromolecular structure starts to develop during the very early stages of diagenesis, in the horizon of unconsolidated sediment (0–5 cm). The main role in the diagenetic transformations of organic matter in sediments is played by various physiological groups of microorganisms, first of all, heterotrophic, which ammonifying, and sulfatereducing bacteria.

Keywords: geochemistry, diagenesis, organic matter, sulfate reduction, pore waters

Insufficient knowledge of the diagenesis of sediments of continental water bodies in general, and of small lakes in Siberia in particular, makes this problem extremely topical both in theoretical and practical aspects. This led the authors of this publication to launch in 2011 a study of freshwater diagenesis. This led the authors of this publication to launch in 2011 a study of freshwater diagenesis. This study was financially supported by the Russian Foundation for Basic Research, project N 11-05-00655 “Diagenesis of Lacustrine and Bog Sediments in the Piedmont-Plain Zone of the Eastern Baikal Shore and Forest–Steppe Zone of West Siberia”. The

methodological approaches applied in studying the geochemistry of diagenesis of oceanic and marine sediments [1, 6] were utilized by the authors in studies of small lakes in different climatic zones in Siberia.

Freshwater diagenesis was investigated in typical small lakes (Bol'shie Toroki and Minzelinskoe) in southern West Siberia and the Eastern Baikal area (Kokotel', Dukhovoe, and Ochki), whose bottom sediments are sapropel (Fig. 1). According to N.V. Korde's definition, sapropel is thin-structure continental sediment containing much organic matter, certain concentrations of inorganic components of biogenic nature, and foreign mineral admixtures [3]

Our research was carried out using materials collected during the 2011–2013 fieldwork. The long cores of undisturbed sediments were obtained by vibrodrilling (with a Livingstone piston corer) the bottoms of lakes to the depths of the bedrock: Bol'shie Toroki (1.8 m), Minzelinskoe (5 m), Ochki (4.5 m), Dukhovoe (7 m), and Kokotel' (14 m). We collected samples of the surface lacustrine and entrapped water and of primary producers of organic matter (plankton and macrophytes).

According to their contents of organic matter and the chemical composition of their mineral constituents, the bottom sediments of the lakes are classified into two sedimentary complexes, which are correlated with the geographic settings of the water bodies. The first sedimentary complex comprises high-ash mineral-organic sapropels of the calcareous type (Table 1), which are formed in sedimentation basins of lakes in southern West Siberia. In contrast to this complex, the other one is composed of carbonate-free low-ash sapropels of organo-mineral and organic types, which are formed in lakes in the Eastern Baikal area [4].

Table 1. Types of lacustrine sapropels [3], their major-component composition (average data per absolutely dry weight, %), and producers of the organic matter (OM)

Sapropel type, its thickness, m	Lake	OM producers	Ash content	SiO ₂	CaO	OM	C _{org}
Mineral-organic sapropels							
Calcareous, 4,2	Minzelinskoe	Macrophytes	70	5.6	30.5	30	14.8
Calcareous–siliceous, 1,4	Bol'shie Toroki	Macrophytes	64	27.2	12.5	36	14.3
Organo-mineral sapropels							
Siliceous, 14,5	Kokotel	Phytoplankton	41	26.0	1.3	59	26.0

Organic sapropels							
Low-siliceous, 1.8	Dukhovoe	Phytoplankton	29	15.3	1.2	71	38.7
Low-siliceous, 2.7	Ochki	Phytoplankton	23	14.6	0.5	77	25.8

Major Trends and Relations in the Transformations of Organic Matter during Diagenesis

Redox potential (Eh) of the sediments. The uppermost (0–5 cm) horizon of sediments in the lakes was determined to be characterized by oxidized or weakly reduced conditions with Eh from +10 (Lake Kotokel') to –3 mV (Lake Bol'shie Toroki). Farther down the sediment thickness, the Eh values rapidly become negative, vary from –76 (Lake Kotokel') to –260 mV (lakes Bol'shie Toroki and Minzelinskoe), and characterize a recovery environment.

Distribution of microorganisms in the vertical sections of the sediments. Our data on the layer by layer distribution of various physiological groups of microorganisms (heterotrophic, nitrifying, ammonifying, iron-oxidizing, and sulfate-reducing) over the vertical sections of the lacustrine sapropel indicate that their maximum numbers occur in the upper sapropel horizons, in which (in the so-called active layer of sediment) labile components of the organic matter are destructed under the effect of the microorganisms (Table 2).

Transformation of organic matter during early diagenesis. Analysis of the pyrograms (chromatographic spectra of the pyrolysis products) of the sediments provides an insight into the composition of organic matter during diagenesis (Fig. 2). The pyrograms show characteristic peaks: high-temperature (500°C), which indicate that the sediments contain macromolecular aliphatic structures, kerogen, which is organic matter significantly transformed under anaerobic conditions, and gently sloped low-temperature peaks (300–400°C), which correspond to labile components of protein–carbohydrate compounds. Data of pyrolysis indicate that organic matter undergoes profound transformations already in the uppermost layers of the sapropels and is remarkably different in composition from the sapropel-forming organisms (producers of the organic matter): macrophytes and plankton.

Table 2. Abundances of various physiological groups of microorganisms in bottom sediments in colony-forming units per gram (CFU/g) × 10⁵

Horizon of sediments, cm	Physiological groups of microorganisms CFU/g × 10 ⁵			
	TAM	heterotrophic	sulfate-reducing	ammonifying
Lake Bol'shie Toroki				
5	2970	29.2	3.5	14.5
35	2490	20.9	5.0	11.9
115	2300	26.4	7.0	7.7
Lake Minzelinskoe				
5	406.7	337.0	Не определяли	16.7
45	124.9	56.6		8.3
105	109.5	23.3		6.1
225	34.5	15.7		5.6
Lake Dukhovoe				
5	6.3	3.0	0.009	2.0
70	4.2	0.2	0.014	0.1
115	2.1	0.3	0.218	0.2

TAM is the total abundance of microorganisms.

Comparative analysis of the pirograms of the primary producers and the sapropel indicates that the sapropel (already in its uppermost 5-cm horizon) contains no labile protein-carbohydrate compounds (low-temperature peaks at ~330°C), which are typical of the primary producers, but contains kerogen (high-temperature peaks at ~500°C), which is organic matter significantly transformed under anaerobic conditions. This indicates that the decomposition of organic matter in the sediments (and the synthesis of kerogen) start already in the uppermost layers of the sapropel during the earliest diagenesis. At further sedimentation, deeper levels of the sapropel contain only highly stable organic matter, which is further decomposed very slowly.

Biogenic elements in the pore waters. Pore waters are determined to be transformed during early diagenesis of sapropel sediments in the lakes, and this leads to an increase in the concentration of mineral modes of organic matter (HCO_3^- , NH_4^+ , HPO_4^{2-}). This elucidates the mechanism

of anaerobic oxidation of organic matter by microorganisms. The decrease in the concentration SO_4^{2-} in the pore waters down the vertical sections of the sediments reflects the process of sulfate reduction SO_4^{2-} because of reduction SO_4^{2-} with the participation of sulfate-reducing bacteria. Thereby the decrease in the concentrations SO_4^{2-} down the vertical sections of sediments in the lakes in southern West Siberia is much more significant than in the western Baikal area, which indicates that sulfate reduction is more intense in the sapropels of the former lakes. This can depend on both the composition of the organic matter (its availability for the sulfate reducers) and the bulk concentrations of sulfates in the pore waters (their main source is the surface waters of the lakes). Our results do not contradict literature data, according to which the main process responsible for changes in the chemical composition of entrapped waters during diagenesis is bacterial sulfate reduction [1, 7, 8, 10].

Sulfate Reduction and Sulfur Geochemistry at Early Diagenesis.

As is known from the literature, the main process resulting in the synthesis of all intermediate and final sulfur compounds in modern bottom sediments is the microbiological reduction of sulfates by a group of anaerobic microorganisms: sulfate-reducing bacteria [1, 2, 9]. In the Siberian lakes discussed herein, sulfate reduction is the most intense in lower horizons of the sediments and is less intense in their uppermost horizons. At bacterial reduction of sulfates, the SO_4^{2-} concentration and Eh simultaneously decrease, and the contents of reduced sulfur species increase. The total alkalinity of the entrapped waters (mostly carbonate and hydrocarbonate ions) also increases with depth. The low sulfate concentrations in the lacustrine waters hamper sulfate reduction, and the major source of the sulfates is the entrapped waters of the sediments. The pore waters inherit their SO_4^{2-} mostly from the bottom waters. Because of this, sulfate concentrations in pore waters in the upper horizons of the sediments are close to sulfate concentrations in the lacustrine waters.

Fe Geochemistry at Early Diagenesis. Using X-ray diffraction techniques, we have determined that the most widely spread Fe minerals of the sapropel sediments of the lakes are sulfides (pyrite), more rare ones are oxides (goethite) and sulfates (jarosite), and even more rare Fe minerals are phosphates (vivianite) and carbonates (siderite) [5]. Pyrite is the most widely spread authigenic diagenetic mineral of the sapropels (Fig. 3), and its contents (according to data recalculated to reduced sulfur) vary from 0.2 to 2.3 wt %, provided that all sulfur occurs in the form of FeS_2 . Pyrite is most often found in lacustrine sediments as framboids, which are spherical or oval aggregates ranging from 10 to 30 μm across (mostly 20 μm).

They consist of pyrite crystals no larger than $\sim 1 \mu\text{m}$: Lake Bol'shie Toroki (horizon 140–150 cm, Fig. 3b) and Lake Kokotel' (horizon 40 cm, Fig. 3c). It is interesting that individual pyrite crystals are formed in Lake Dukhovoe in smooth spherical capsules, which are cysts of yellow-green algae (Chrysophyceae). Throughout the whole vertical section of the sapropel, pyrite is found exclusively in the cysts as individual crystals or accumulations of two to six crystals (Fig. 3d).

Conclusion

According to our data, all of the lakes are characterized by a reduced type of diagenesis, when organic matter is destructed with the participation of microorganisms, the chemical composition of the pore waters is modified, and authigenic minerals (first of all, pyrite) are formed.

Pyrolysis data indicate that organic matter is deeply transformed already in the uppermost horizons of the sapropel sediments, and its composition is notably different from that of the producers of organic matter – macrophytes and plankton.

It was determined that pore waters are modified in the course of early diagenesis of sapropel sediments in the lakes. These transformations lead to an increase in the contents of mineral modes of organic matter (HCO_3^- , NH_4^+ , HPO_4^{2-}), and this highlights the mechanism of anaerobic oxidation of organic matter by microorganisms. The decrease in the SO_4^{2-} concentrations in the entrapped waters down the vertical section of the sediments reflects the process of sulfate reduction: the reduction of with the participation of sulfate-reducing bacteria.

The sediments of all of the lakes, except only Lake Ochki, were determined to contain authigenic (diagenetic) pyrite, which is a typical mineral of most modern reduced sediments. Comparative analysis shows that sapropels in lakes in southern West Siberia generally contain more reduced Fe species and pyrite than lakes in the eastern Baikal area do, and this may reflect more intense sulfate reduction processes in the West Siberian lakes.

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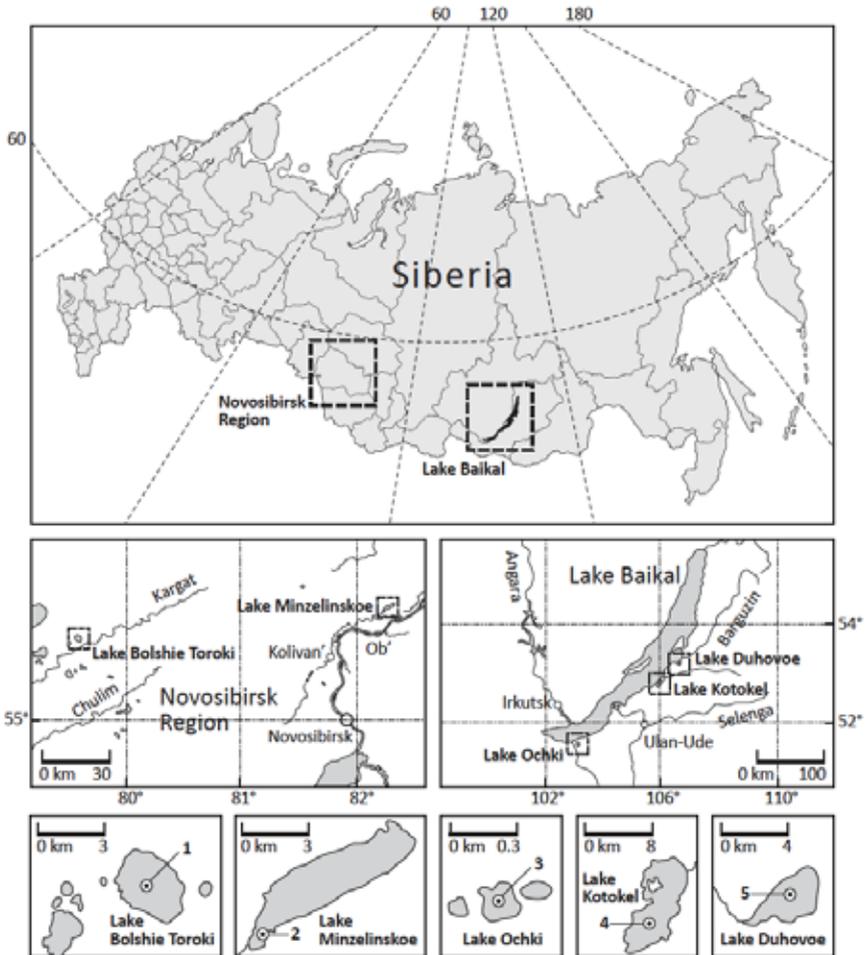


Fig. 1. Overview map of study areas. 1, 2, 3, 4, 5 – points of drilling of sapropel deposits of lakes

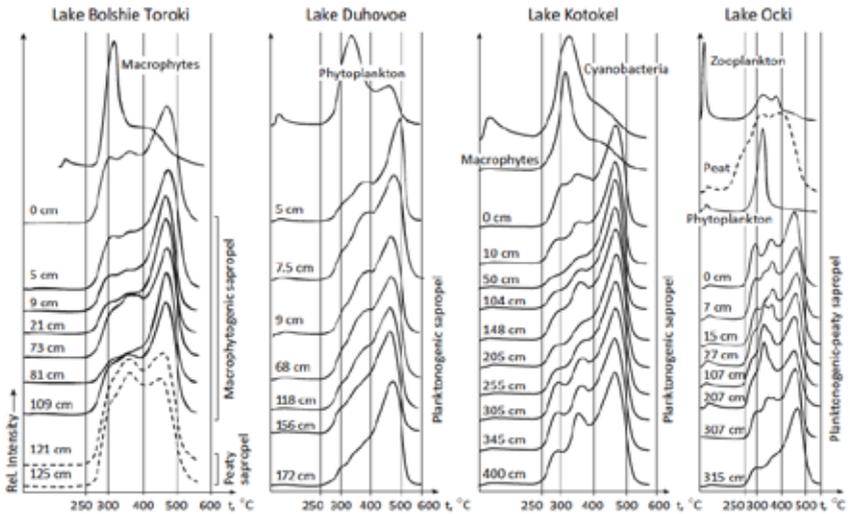
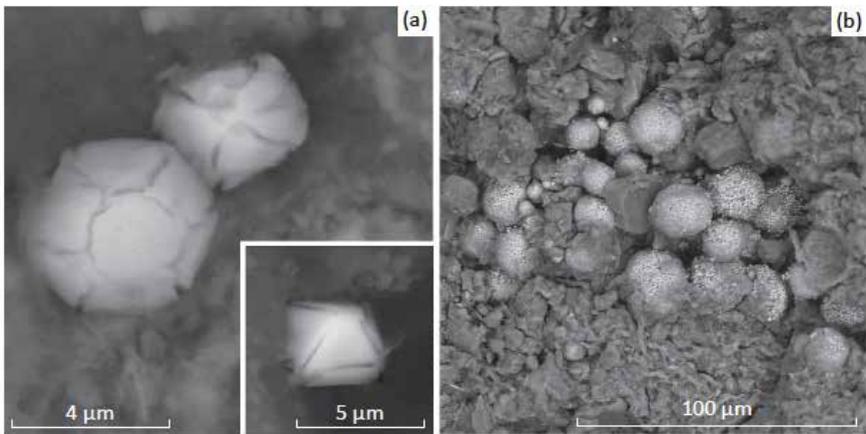


Fig. 2. Pyrograms of producers of organic matter and sediments of the lakes of Great Toroki (A), Duhovoye (B) and Points (C). BUT - unconsolidated sediment (0–2 cm). Rel. Intensity - the rate of release of a substance per unit of time at a given temperature



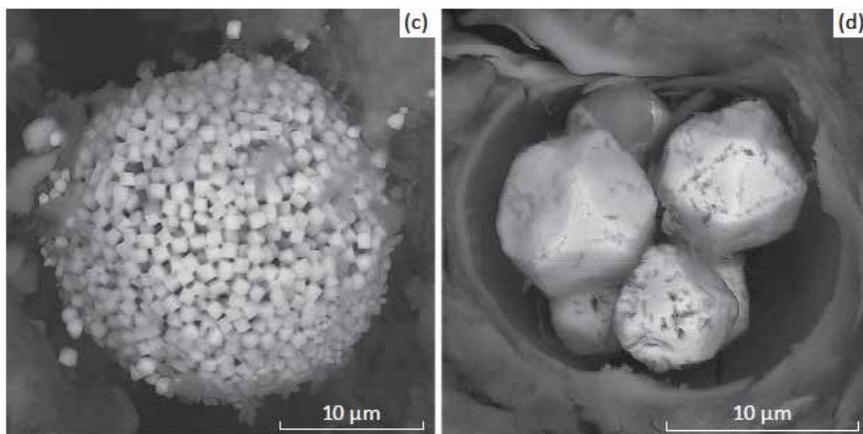


Fig. 3. SEM images (taken together with Dr. E.M. Lazareva of the Sobolev Institute of Geology and Mineralogy, Siberian Branch, Russian Academy of Sciences) of pyrite (a), (d) crystals and (b), (c) framboids from various horizons of sediments in (a, b) Lake Bol'shie Toroki, (horizons 0–2 and 140–150 cm, respectively), (c) Lake Kokotel' (horizon 40 cm), (d) Lake Dukhovoe (135 cm) (pyrite crystals hosted in alga cysts)

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MATHEMATICAL MODEL OF THE FORMATION OF ELECTRICITY FROM THE ATMOSPHERE OF OUR PLANET

Belashov Aleksey Nikolayevich

Theoretical physicist, author of over 60 inventions, discoveries of five constants, four physical quantities, many mathematical formulas and laws of physics in the field of electrical and magnetic phenomena, electrostatics, electrical engineering, hydrodynamics, astronomy, astrophysics and stellar astronomy.

ORCID 0000-0002-4821-8004

Abstract. The article is devoted to the mathematical model of the internal structure of the atmosphere of our planet based on the discovery of new laws that allow to determine the strength of physical interaction between the electrons of various atoms or molecules in the atmosphere of our planet. The structure of the interatomic space of the atmosphere consists of various atoms or molecules that are not subjected to violent actions over the interatomic space of these atoms or molecules, where the altered structure of the interatomic space of the atmosphere under the influence of various factors changes the energy balance and density of the interatomic space of atoms or molecules of the atmosphere of our planet. The scientific community is faced with a dilemma: to accept the interatomic space of the atoms of the atmosphere of our planet, which, with the help of external influences, changes their density and decomposes into electrons or the interatomic space of atmospheric atoms, with the help of external influences, changes the density, the force of interaction between electrons receives and transfers power to other objects located in the atmosphere of our planet.

Keywords: mathematical proof of the structure of atoms, the energy connection between atoms and molecules, new laws that determine the strength of the physical interaction between the electrons of an atom.

Many scientists have been interested in how the atom works for a long time. In my opinion, a more correct model of the atom was proposed in 1903 by the English physicist Thomson Joseph Johnson, according to which the atom is a positively charged sphere with electrons embedded in it, where the total negative charge of electrons is equal to the positive

charge of the sphere. In 1904, Thomson introduced the idea that electrons in an atom are divided into groups forming various configurations that determine the periodicity of chemical elements, where the atomic nucleus was not present in Thomson's model of the atom, Fig. 1.



Fig.1

According to many modern scientists, who claim that the atom contains a nucleus, which consists of nucleons - positively charged protons and neutral neutrons, connected with each other through a strong interaction, where the nucleus of the atom should be positively charged and, according to its properties, should determine the chemical element to which the given atom belongs. In 1913, the scientific community made a decision based on the idea of the German theoretical physicist, the creator of Planck's quantum theory, Marx Karl Ernst Ludwig, about the quantum energy of the atom based on the assumption that atomic oscillators emit energy only in certain portions - quanta, where the quantum energy is proportional to classical physics. oscillation frequency. Danish theoretical physicist Niels Henrik David Bohr, based on the model of the atom proposed by the English physicist Ernest Rutherford, created their own theory of the hydrogen-like atom. This theory was based on three postulates that directly contradicted classical concepts and laws. Moreover, Ernest Rutherford made an experiment in 1919 that became the most significant in his life and in the development of nuclear physics. The scientist, by bombarding it with alpha particles of nitrogen, turned it into oxygen and hydrogen and did what many alchemists dreamed of at the time, where one element was converted into another.

Of course, you can change the structure of the atom itself with the help of radioactivity, but it will already be a different atom with different physical and chemical properties and will be very different from the original. For example, it is not known at what level the electron of the new atom

has become, how its mass, size, density changed, the force of interaction between the electrons of the atom, which will be located at different levels, and the energy of the interatomic space of a given atom, and so on...

You can, of course, divide the interatomic space of an atom into separate electrons, but then the question arises where the spent electrons, neutrons and protons, moving along the conductor after performing work in the conductor, go, since a separate electron from any atom cannot be attached anywhere without radioactive interference.

If it were so easy to move electrons from one atom to another atom and change the density of interatomic space, it would be easier to obtain gold atoms from mercury atoms to enrich oneself and one's country.

Now it is not a sensation that the beginning of all living organisms on our planet came from radionuclides, and nuclear reactions over individual atoms or molecules with the help of radioactive radiation and internal conversion took place on our planet during its formation, forming the atmosphere of our planet.

For example, according to the new law of the force of interaction between the electrons of a nuclear-free atom of the material under study, which was discovered and published in the scientific and practical journal "High school" № 3 for 2021, we will determine the force of interaction between various nitrogen atoms and oxygen atoms that make up the atmosphere of our planet.

$$F = P \cdot (\lambda \cdot n_a) \cdot (\lambda \cdot n_k) = \frac{\kappa \mathcal{Z}}{M^3} \cdot \left(\frac{M^2}{c} \cdot \text{шт} \right) \cdot \left(\frac{M^2}{c} \cdot \text{шт} \right) = H$$

$F = 1,2041 \text{ kg/m}^3 \cdot (0,000019 \text{ m}^2/\text{s} \cdot 5) \cdot (0,000019 \text{ m}^2/\text{s} \cdot 6) = 1,30404 \cdot 10^{-8} \text{ H}$
where:

F - the force of interaction between nitrogen and oxygen atoms, H

P - density of the interatomic space of air at 20 °C = 1,2041 kg/m³

λ - thermal diffusivity of electrons in air at 20 °C = 0,000019 m²/s

n_a - number of electrons in the outer row of nitrogen = 5 pc.

n_k - number of electrons in the outer row of oxygen = 6 pc.

For example, Fig. 2, according to the new law, we will determine the strength of the interaction between the two electrons of the first row of the nitrogen atom included in the atmosphere of our planet.

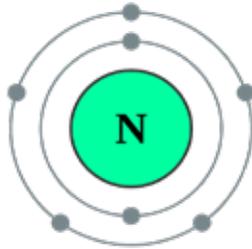


Fig.2

$$F = P \cdot (\lambda \cdot n_b) \cdot (\lambda \cdot n_h) = H$$

$F = 1,2505 \text{ kg/m}^3 \cdot (0,02775 \text{ m}^2/\text{s} \cdot 1) \cdot (0,02775 \text{ m}^2/\text{s} \cdot 1) = 0,00096296315625 \text{ H}$
 where:

F - the force of interaction between two electrons of a nitrogen atom, H

P - density of nitrogen gas atoms at 20 °C = 1,2505 kg/m³

λ - thermal diffusivity of nitrogen electrons at 20 °C = 0,02775 m²/s

n_b - the number of electrons in the first row of the nitrogen atom = 1 pc.

n_h - the number of electrons in the first row of the nitrogen atom = 1 pc.

For example, according to the new law, we will determine the strength of the interaction between two electrons of the first row of the nitrogen atom and five electrons of the second row of the nitrogen atom that make up the atmosphere of our planet.

$$F = P \cdot (\lambda \cdot n_b) \cdot (\lambda \cdot n_h) = H$$

$F = 1,2505 \text{ kg/m}^3 \cdot (0,02775 \text{ m}^2/\text{s} \cdot 2) \cdot (0,02775 \text{ m}^2/\text{s} \cdot 5) = 0,0096296315625 \text{ H}$
 where:

F - the force of interaction between electrons of different levels of the nitrogen atom, H

P - density of nitrogen gas atoms at 20 °C = 1,2505 kg/m³

λ - thermal diffusivity of nitrogen electrons at 20 °C = 0,02775 m²/s

n_b - the number of electrons in the first row of the nitrogen atom = 2 pc.

n_h - the number of electrons in the first row of the nitrogen atom = 5 pc.

Let us determine the total strength of the internal interaction between all the rows of electrons of one nitrogen atom.

$$0,00096296315625 \text{ H} + 0,0096296315625 \text{ H} = 0,01059259471875 \text{ H}$$

For example, according to the new law, we will determine the strength of the interaction between two nitrogen atoms of the same name that make up the atmosphere of our planet.

$$F = P \cdot (\lambda \cdot n_b) \cdot (\lambda \cdot n_h) = H$$

$F = 1,2505 \text{ kg/m}^3 \cdot (0,02775 \text{ m}^2/\text{s} \cdot 5) \cdot (0,02775 \text{ m}^2/\text{s} \cdot 5) = 0,02407407890625 \text{ H}$
 where:

F - the force of interaction between electrons of different levels of the nitrogen atom, H

P - the density of nitrogen gas atoms at 20 °C = 1,2505 kg/m³

λ - thermal diffusivity of nitrogen electrons at 20 °C = 0,02775 m²/s

n_b - the number of electrons in the second row of the nitrogen atom = 5 pc.

n_H - the number of electrons in the second row of the nitrogen atom = 5 pc.

For example, Fig. 3, according to the new law, we will determine the strength of the interaction between the two electrons of the first row of the oxygen atom included in the atmosphere of our planet.

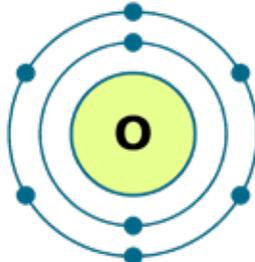


Fig.3

$$F = P \cdot (\lambda \cdot n_b) \cdot (\lambda \cdot n_H) = H$$

$F = 1,42895 \text{ kg/m}^3 \cdot (0,02845 \text{ m}^2/\text{s} \cdot 1) \cdot (0,02845 \text{ m}^2/\text{s} \cdot 1) = 0,0011565957023 \text{ H}$
 where:

F - the force of interaction between two electrons of an oxygen atom, H

P - density of oxygen gas atoms at 20 °C = 1,42895 kg/m³

λ - thermal diffusivity of oxygen electrons at 20 °C = 0,02845 m²/s

n_b - the number of electrons in the first row of an oxygen atom = 1 pc.

n_H - the number of electrons in the first row of an oxygen atom = 1 pc.

For example, according to the new law, we will determine the strength of the interaction between two electrons of the first row of the oxygen atom and six electrons of the oxygen atom of the second row that make up the atmosphere of our planet.

$$F = P \cdot (\lambda \cdot n_b) \cdot (\lambda \cdot n_H) = H$$

$F = 1,42895 \text{ kg/m}^3 \cdot (0,02845 \text{ m}^2/\text{s} \cdot 2) \cdot (0,02845 \text{ m}^2/\text{s} \cdot 6) = 0,0138791484285$
 where:

F - the force of interaction between the electrons of the oxygen atom, H
 P - density of oxygen gas atoms at 20 °C = 1,42895 kg/m³
 λ - thermal diffusivity of oxygen electrons at 20 °C = 0,02845 m²/s
 n_b - the number of electrons in the first row of an oxygen atom = 2 pc.
 n_H - the number of electrons in the second row of an oxygen atom = 6
 pc.

Let us determine the total strength of the internal interaction between all rows of electrons of one oxygen atom.

$$0,001156595702375 H + 0,0138791484285 H = 0,015035744130875 H$$

For example, according to the new law, we will determine the strength of the interaction between the oxygen atoms of the same name that make up the atmosphere of our planet.

$$F = P \cdot (\lambda \cdot n_b) \cdot (\lambda \cdot n_H) = H$$

$$F = 1,42895 \text{ kg/m}^3 \cdot (0,02845 \text{ m}^2/\text{s} \cdot 6) \cdot (0,02845 \text{ m}^2/\text{s} \cdot 6) = 0,0416374452855 H$$

where:

F - the force of interaction between the electrons of an oxygen atom, H
 P - density of oxygen gas atoms at 20 °C = 1,42895 kg/m³
 λ - thermal diffusivity of oxygen electrons at 20 °C = 0,02845 m²/s
 n_b - the number of electrons in the second row of an oxygen atom = 6
 pc.
 n_H - the number of electrons in the second row of an oxygen atom = 6
 pc.

For example, Fig. 4, according to the new law, we will determine the strength of the interaction between one electron of the fourth row of the copper atom and six electrons of the second row of the oxygen atom included in the atmosphere of our planet.

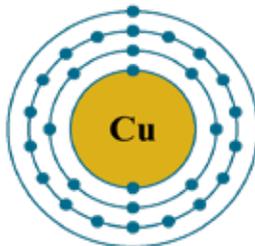


Fig.4

$$F = P \cdot (\lambda \cdot n_M) \cdot (\lambda \cdot n_K) = H$$

Process Management and Scientific Developments

$F = 1,2041 \text{ kg/m}^3 \cdot (0,0001125 \text{ m}^2/\text{s} \cdot 1) \cdot (0,02845 \text{ m}^2/\text{s} \cdot 6) = 2,31232353 \cdot 10^{-5} \text{ H}$
where:

F - force of interaction between copper and oxygen atoms, H

P - density of the interatomic space of air at 20 °C = 1,2041 kg/m³

λ - thermal diffusivity of copper electrons at 20 °C = 0,0001125 m²/s

λ - thermal diffusivity of oxygen electrons at 20 °C = 0,02845 m²/s

n_m - the number of electrons of the fourth row of copper = 1 pc.

n_k - number of electrons in the second row of oxygen = 6 pc.

For example, let us determine the strength of the interaction between the electrons of the first row of a copper atom having two electrons.

$$F = P \cdot (\lambda \cdot n_b) \cdot (\lambda \cdot n_h) = H$$

$F = 8,93 \text{ kg/m}^3 \cdot (0,000111 \text{ m}^2/\text{s} \cdot 1) \cdot (0,000111 \text{ m}^2/\text{s} \cdot 1) = 0,00000011002653 \text{ H}$
where:

F - the force of interaction between the electrons of the copper atom, H

p - density of the medium of the interatomic space of copper = 8,93 kg/m³

λ - thermal diffusivity of copper electrons at 25 °C = 0,000111 m²/s

n_b - the number of electrons in the first row of a copper atom = 1 pc.

n_h - the number of electrons in the first row of a copper atom = 1 pc.

For example, let us determine the strength of interaction between two electrons of the first row of a copper atom and eight electrons of a copper atom of the second row.

$$F = P \cdot (\lambda \cdot n_b) \cdot (\lambda \cdot n_h) = H$$

$F = 8,93 \text{ kg/m}^3 \cdot (0,000111 \text{ m}^2/\text{s} \cdot 2) \cdot (0,000111 \text{ m}^2/\text{s} \cdot 8) = 0,00000176042448 \text{ H}$
where:

F - the force of interaction between the electrons of a copper atom, H

p - density of the medium of the interatomic space of copper = 8,93 kg/m³

λ - thermal diffusivity of copper electrons at 25 °C = 0,000111 m²/s

n_b - the number of electrons in the first row of a copper atom = 2 pc.

n_h - the number of electrons in the second row of a copper atom = 8 pc.

For example, let us determine the strength of the interaction between the eight electrons of the second row copper atom and the eighteen electrons of the third row copper atom.

$$F = P \cdot (\lambda \cdot n_b) \cdot (\lambda \cdot n_h) = H$$

$F = 8,93 \text{ kg/m}^3 \cdot (0,000111 \text{ m}^2/\text{s} \cdot 8) \cdot (0,000111 \text{ m}^2/\text{s} \cdot 18) = 0,0000158438203 \text{ H}$
where:

F - the force of interaction between the electrons of a copper atom, H

p - density of the medium of the interatomic space of copper = 8,93 kg/m³

λ - thermal diffusivity of copper electrons at 25 °C = 0,000111 m²/s

n_b - the number of electrons in the second row of a copper atom = 8 pc.

n_h - the number of electrons in the third row of a copper atom = 18 pc.

For example, let us determine the strength of the interaction between eighteen electrons of the third row of the copper atom and one electron of the fourth row of the copper atom.

$$F = p \cdot (\lambda \cdot n_b) \cdot (\lambda \cdot n_h) = H$$

$F = 8,93 \text{ kg/m}^3 \cdot (0,000111 \text{ m}^2/\text{s} \cdot 1) \cdot (0,000111 \text{ m}^2/\text{s} \cdot 18) = 0,0000019804775 \text{ H}$
 where:

F - the force of interaction between the electrons of a copper atom, H

p - density of the medium of the interatomic space of copper = 8,93 kg/m³

λ - thermal diffusivity of copper electrons at 25 °C = 0,000111 m²/s

n_b - the number of electrons in the third row of a copper atom = 18 pc.

n_h - the number of electrons in the fourth row of a copper atom = 1 pc.

Let us determine the total force of the internal interaction of all electrons of one copper atom.

$0,00000011002653 \text{ H} + 0,00000176042448 \text{ H} + 0,0000158438203 \text{ H} = 0,00001771427131 \text{ H}$

For example, let's define the strength of the interaction between the atoms of the same name of copper.

$$F = p \cdot (\lambda \cdot n_b) \cdot (\lambda \cdot n_h) = H$$

$F = 8,93 \text{ kg/m}^3 \cdot (0,000111 \text{ m}^2/\text{s} \cdot 1) \cdot (0,000111 \text{ m}^2/\text{s} \cdot 1) = 0,00000011002653 \text{ H}$
 where:

F_M - the force of interaction between the electrons of the copper atom, H

p - density of the medium of the interatomic space of copper = 8,93 kg/m³

λ - thermal diffusivity of copper electrons at 25 °C = 0,000111 m²/s

n_b - the number of electrons in the fourth row of a copper atom = 1 pc.

n_h - the number of electrons in the fourth row of a copper atom = 1 pc.

After the calculations, Fig. 5, it turned out that the force of interaction between like-named nitrogen atoms is less than between like-named oxygen atoms. The total force of the internal interaction of all electrons in the interatomic space of oxygen is greater than all electrons in the interatomic space of nitrogen.

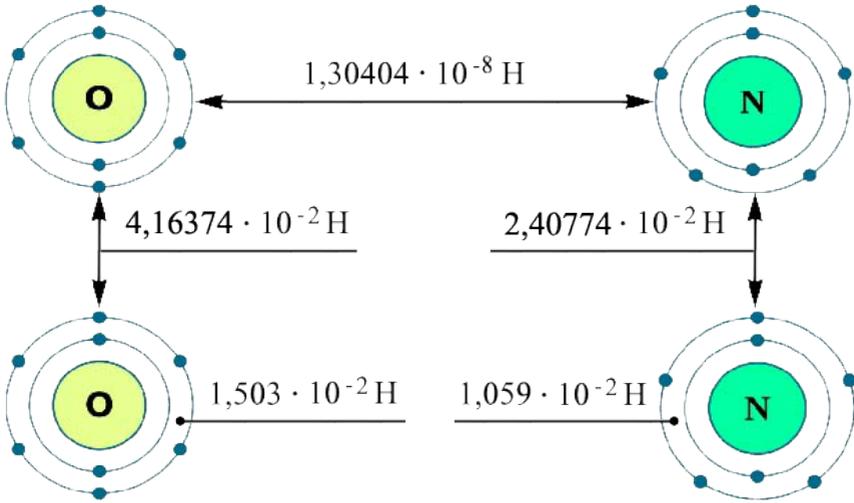


Fig.5

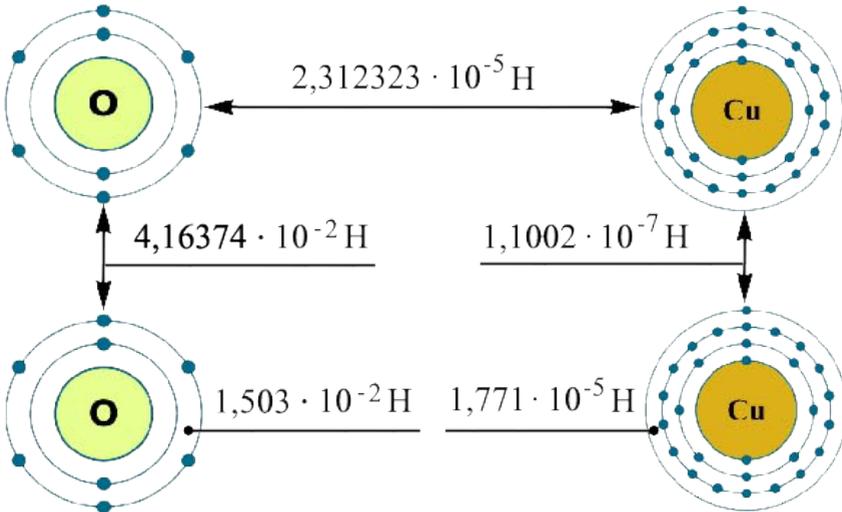


Fig.6

The force of interaction between the like-named copper atoms Fig. 6 is less than between the like-named oxygen atoms. The total force of the internal interaction of all electrons in the interatomic space of oxygen is greater than all electrons in the interatomic space of copper. The force of interaction between an oxygen atom and a nitrogen atom is less than between an oxygen atom and a copper atom.

After the contact of oxygen atoms with copper atoms, the difference in the internal forces of interaction between these atoms is obtained. The internal forces of oxygen atoms are redistributed and transfer part of their energy to copper atoms. After the redistribution of internal forces, the oxygen atom begins to deplete and lose some of its strength and energy. As a result, the density and internal stress of oxygen atoms decreases. Then the depleted oxygen atom begins to absorb the magnetic energy of our planet and partially restore its energy balance.

Further, the saturated oxygen atom with magnetic energy, using artificial or natural convection, moves along the surface of a conductor consisting of copper and transfers the accumulated magnetic energy to another object. After completing this work, the oxygen atom is freed from magnetic energy and restores its original purpose without disturbing the ecological system of our planet.

Mathematical proofs are being put forward, deserving special attention, according to which it is not electrons that move along the conductor, but oxygen atoms or nitrogen atoms, which can receive energy from some energy sources and give it to other energy sources. In this case, it is necessary to pay special attention to the fact that after performing a certain work, the oxygen atoms moving along the conductor are restored in the atmosphere of our planet.

This mathematical evidence confirms that individual electrons, neutrons or protons cannot move along the conductor, since it is not known where they then go after the work is done and where they came from, if they were not subjected to external violent exposure to radioactive radiation. It should also be noted that without violent interference in the structure of the atom, it is impossible to divide it into separate electrons in any other way. This evidence can be confirmed by the mechanism of formation of thermoelectric currents arising in dissimilar conductors when the temperature of the hot and cold junction changes, where there is no violent interference with the structure of oxygen or nitrogen atoms by radioactive radiation.

It should be emphasized that both oxygen atoms and nitrogen atoms, which have different densities of interatomic space and different numbers of electrons, can be carriers of the magnetic energy of our planet.

In conclusion, we can say that our material world is very diverse and all the processes occurring in it from random circumstances that occur in time, in varying degrees, affect one another, therefore a new theory of multifaceted dependence is being put forward. In this world, everything is intertwined, and one phenomenon of nature is in varying degrees dependent on another. More active material bodies dominate over less active material bodies, therefore there can be no independent and constant constants, laws or physical quantities. For example, the new law of gravitation and cosmic interaction between two material bodies that are located in the space of the Solar system or another system is closely related to the new law of gravitation of one material body located in the space of the Solar system to the central star of the Sun. At the same time, the laws of gravitation and cosmic interaction are in constant dependence on the new law of the activity of a material body located in space and the new law of the acceleration of free fall of bodies in space. And the listed laws are closely related to the new law of energy between two material bodies that are in the space of the solar system and the new law of the energy of one material body located in the space of the solar system to the central star of the sun and many others...

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**THE EXPEDIENCY ANALYSIS OF USING ANDROID
SMARTPHONE AS AN MAIN MODULE OF WATER CANNON
CONTROL**

Bochkov Vladimir Sergeevich

Postgraduate

Kataeva Liliya Yurievna

Doctor of Physico-mathematical Sciences, Full Professor
Nizhny Novgorod State Technical University

Abstract. As part of the scientific work, an analysis of the problems of a previously developed prototype of a water cannon robot operating on the basis of a multithreaded asynchronous video analysis kernel and corresponding algorithms for filtering incoming frames to identify areas of the environments, with the ability to process neural network models of color segmentation of the flame in real time.

Special attention is currently being paid to the problem of preventing natural disasters. Forest fires are the most common catastrophe causing serious damage to the Russian economy. It should be noted that the most often guilty in the occurrence of these phenomena is a person and careless handling of fire. Also, one cannot ignore the fact that our country has vast forests, and there is not enough professional personnel to monitor them. Therefore, the scientific community is faced with the task of developing automated means of protecting and counteracting forest fires. One of the promising areas of computational cybernetics is the development of new methods of detection and analysis behind flames. In case of forest fires, the supply of water to the hearth of the flame without taking into account its structure is ineffective, therefore it is necessary to develop an algorithm for extracting the zones of fire vulnerability on video.

As part of the scientific work, a prototype of a robot-water cannon was developed [1], shown in fig.1.



Fig. 1 – Robot water cannon prototype

During testing of the robot shown in fig. 2, the problem of overexposure of the flame in the frame area was identified.



Fig. 2 – Water cannon robot testing

Real-time fire analysis [2] and correct display of the color spectrum of the flame on video are key factors in the effectiveness of fire extinguishing. In the implementation of video analytics as part of the design of the robot, an algorithm was developed to search for flame zones without specifying its color configuration [3]. To enable it to work in real time on the Raspberry PI 3 Model B microprocessor architecture, the core of asynchronous multithreaded video analysis was developed [4]. In order to qualitatively improve the results of flame detection, approaches to flame segmentation were applied using modern convolutional neural networks of the UNet class [5], and its modification was developed for the problem of segmentation of objects of the same kind on the basis of wUUNet [6]. Objects of the same kind within the framework of our task are the contours of the flame, and the sign that distinguishes the types of flame from each other is the color (Yellow, orange and red). This division was made in order to follow the rule of extinguishing a fire in the lower zone of the flame with a temperature of 600K [7], which corresponds to the red color in the video. In order for this neural network algorithm to work effectively, it is necessary to select a device capable of high-quality photographing of the flame and process the frame in real time. To do this, we took the initial configuration in the form of a Raspberry PI 3 Model B board and a Pi camera module, and opposed it with the Android smartphone Realme X2 Pro, which has a 64 MPix camera and a system based on a Qualcomm Snapdragon 855 chip. The comparison results between the frames of the flame fixing devices are shown in fig. 3-5.



Fig. 3 – Flame video recording on Raspberry PI 3 Camera module with auto setting

The Raspberry PI Camera module supports automatic shooting mode, in which the flame contour appears to be overexposed as a circle, which does not correspond to the successful detection of vulnerable zones. Experimentally, the "spotlight" operating mode was found, in which a bright object becomes clearly visible. However, in this case, we lose information about the environment surrounding the flame, which is important for the operation of both the convolutional neural network and the subsequent stages of video processing in order to search for additional information.



Fig. 3 – Flame video recording on Raspberry PI 3 Camera module with spotlight setting



Fig. 5 – Flame video shooting on Realme x2 Pro

Video shooting on the Realme x2 pro smartphone is optimal both in terms of obtaining correct information about the flame and its surroundings.

The second stage of comparison between the considered software and hardware configurations is to obtain performance characteristics of the computations of the neural network model UNet above the frame, in order to find clear contours of a flame of different colors. Neural networks are massively parallel algorithms for matrix calculations, so the presence of a graphics core in a mobile phone chipset is an important advantage over the lack of one on a Raspberry PI 3 Model B microcomputer. Indeed, Table 1 shows a significant advantage of using a mobile phone.

Tab. 1 – Device performance characteristics

Device	Processing time for 1 frame, UNet model	FPS indicator
Raspberry PI 3 Model B	0.87 sec.	1.14
Realme x2 Pro	0.25 sec.	40

Thus, it was found that the use of a modern mobile phone shows better results in comparison with the Raspberry PI3 Model B microcomputer in the task of filming and timely segmentation of the flame by color.

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THEORY AND PRACTICE OF SUCROSE EXTRACTION FROM BEET TISSUE

Kulneva Nadezhda Grigorievna

Doctor of Technical Sciences, Full Professor

Nozdrevatykh Yulia Alekseevna

Master

Voronezh State University of Engineering Technologies,
Voronezh, Russia

Abstract. Sucrose is extracted from beet tissue by way of diffusion and it includes sucrose transfer from internal layers of chips to their surface following molecular diffusion laws and from the surface of chips to extractant. One of the ways to enhance efficiency of the diffusion process in beet sugar production is thermal action on beet chips with various heat carriers in order to destroy protoplasm that prevents sucrose release from vacuoles to the beet tissue periphery. The objective of this thesis is to ensure utmost performance of the diffusion process by choosing the most effective components of chemical heat treatment of beet chips. Rational conditions of solution electrochemical activation for beet chips chemical heat treatment prior to extraction have been selected experimentally.

Keywords: extraction, beet tissue, molecular diffusion coefficient, chemical heat treatment.

Extraction of one of multiple components from a compound raw material using a dissolvent is a fundamental stage of beet sugar production [1,2].

It is commonly supposed that sucrose extraction from beet proceeds under certain conditions (temperature of 72-75 °C) and comprises two most important stages: sucrose transfer (convective diffusion) from internal layers of chips to their surface following molecular diffusion laws and from the surface of chips to extractant (mass exchange). Sucrose is extracted from beet chips as a result of diffusion, which is spontaneous equalization of the matter concentration at the interface of two phases mediated by heat motion of molecules. Sucrose extraction in itself is a complex mass

exchange process, during which the mass exchange rate is related to the mechanism of distributed matter transfer in the phases involved in mass exchange. Mass exchange is mainly affected by molecular diffusion, which is understood to be mass transfer from one part of the system to another one mediated by heat motion of molecules [3,4,5].

Reliable research data on matter diffusion from plant tissue cells in “pure” solutions is of high theoretical and practical relevance for the study of the mechanism of matter transfer from inside cells of the plant tissue to its surface as well as its mass transfer from the surface to the extractant. Analysis of reference data has yielded the following equation for the calculation of the sucrose diffusion coefficient in pure water at a temperature of 20-70 °C and sucrose concentration of $C = 5-30\%$ w/w. The equation is as follows:

$$D = 0,422 \cdot 10^{-5} e^{-0,015e} e^{\frac{-2700}{T}},$$

where T is absolute temperature, K.

The process of sucrose diffuse extraction from beet chips is a fundamental mass exchange process in beet sugar production. Workmanship and technology of the diffusion department of a beet sugar factory predetermines operational efficiency of all downstream stations as well as quality and output of finished products [6,7].

Production of the diffusion juice with the best possible technology parameters throughout the production season is the most critical task of the sucrose extraction station. To solve this task, operational efficiency of this production area has to be maintained at the highest level possible, namely: the optimal diffusion process has to be ensured and problems occurring during sucrose extraction have to be promptly identified and eliminated.

One of the ways to enhance efficiency of the diffusion process in beet sugar production is thermal action on beet chips with various heat carriers. The main objective of thermal action is to destroy a complex system of barriers that prevent sucrose release from cell vacuoles to the beet tissue periphery. These barriers represent a cellular system comprising the cell membrane and many cell organelles of the beet tissue. According to researchers, [8] the most effective way to destroy the above barriers is heat treatment of beet chips with various heat carriers, the most effective of which is heating steam. However, some think that long-term heat treatment of beet chips is unfeasible. The objective of this thesis is to ensure utmost performance of the diffusion process by choosing the most effective components.

Results and their discussion

Diffusion with chemical heat treatment of beet chips with heating steam and solutions of the proposed saline reagents before extraction (figure 1) has been studied.

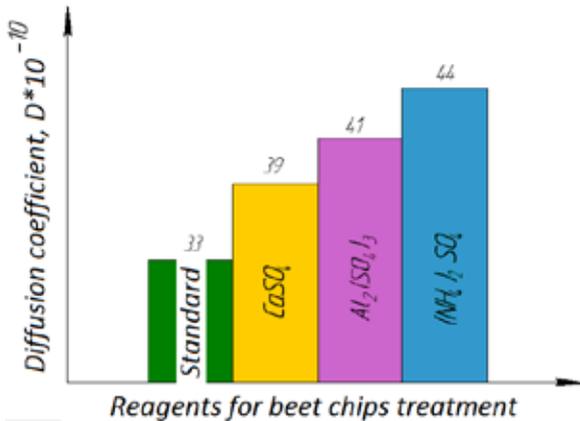


Figure 1 – Sucrose diffusion coefficient when various reagents are used

Analysis of diffusion coefficient values allows to draw a conclusion on the positive influence of beet tissue chemical heat treatment with solutions of the proposed reagents on the coefficient. The highest diffusion coefficient value is attained when the beet tissue is treated with the hot solution of ammonia sulphate $(NH_4)_2SO_4$ [9].

Conventional technologies used at most today’s beet sugar enterprises do not ensure high quality of diffusion juice. This brings about a need to improve the existing technical and manufacturing methods using the modern scientific approaches that secure high tech effect with minimum resource and power outlays [10,11].

Scientific progress has brought to life a prospective school based on the use of electrophysical and electrochemical impacts of high- and low-frequency electric fields on various semi-finished products of beet sugar production.

The most promising is electrophysical and electrochemical impact of electric field (electrochemical activation) on production solutions and process liquids of beet sugar production. Use of electric fields is enabled by the presence of electrically charged particles in process fluids that interact

with the external electric field. It is important to note that harmful nonsugars (HMC, HOA, protein-pectic complex substances) carry electric charges of certain polarity, while sugars have no electric charge. In addition to its technology effect, electrochemical activation (ECA) features high controllability, full automation possibility and may be used to develop highly efficient and environmentally sound technologies [12].

Experimental studies have been conducted to describe feasibility of application of ECA reagent solutions for the enhancement of heat mass exchange parameters of extraction and to determine reasonable parameters of electrochemical action.

At the first stage, in order to justify feasibility of application of ECA reagent solutions for the enhancement of beet tissue permeability, aqueous solutions of ammonia and aluminium sulphate with reagent concentration of 0.05% were prepared and subjected to ECA for 60 s with electrode current density of 3 mA/cm² and electric field intensity of 1.2 V/cm. Reagent solutions thus electroactivated were heated to 72 °C and used for beet tissue chemical heat treatment. Diffusion coefficient was used as a criterion of beet tissue permeability; it was calculated in line with the method [13] (figure 2).

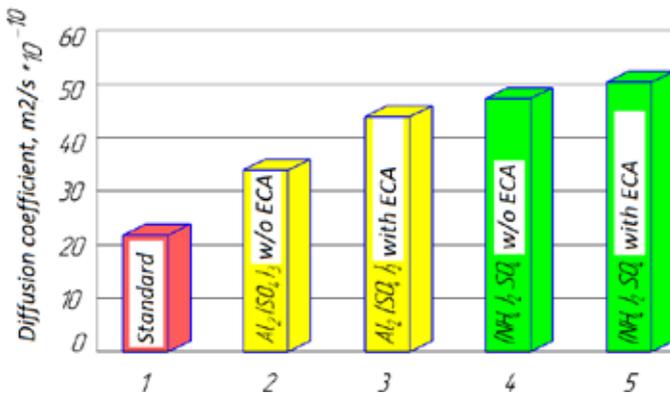


Figure 2 – Diffusion coefficient depending on the method of chemical heat treatment of chips

Analysis of the resulting sucrose diffusion coefficient values confirms feasibility of electrochemical action on aqueous solutions of the reagents used for chemical heat treatment of chips. This processing method enables fast denaturation of the protein-pectate membrane of cell walls,

which results in its reduced stability that causes destruction and fragmentation. This brings about elevated permeability of the beet tissue.

Qualitative indicators of the semi-finished products obtained using the conventional technology and with prior chemical heat treatment of beet chips with electroactivated solution of ammonia sulphate are presented in table 1.

Table 1 – Qualitative indicators of diffusion and purified juices

Indicators of semi-finished products	Flowchart without treatment of beet chips before extraction	Prior treatment of beet chips with ECA (NH ₄) ₂ SO ₄ solution
Diffusion juice		
Purity, %	85.7	87.6
Protein content, mg/cm ³	0.38	0.21
Purified juice		
Purity, %	91.0	92.7
Color index, optical density units	216	178
Mass fraction of calcium salts, % CaO	0.031	0.025

Conclusion

Analytical study of the experimental data obtained has resulted in the elaboration of methods of diffusion juice production with chemical heat treatment of beet chips with steam and aluminium and ammonia sulphate solutions before extraction [14,15,16].

Combination of heat and chemical treatment allows to heat up beet chips to the optimal diffusion temperature of 72 °C outside of the beet diffuser. Heated chips are fed to the beet diffuser, which helps decrease the process time. Steaming period is 30-60 s. Temperature of chips after steaming is 72 °C.

Qualitative indicators of the semi-finished products obtained using the method with prior chemical heat treatment of chips before sucrose extraction are much better than those of conventionally obtained juices. This evidences feasibility of the proposed method with thermal and chemical preparation of beet chips prior to sucrose extraction.

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INVESTIGATION OF THE PROPERTIES OF RUBBER-METAL SHOCK ABSORBERS

Grigoreva Elena Vladimirovna

Far Eastern State Technical Fisheries University
Vladivostok, Russia

Abstract. The work is devoted to the study of the elastic properties of rubber shock absorbers. Its purpose is to obtain the data necessary for calculation and design. For rubber grades most often used in the manufacture of shock absorbers, graphical dependences "deformation-force" of samples with different ratios of loaded and freely deformed surface, dependence of elastic modulus and a graph of dependence of the ratio of dynamic stiffness and static hardness of rubber (measured by Shore) were obtained.

Keywords: rubber-metal shock absorbers, rubber, shock absorbers

Introduction

In the last decade, the tendencies towards an increase in the power of machines and the productivity of technological equipment with a simultaneous decrease in weight and dimensions, which is achieved by a more efficient use of production space, have become more and more clear. A decrease in the weight of the equipment with an increase in its power leads, as a rule, to an increase in vibration (due to the lack of rigidity of the structure).

Suppression of vibration and noise has become an urgent problem of our time. To solve this problem means, on the one hand, to ensure healthy working conditions, and on the other, to free up additional reserves of labor productivity.

In the fishing industry, vibrations and noises are especially harmful for personnel working with machines and mechanisms installed in confined spaces, such as ship premises of fishing, processing and transport-refrigerated vessels, press-stamping areas, compressor stations, etc.

The cost of manufacturing precisely balanced mechanisms and machines is high and rising sharply with the increasing requirements for precise balancing and overall accuracy, and the cleanliness of machining parts and assemblies of the machine.

The most economical is the way in which certain imbalances of the machine are allowed, and the inevitable vibrations that arise are reduced to acceptable values with the help of shock absorbers.

Static and dynamic tests of rubber compression absorbers

Metal-rubber shock absorbers have a number of indisputable advantages and have a great effect on increasing the service life of machine parts and components exposed to shock and vibration loads.

However, their wider application is limited by a number of reasons resulting from insufficient knowledge of the properties and behavior of rubber as an elastic-viscous shock absorber element under various conditions of its loading.

The literature contains insufficient information required for the design of rubber-metal shock absorbers using different brands of rubber for different operating conditions. The present work is an attempt to obtain some of the data required for this purpose.

For the study, rubbers of grades 1847, 2959, 2462 and NO-68-1 from natural rubber were taken, as well as samples obtained from raw rubber by vulcanization, for the main characteristic of which their hardness was taken. The samples were in the form of cylinders with a diameter of 50 and 100 mm and samples of square cross-section.

As a result of experiments, it was found that rubber samples after the first loading to a deformation of 50% gave a permanent deformation (settlement) up to 0.5-1.5% of the initial height.

Then, four more loads were carried out up to a deformation of 50%, the size of the specimen in height was stabilized. The original size is restored after removing the load in 4-5 minutes.

Before static calibration, the sample was loaded five times and held after each loading for 5 minutes. Loading speed 50 mm/min.

Calibration results after processing by average values (statistical method) are summarized in a graph (fig. 1).

The scatter of the experimental readings of the efforts from the average ones used in the construction of the graph does not exceed $\pm 14\%$.

The modulus of elasticity of rubber, like any elastic-viscous substance, does not remain constant. The rubber itself is practically not compressible. With a load of 2000 kg / cm², its volume decreases only by 5%.

The activated ability of rubber is manifested only when the rubber under load can freely deform in any direction.

It follows from this that the ratio between the loaded and free surfaces (let's call it the form factor) in a rubber shock absorber has a very large effect on the load-deformation relationship.

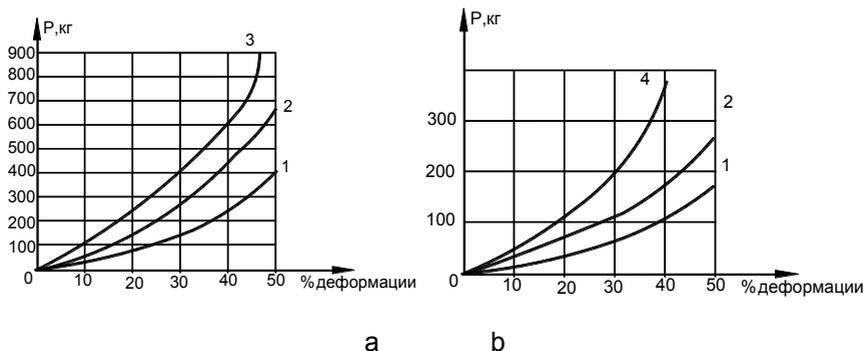


Fig. 1 "Deformation-force" relationship graph

a) the test piece had dimensions: Ø50 mm and H = 50 mm; b) the tested sample had dimensions Ø100 mm and H = 100 mm, made of rubber
 1- 1847, 2- 2959, 3- 2462, 4- NO-68-1.

Since in conditions under which rubber-metal shock absorbers are made by vulcanization from raw rubber, when the final material of the elastic element in composition and properties may differ from standard rubber grades, it is more convenient to take the Shore hardness of rubber as the main characteristic.

Therefore, we carried out work to study the dependence of the elastic modulus of rubbers of certain ranges of hardness on the form factor.

The tests were carried out on rubber samples of different hardness, namely: 45°, 55°, 70° Shore.

To avoid errors due to material heterogeneity, the shape factor was changed by decreasing the height of the same samples. The supporting surface remained unchanged.

The loading was carried out on a screw press. The force was changed by a spring dynamometer. Sample sizes in height: 75 mm, 37.5 mm, 25 mm, 18.7 mm, 15 mm. Samples were tested with aspect ratios of 0.25, 0.50, 0.75, 1.00, 1.25, and were compressed by 10% of their height.

The test results after processing are summarized in a graph (fig. 2). As can be seen from the graph, with a decrease in the shape factor, i.e., with a decrease in the freely deformable surface with a constant bearing surface area, the stiffness of the shock absorbers increases significantly.

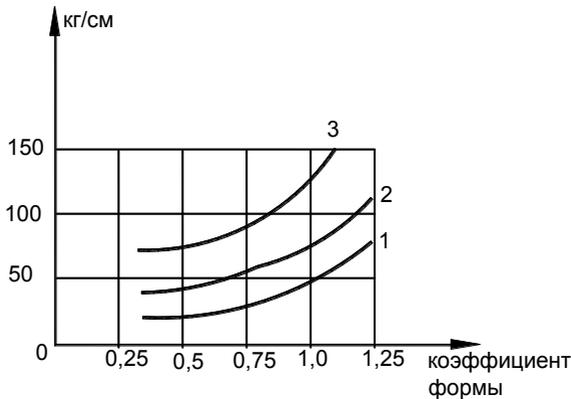


Fig. 2 Dependence of the elastic modulus of rubber in compression of the ratio of the loaded surface to the freely deformed surface for rubber of different hardness

By varying the height of the shock absorber, it is possible to significantly change the static (and, consequently, the dynamic stiffness) of the shock absorber, and then select the most suitable dimensions with a resolution corresponding to the frequency of the exciting force.

Knowing that the effect of vibration absorption by installing machines on shock absorbers depends on the ratio of the frequency of the exciting force to the frequency of the natural vibrations of the system.

The latter depends on the stiffness of the shock absorbers.

The stiffness and modulus of elasticity of rubber under static and dynamic loading are different. Unfortunately, data on the ratio of static and dynamic stiffness (or the ratio of the corresponding modulus) are not often found in the literature. Moreover, these data are often different from different sources do not coincide.

Work has been carried out to analyze the technical data of the manufactured rubber-metal shock absorbers. Recommendations for dynamic loads with a frequency of 1000 to 2000 per minute are presented in Figure 3, a graph of the dependence on rubber hardness and the ratio of dynamic to static hardness.

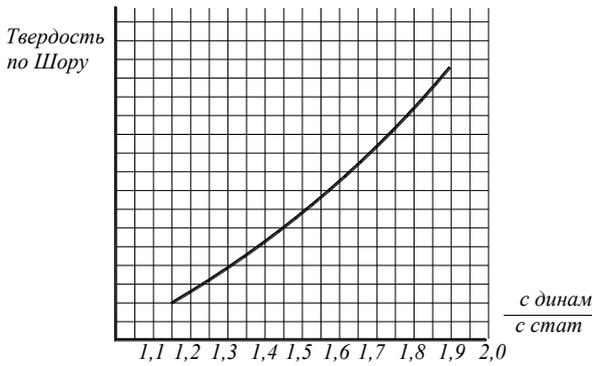


Fig. 3 Ratio of dynamic to static stiffness depending on rubber hardness

Conclusion

The data obtained greatly facilitate the design work in the design of new forms of rubber-metal shock absorbers, as well as in the selection of commercially available shock absorbers for each specific case of machine installation.

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FIELD RESEARCH OF THE ICE REGIME OF THE KARASUK RIVER IN THE NOVOSIBIRSK REGION

Fomicheva Nyailya Nikolaevna

Candidate of Technical Sciences, Associate Professor

Vasilenko Dmitriy Sergeevich

Student

Siberian State University of Water Transport

Abstract. The article presents data from field studies of the ice regime of the Karasuk River in Novosibirsk region: the results of measurements of the thickness of the ice cover, snow on ice, and air temperature. The data on the strength of winter ice obtained from the compression tests of specimens are also given, and the structure of the ice is described.

Keywords. Ice regime, congestion, ice thickness, ice strength, ice structure.

Ice phenomena on the rivers: congestions, gales are classified as hazardous hydrological phenomena. In Western Siberia, catastrophic floods occur mainly during the spring flood, when ice jams occur. In order to take proactive measures to prevent or reduce the risk and damage from such natural phenomena, it is necessary to draw up long-term and short-term forecasts. This problem can be solved only by relying on an extensive database for monitoring certain hazardous phenomena [1]. Today, mathematical models of the development of unfavorable events are being drawn up. But they also require specific initial data for the sections under consideration [2].

The sources of the initial data are both systematic observations of the ice regime and expeditionary field work in individual sections of the river.

The impact of ice on hydraulic structures (bridges, piers, etc.) is associated with the study of the dynamic impact of ice masses. The force of the impact of a moving ice field can be determined by the formula [1]:

$$P = k_{cp} \cdot \sigma_c b t_n, \text{ mH}, \quad (1)$$

where k_{cp} – structure aspect ratio;

- σ_c – compressive strength of ice, MPa;
- b – width of the structure, m;
- t_n – ice field thickness, m.

For structures of a sloping type, knowledge of the ultimate strength of ice during bending will be required. This issue has been studied in detail and is reflected in the literature [3,4,5].

The purpose of this work is to conduct field studies of the ice regime on the Karasuk River, Novosibirsk region.

The tasks include: measuring the increase in the thickness of the ice cover and assessing the influence of meteorological conditions on this process; compressive strength testing of ice samples; study of the structure of winter ice.

Table 1 shows the results of measurements of the increase in the thickness of the ice cover on the Karasuk River. The measurements were carried out at different points: near the bank and in the middle of the river, while the measurement points were coordinated. Measurements of the thickness of the snow on the ice were also carried out. To assess the influence of meteorological factors on the formation of the ice cover, the air temperature was measured.

Table 1 – Results of field studies to measure the thickness of ice and snow cover on the Karasuk River in 2020–2021.

Indicators \ Date		Date	19.12. 2020	06.01. 2021	16.01. 2021	31.01. 2021	14.02. 2021	23.02. 2021	06.03. 2021	14.03. 2021
h_{ice} , cm	middle		29.5	34.0	51.0	55.0	56.0	65.0	87.0	70.0
	by the coast		25.0	45.0	41.0	51.0	52.0	52.0	78.0	45.0
h_{snow} , cm	middle		6.0	16.0	15.0	12.5	11.5	17.0	11.0	15.5
	by the coast		13.5	40.0	24.0	27.0	30.0	30.0	14.0	43.0

The increase in the thickness of the ice cover is shown in fig. 1.

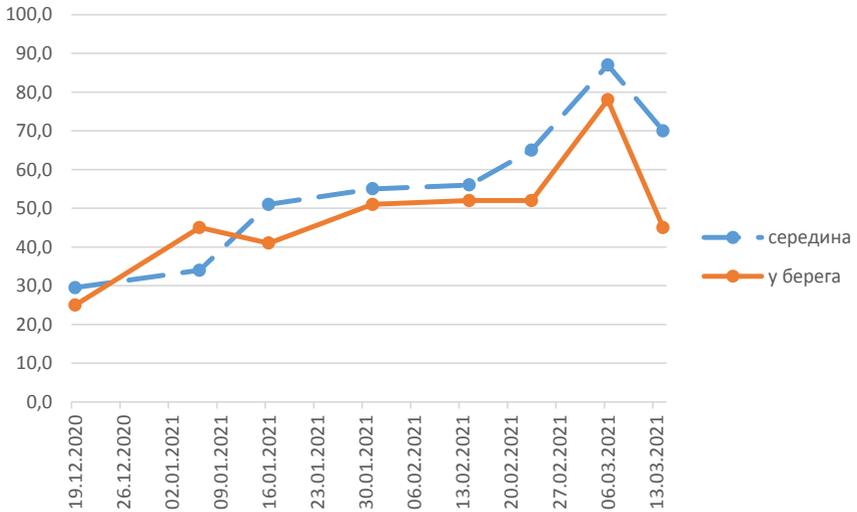


Fig. 1. Ice thickness at the coast and in the middle of the course of the Karasuk River

Figure 2 shows the course of air temperature during the period of field studies.

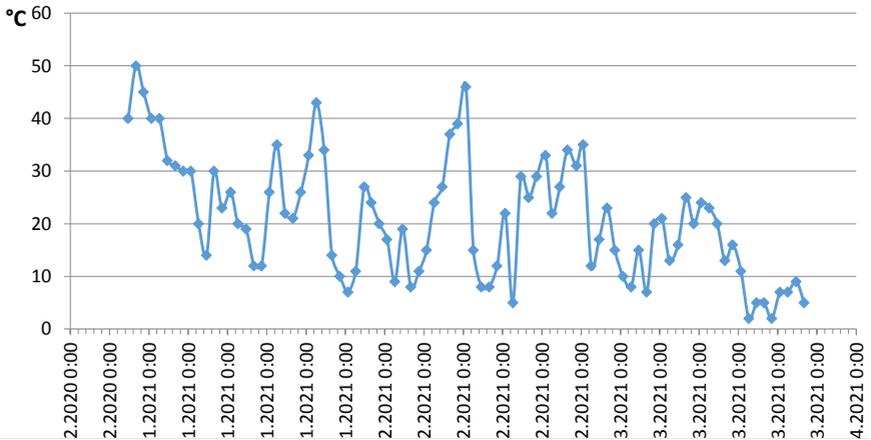


Fig. 2. Graph of air temperature changes in the study area

The intensity of the increase in the thickness of the ice cover, as can be seen from the above results, is on average: for points near the coastal strip - 0.70 cm/day; for the middle flow - 0.76 cm/day.

The structure of the river ice cover is shown in fig. 3. The sample has a non-uniform structure. The upper layer is snow ice of about 10 cm, then dense water ice (90 cm) and the lower layer is turbid with inclusions of solid particles and significant roughness at the base. For comparison, the ice structure of the Novosibirsk reservoir is shown [4].



Fig. 3. Structure of winter ice of the Karasuk river

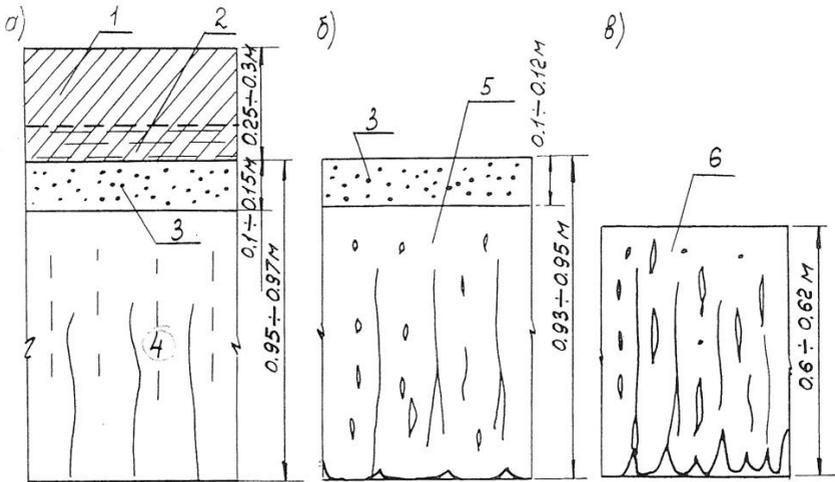


Fig. 4. Ice structure of the Novosibirsk reservoir in the area of the willage Borovoe

a) 4.04.82, b) 11.04.82, c) 15.04.82

1 – snow; 2 – water; 3 – cloudy ice; 4 – transparent ice;

5 – transparent ice with bubbles air;

6 – transparent ice with vertical channels filled with water

Strength tests of ice samples were carried out on a P-125 hydraulic press (fig. 5). The samples were 10x10 cm in size and were cut from different layers of ice. The results obtained are shown in Table 2.

Table 2. Results of testing samples for strength

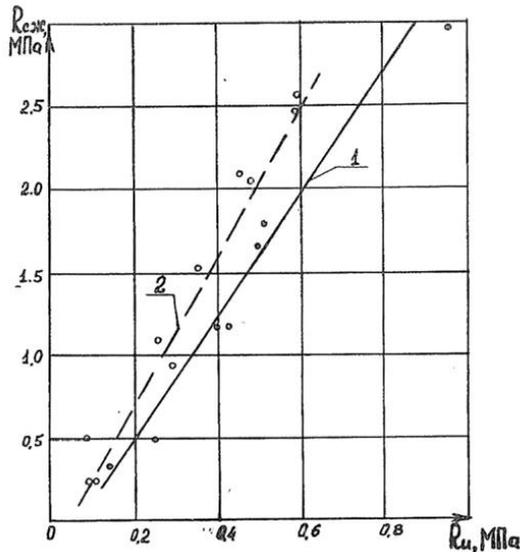
№ of the sample	1	2	3	4	5
Compressive strength, MPa	2.76	3.88	2.35	1.41	1.64



Fig. 5. Test of ice cubes for strength

The table shows that the strongest is water ice, which is located at a depth of 10-30 cm from the surface.

Research results and analysis of literature data [3] allow for the approximate period from compressive strength to tensile strength in bending to recommend the graphs shown in fig. 6.



**Fig. 6. Averaged graphs of the relationship between the tensile strength in bending of cantilever specimens and the compressive strength obtained when testing specimens with a size of 8x8x8 cm³
1 – winter ice; 2 – spring ice**

Conclusions:

1. Full-scale studies of the increase in the thickness of the ice cover of the Karasuk River in the Kochkovsky region of Novosibirsk region in the winter period of 2020-2021 have been carried out.
2. The results show the intensity of the increase in the thickness of the ice cover, which is 0.70-0.76 cm/day.
3. Compression tests of ice cover samples were carried out. The ultimate strength was 1.4÷3.9 MPa for various layers of winter ice.

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**THE DEVELOPMENT OF DIGITALIZATION AND UNIFICATION
PROJECT FOR THE BUSINESS-PROCESS OF VEHICLE LEASING
IN THE LEASING COMPANY'S BRANCHES**

Trofimova Elena Valerievna

Candidate Of Economic Sciences, Associate Professor

Baranov Nikita Sergeevich

Master student

St. Petersburg State University of Economics

St. Petersburg, Russia

Abstract. The article presents a project of digitalization and unification for the leasing company business processes. describes the current state of the business process (As Is), proposes a new business process (To Be), unified in all branches of the company. According to the project goals company plans to reduce costs, improve business processes management and to implement the information system for the vehicle leasing.

Key words: business-process, vehicle leasing, digitalization, unification, information technology.

In recent years, the role of information technology in business has grown significantly. Information technology simplifies work and can be applied in almost all areas of the company. However, not all companies use information technology at all stages of production. Therefore, the problem of business-processes digitalization is acute in many Russian companies.

The Russian leasing company has more than 30 branches in various regions of Russia. At the present time not all business processes in company are unified. The business process of vehicle leasing is different in different branches. In this regard, there are a lot of difficulties in interaction within the company. Also, in such circumstances company has no ability to digitize the processes. To solve these problems, the company has developed a project for the unification and digitalization of business processes of vehicle leasing. As a result of the project the company plans to reduce costs, improve business processes management and to implement the information system for the vehicle leasing.

Process Management and Scientific Developments

At first, Business canvas was built to better understand the company's business (Figure 1).

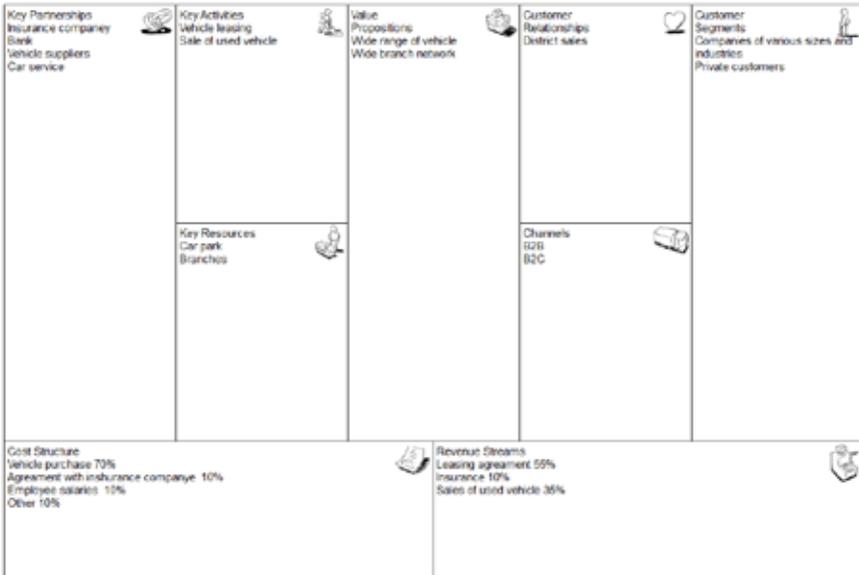


Figure 1 Business canvas

According to the Business canvas analysis Key partners of the company are Insurance company, Bank, Vehicle supplier and Car service. Key Activities of the company are Vehicle leasing and Sale of used vehicle. Key resources are Car park and branches. The value of the services provided lies in a wide selection of cars and vehicles, as well as in a wide network of branches, which allows to work with customers from different regions. The company carries out direct B2B and B2C sales. The clients of the company can be both organizations and individuals.

Information about the business process of providing vehicle for leasing was collected from different branches and analyzed. A model "AS IS" shows a generalized business process of vehicle leasing (figure 2).

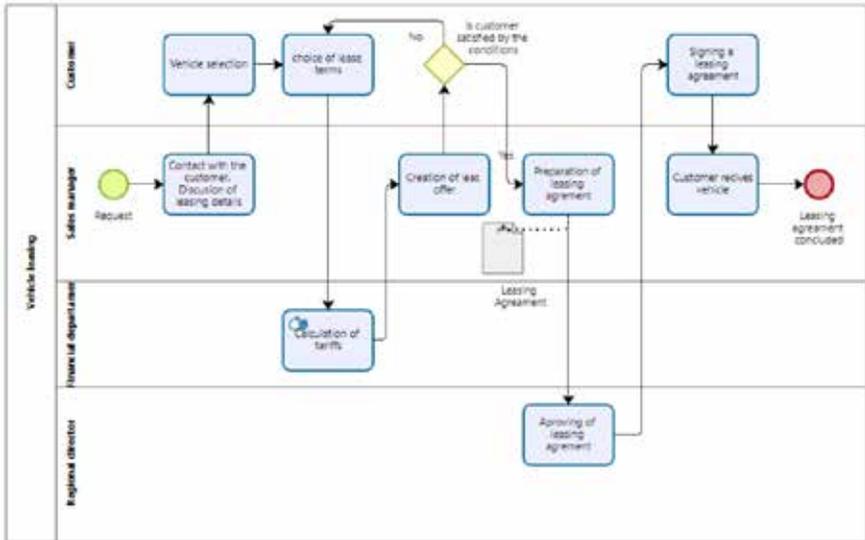


Figure 2 Business-process AS IS

This business process involves a sales manager, a finance department, and a regional director. Sales managers contact customer and discuss details of leasing. Customer chooses a vehicle and the term of the agreement. Financial department calculates tariffs manually. Then sales managers make a leasing offer to customer. After that if customer agree with this offer sales manager manually prepare documents for a leasing. Regional directors approve documents. Customer sign leasing agreement and receive a vehicle.

The main disadvantage of this business process is the manual re-calculation of tariffs if the client is not satisfied with the terms of the contract. Also, it is necessary to have a financial department in every branch. To solve this problem of a model "To Be" of the business-process was built (figure 3).

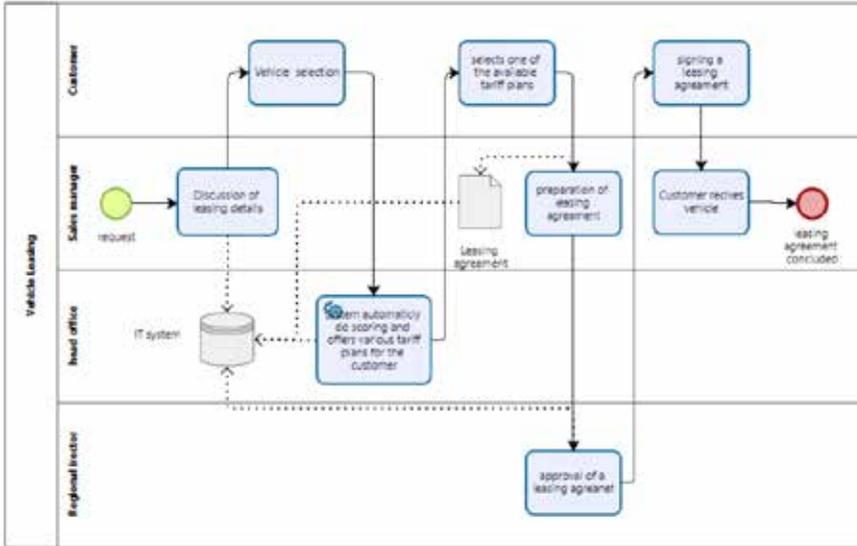


Figure 3 Business process TO BE

In the model of business process TO BE, after the customer has selected a vehicle, the data is sent to the head office, where the system automatically calculates all possible offers for this customer. Then the customer chooses one of the available offers. In a new business process, we need not calculate tariffs several time for one customer, also to have finance department in every branch anymore. The implement of the information system for the automatically calculation of tariffs allows company to plan a next step of digitalization – to organize sales with internet site.

To better understand the goals of the regional director, a motivational model was built. It is shown in Figure 4.

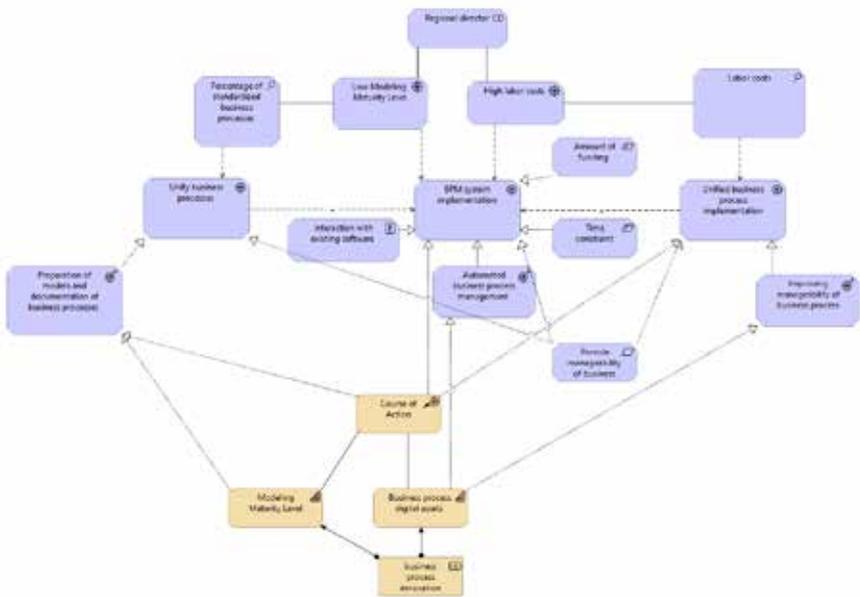


Figure 4 Motivation model

Based on the motivational model, the key goals for the regional director are:

- 1) Unify business-process.
- 2) Unified business process implementation.
- 3) BPM system implementation.

To realize these goals of the company, it was proposed to implement the project “Unification of business process Providing vehicle for leasing in a leasing company.” Table 1 presents the basic data from the project charter.

To implement the project, it is necessary to choose a methodology. Some of them are more modern, while others, on the contrary, are conservative. But there is no one best methodology for all projects. The methodology should be chosen depending on the tasks, terms, and budget of the project. The correct choice of methodology can save the company finances, as well as shorten the project implementation terms. The following options were considered for this project: waterfall model, scrum, and Kanban. Their comparison is presented in table 2.

Table 1 Project charter

Unification of business process “Providing vehicle for leasing in a leasing company”	
Defining business driver: improve business processes management, reduced costs	
Project starts:01.06.2021	Project ends: 22.03.22
Benefits: 1. Improving the manageability of the company. 2. Reduction of labor costs.	The following indicators will improve: 1. The manageability of the company will improve. 2. Reduced labor costs
Description of the problem: The business process of providing vehicle for leasing in different branches is different. Project task: Analyze, build an business process AS IS, build a business process TO BE, develop the necessary regulations and purchase the necessary software. Implement regulations and software.	

Table 2 Methodologies

Methodology	Waterfall	Scrum	Kanban
Predictability in terms and costs	The terms and costs of the project can be calculated accurately before its start	It is difficult to predict costs and terms	It is difficult to predict costs and terms
Requirements for clarity of project objectives	Project objectives must be clearly defined before starting	During the project, you can change the requirements for the result	During the project, you can change the requirements for the result
The cost of making changes to the project	High	Low	Low
How difficult is it to make changes to the project?	It is possible to make changes only after the end of the project	At the beginning of each Sprint	At any time, you can add a new task to the backlog
Possibility to show the customer results of the work	At the end of the project	At the end of each Sprint	At any time

The project must be completed on a tight schedule. This is an internal project, so there is not necessary to show results of the work to the customer at each stage of the project. The objectives of the project are clearly defined, so there is no need to make changes to the project. For this

project, it is better to use a waterfall methodology. A project plan was also developed, it is shown in Figure 5.



Figure 5 Project plan

The project consists of 6 major stages. Research, planning, software purchase, testing, implementation, and support. Each of the stages is divided into small sub-tasks.

The Business Process Unification project can help to improve the manageability of the company, and allow company reduce costs, and it's also simplify the collection of data for analytics in the company.

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RESULTS OF METAL ENDURANCE TESTS OF BRIDGE SPANS THAT HAVE BEEN IN OPERATION

Kondratov Valery Vladimirovich

Candidate of Technical Sciences, Head of Department

Olekov Vyacheslav Mikhailovich

Candidate of Technical Sciences, Research Officer

Rumyantsev Yevgeny Ivanovich

Chief Mechanic

Research Institute of Bridges

Abstract. The article presents the results of endurance tests of steel samples cut from the elements of spans that have been in operation for more than 70 years. Samples for endurance tests were made from fragments of the lower chords of the main trusses and the webs of the longitudinal beams of the carriageway of the replaced superstructures.

The results of endurance tests showed that the durability of a certain steel grade is proportional to the yield point of the metal and practically does not depend on the service life of the bridge structure at the value of maximum stresses in the elements of superstructures from constant and train loads up to 120 MPa. The linear hypothesis of the accumulation of fatigue damage in the elements of operating spans at a stress level below the fatigue limit of the connection under consideration cannot be used to assess the durability and residual life of steel bridge structures.

Keywords: Railway bridges, spans, steel, stress concentration, endurance, fatigue, damage accumulation

State of the issue

The article [1] shows that the strength capacity of steel superstructures, designed according to the standards of 1907-1932, is sufficient to handle promising train loads with an intensity of up to 10.5 tf/m track. At the same time, the fatigue resistance of these spans, which have a service life of more than 70 years, in the case of an increase in linear train loads, has not been studied enough. Calculations for the assessment of the fatigue life of the elements of the main trusses of the operated steel superstructures, per-

formed 30 years ago in accordance with the Guidelines [2], showed that a number of bridge structures built at the beginning of the XX century should have exhausted their fatigue life as early as 1985-1999 years. At the same time, a survey of span structures carried out by employees of the Research Institute of Bridges 10 years ago did not confirm the presence of any fatigue damage in the elements of the inspected riveted structures, which, according to the forecasts mentioned, should have already had such damage.

At the same time, previously conducted surveys of operated bridges of old construction years revealed fatigue failures in individual elements of lattice girders [3,4]. To develop an optimal strategy for the maintenance and replacement of operated steel spans, it is necessary to accumulate data on the state of the metal of the spans of the design of the late 19th - first half of the 20th centuries, the mechanical characteristics of which are often unknown at the delivery stage. Information on the fatigue resistance of the metal of the span structures of these bridges, on the possible accumulation of fatigue damage in the zones of stress concentration in the elements and nodes of bridge structures is important.

To set the timing of replacement of such structures, it is necessary to have a more reliable methodology for assessing the residual life of superstructures, especially in the case of commissioning heavier train loads. An urgent task is to clarify the dependence of the durability of bridge elements on the nature of their loading and, in particular, on the magnitude of the minimum stresses that cause fatigue damage to steel spans.

Formulation of the problem

To study the mechanical characteristics of the metal of the operated steel spans and its durability, elements of the replaced spans of bridges of various years of construction were selected. Brief information about the spans from which the samples were cut and the mechanical characteristics of the steel grades used for their manufacture are given in table 1.

Samples for endurance tests were made from fragments of the lower chords of the main trusses and the webs of the longitudinal beams of the carriageway of the replaced superstructures. The durability of both the base metal and the samples with stress concentrators in the form of round holes was investigated. To assess the accumulated fatigue damage in the hole zones from the rivets, several series of samples were made. The manufacture of samples with stress concentrators in the form of rivet holes was carried out as follows. The heads of the connecting rivets from the side of the corners were cut off by autogenous, after which the remaining parts of the rivets were knocked out with a punch. After removing the rivets, the parts of the fragments of the lower chords were separated from each other.

Then, on a milling machine, a disk cutter from horizontal sheets was used to cut samples to size.

Table 1 – Information on spans and characteristics of steel grades used for their manufacture

Truss span length, m	Design standards, year/ year of construction of the bridge	Truss life in years	Ton-nage passed over the period of operation million tons km	Structural elements from which samples are cut	Thick-ness of sheet metal-roll, mm	Steel grade according to the re-sults of chemi-cal analy-sis	Mechanical char-acteristics of metal, MPa	
							Temp-orary resis-tance	Yield point
44.5	1896/ 1897	105	1510	Truss bottom belt	10	St.0	410	212
106.68	1907/ 1912	90	1340	Longitudinal beam wall	10	St.0	465	269
87.0	1907/ 1916	85	2650	Longitudinal beam wall	10	St.3 kp	438	230
87.0	1907/ 1916	85	2650	Truss bottom belt	11,9	St.0	465	269
65.88	1907/ 1923	80	2000	Longitudinal beam wall	10	08 kp	410	276
65.88	1907/ 1923	80	2000	Truss bottom belt	11,9	St.kp	438	230
87.6	1925/ 1931	72	2370	Truss bottom belt	10	Cast iron	370	218

Samples of series 1 were strips 260 mm long, 70 mm wide, and 11 and 9 mm thick. After cutting, the width of the samples decreased to 52 mm. In the middle of each specimen, there was a hole 20 mm in diameter from the remote rivet. During operation, this hole was filled with a connecting rivet. These holes were not subjected to any mechanical processing, i.e., the conditions under which the metal worked in the structure during its operation were preserved. Samples of series 2 were cut from the middle part of horizontal sheets of truss chords, where there were no connecting rivets. They also consisted of strips 260 mm long, 70 mm wide, and 11 and 9 mm thick. After cutting out the strips, their width decreased to 52 mm, and a hole with a diameter of 20 mm was drilled in the center of each sample.

The shape and dimensions of the samples of these series were taken in accordance with GOST 25.502-79. The samples were made from plates cut by autogenous from the walls of the longitudinal beams or from vertical sheets of fragments of the lower chords. Cutting of blanks from the plates was carried out with a disk cutter. The same plates were used to make strips for standard mechanical tests.

Fatigue tests of the samples were carried out on a TsDM-10 PU press-pulsator with a frequency of 1000 cycles per minute on the basis of 3 million cycles. When testing all series of samples, the cycle asymmetry coefficient was taken equal to 0.1 ($\rho = 0.1$). Determination of stresses in the samples was carried out according to the readings of strain gages using a strain gauge control system.

Laboratory test results

Table 2 shows the limited endurance limit values of $\sigma_{0.1}$ (based on 2 million load cycles) for all tested series of samples.

Table 2 – Limited endurance limits of tested specimens

№ sample series	Span length, m	Superstructure element	Steel grade	$\sigma_{0.1}$, MPa
1	87.0	Horizontal sheets of the lower chord of the main truss (holes after rivets removed)	St. 0	105.5
2		Horizontal sheets of the lower chord of the main truss (newly formed holes)	St. 0	155.6
3		Longitudinal beam wall (stretched zone)	St.3 kp	218.1
4		Longitudinal beam wall (at the neutral axis)	St.3 kp	215.7
5	44.5	Main truss bottom chord vertical sheet	St. 0	198.1
6	65.88	Longitudinal beam wall (stretched zone)	08 kp	243.8
7		Horizontal sheets of the lower chord of the main truss (holes after rivets removed)	St.3 kp	131.2
8		Horizontal sheets of the lower chord of the main truss (newly formed holes)	St.3 kp	151.2
9	106.68	Longitudinal beam wall (stretched zone)	St. 0	233.4

№ sample series	Span length, m	Superstructure element	Steel grade	$\sigma_{0.1}$, MPa
10	87.6	Vertical sheets of the lower chord of the main truss (holes after rivets removed)	Cast iron	133.6
11		Main truss bottom chord vertical sheets (newly formed holes)	Cast iron	150.6

As can be seen from Table 2, the endurance limits $\sigma_{0.1}$ of the series of samples with holes from the connecting rivets turned out to be lower than the endurance limits of the series of samples with newly formed holes. Since the samples of these series were made from the same fragments of the lower chords of the main trusses of the span structures, the decrease in the durability of the samples with holes from the connecting rivets can be explained by the change in the metal structure in the zones of the riveted holes that occurred over the years of operation of the bridges. It should be noted that the values of the endurance limits of samples of series 3, cut from the stretched zone of the longitudinal beam wall, and samples of series 4, cut from the zone near its neutral axis, turned out to be very close. The difference between them is practically within the scatter of experimental data (figures 1, 2).

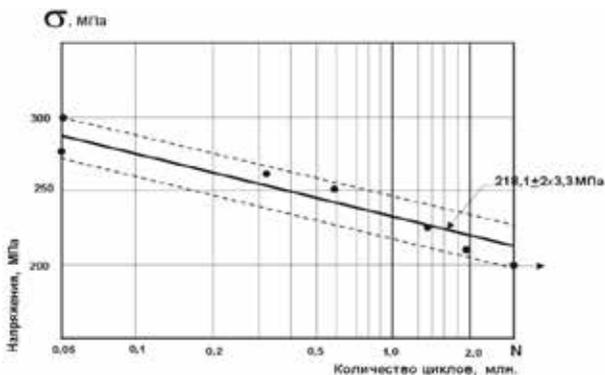


Figure 1 – Base metal from the tensioned zone of the longitudinal beam wall. Series 3

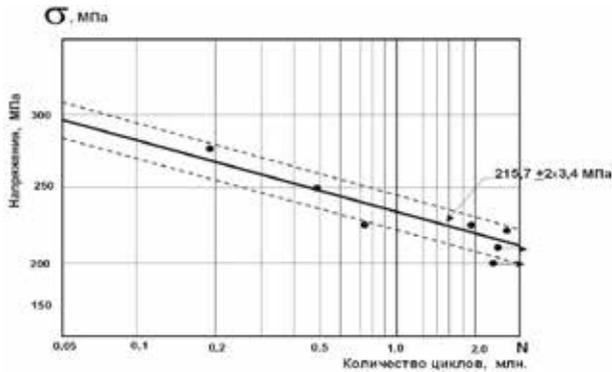


Figure 2 – Base metal from the zone of the neutral axis of the longitudinal beam. Series 4

To analyze the data obtained, a calculated assessment of the stress state of that zone of the longitudinal beam wall from which the tested samples were cut was performed (Table 3). The stresses in the wall from the considered loads are in the range from 80 to 122 MPa, or from 31.1 to 58.5 MPa with an equivalent symmetric loading. This indicates that alternating stresses with amplitudes of up to 58.5 MPa under a symmetric loading cycle have practically no effect on the accumulation of fatigue damage in steel, i.e. there are no significant structural changes in the metal that affect its durability.

Table 3 – Design stresses (MPa) in the web of the longitudinal beam in the interface zone with the upper chord under the influence of train loads

Stress type	Train load types					
	Steam locomotives		Electric locomotives		Linear load from wagons, tf/m track	
	«L»	«E»	VI22	VL80	7.95	7.2
From constant load	24.75	24.75	24.75	24.75	24.75	24.75
From temporary load, taking into account dynamic impact	97.67	96.89	80.45	54.71	97.40	80.45

Maximum calculated	122.4	121.6	105.2	79.46	122.15	105.2
Cycle asymmetry coefficient ρ	0.20	0.20	0.235	0.311	0.20	0.235
Reduced to a symmetric cycle ($\rho = -1$)	58.5	58.3	47.2	31.1	58.4	47.2

For a comparative assessment of the impact on the endurance of a superstructure element of the considered types of load, the calculated maximum stresses are reduced to one characteristic of the cycle $\rho = -1$ in accordance with the relationship [5]:

$$\sigma_{-1} = \frac{\sigma_B \sigma_\rho (1 - \rho)}{(\sigma_B - \sigma_\rho \rho) - (\sigma_B - \sigma_\rho)(-1)} \quad (1)$$

where σ_B - temporary resistance of the considered steel grade, σ_ρ - maximum stresses in the superstructure element at the cycle characteristic ρ .

The results of vibration tests of the base metal of the above spans also showed that the durability of cast iron specimens without stress concentrators is at the level of durability of similar specimens from modern low-carbon steels, which is consistent with the results of previous studies [6, 7].

Analysis of the obtained results

Let us analyze the test results of samples cut from horizontal sheets of the lower chord of the superstructure with a length of 65.88 m (series 7 and 8, Figures 3 and 4). The regression line equation describing the dependence of the durability of samples with holes on remote rivets is as follows:

$$N = 10^{27,377 - 9,872 \lg \sigma_\rho} \quad (2)$$

Here σ_ρ - maximum stresses in the element under consideration at the cycle characteristic ρ , N – the corresponding durability of the element.

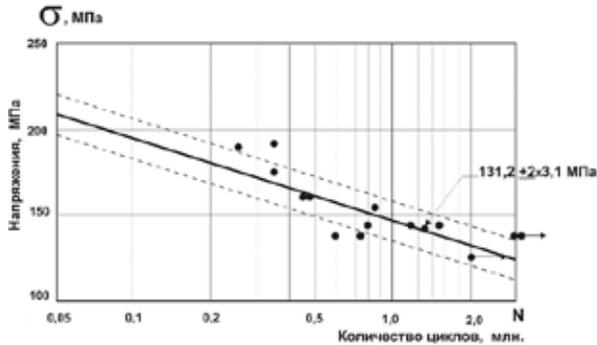


Figure 3 – Samples with holes from removed rivets. Series 7

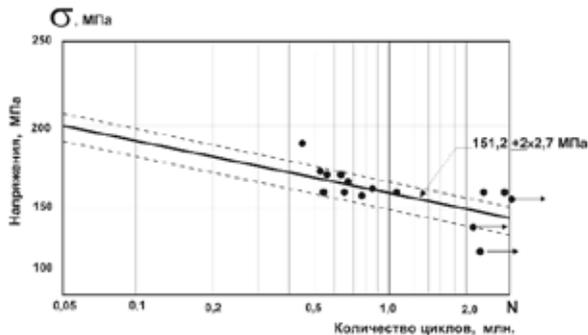


Figure 4 – Samples with newly formed holes. Series 8

The regression line equation describing the dependence of the durability of samples with newly formed holes is written as:

$$N=10^{30,671-11,186lg \sigma_p} \quad (3)$$

Let us estimate the calculated durability of these samples at the stress level in the considered element of the lower chord at the stage of operation of the superstructure with a length of 65.88 m, assuming that the relationship between the durability of the metal and its stressed state remains at any stress level. The live load is taken in the form of a train consisting of a steam locomotive of the "L" type and a wagon load with an intensity of 7.2 tf/m track. The constant load is taken according to the Guidelines [2]. Reduced to the characteristic of the cycle $\rho=0.1$ (formula 1), the maximum

design stresses in the lower belt are 68.7 MPa. At this level of stresses, the durability of the metal of the lower chord in the zones of holes from the connecting rivets will be 1557.5 million cycles, and of the metal with newly formed holes - 11,650 million cycles. The difference between the given values of the durability is about 10 billion cycles. As the experience of operating railway bridges shows, during the service life of the superstructure, no more than 2 million trains pass through it, including not only heavy freight, but also empty, as well as passenger trains. About one million trains have passed over the bridge under consideration during the operation of the superstructure. If we accept the commonly used hypothesis that fatigue damage in the elements of spans accumulates at any stress level in accordance with the dependence described by the regression line constructed during metal testing at sufficiently high stresses on the basis of 2 million cycles, then with this approach to the assessment the accumulation of fatigue damage in the elements of the main trusses of the superstructures, one train must create about 10 thousand equivalent loading cycles. This is unrealistic, given the nature of the change in the stress state in the elements of spans when they are loaded with a temporary load. Hence, it follows that the indicated hypothesis of the accumulation of fatigue damage in the elements of operated span structures at a stress level below the fatigue limit of the connection under consideration cannot be accepted for assessing the durability and residual life of steel bridge structures.

Conclusions

1. The mechanical characteristics of the base metal of span structures practically do not change over 80 - 100 years of operation. The durability of a certain steel grade increases with an increase in the yield point of the metal and practically does not depend on the service life of the bridge structure at the maximum stresses in the elements of superstructures from constant and train loads up to 120 MPa or at variable stresses up to 58.5 MPa with an equivalent symmetric loading.
2. The durability of the metal of riveted elements of span structures in the area of holes from connecting rivets is lower than in the area of the same newly formed holes. This indicates the effect of its stressed state on the durability of steel, due to the concentrated effect of rivets on the metal of the elements. More research is needed to quantify this effect.
3. The results of endurance tests showed that the linear hypothesis of the accumulation of fatigue damage in the elements of the operated spans at a stress level below the fatigue limit of the connection under consideration cannot be used to assess the durability and residual life of steel bridge structures.

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ESTIMATION OF MINIMAL DAMAGING STRESSES UNDER CYCLIC LOADING OF STEEL RIVETED BRIDGE SPANS

Kondratov Valery Vladimirovich

Candidate of Technical Sciences, Head of Department
Research Institute of Bridges

Abstract. The article presents the results of studies on the assessment of the value of the minimum damaging stresses during cyclic loading of steel riveted spans of railway bridges. A gradual accumulation of irreversible distortions of the crystal lattice of steel in the zone of riveted holes during the service life of the span was experimentally established. Cyclic loading of low-carbon steel at stresses below the endurance limit and above the cyclic elastic limit leads to the formation of submicrocracks in the metal structure, which ultimately reduces its vitality and affects the accelerated formation of microcracks at stresses exceeding the endurance limit.

When calculating the durability and residual fatigue life of steel superstructure elements, one should take into account those total stresses from constant and temporary loads that exceed the fatigue limit of the considered type of bridge structure connection. In this case, the limiting value of fatigue damage v_{lim} , accumulated by a certain element of the truss when exposed to heavy train loads, should be taken equal to 0.3 when summing these damages in accordance with the Palmgren - Miner hypothesis

Keywords: railway bridges, steel, spans, cyclic loading, submicrocracks, fatigue, endurance limit

State of the issue

Endurance tests of steel samples without stress concentrators cut from different elements of span structures, which were in operation for 70 to 100 years, did not reveal any fatigue damage to the base metal during the operation of bridge structures [1]. The values of the endurance limit of the studied steel grades correspond to the analogous characteristics of modern steel grades of the same strength class. The results of endurance tests of metal with stress concentrators in the form of holes do not find a satisfactory explanation based on the commonly used hypothesis of fatigue

damage accumulation in spans at stresses below the fatigue limit. It should be noted that there is a contradiction between the actual fatigue life of the operated steel bridge spans and its calculated value determined according to the Guidelines [2]. To set the timing of replacement of such structures, it is necessary to have a more reliable methodology for assessing the residual life of superstructures, especially in the case of commissioning heavier train loads. It is necessary to clarify the dependence of the durability of bridge elements on the nature of their loading and, in particular, on the value of the minimum stresses that cause fatigue damage to steel spans.

Analysis of the test results of the metal of the superstructure taken out of service

The results of endurance tests of specimens cut from a fragment of the lower belt of the superstructure with a length of 65.88 m, presented in article [1], are shown in figure 1.

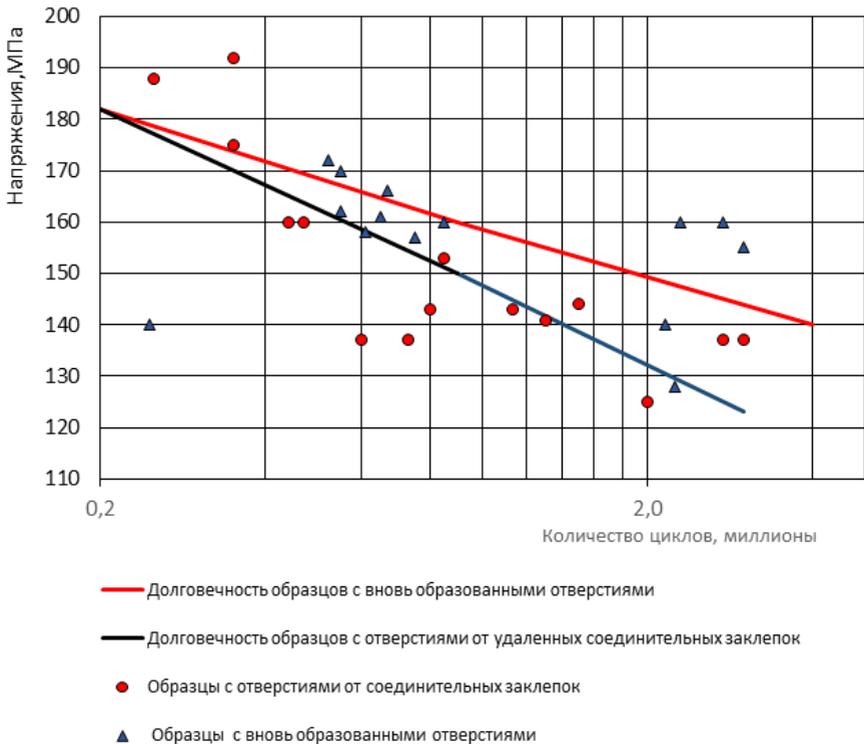


Figure 1 – Durability of perforated steel specimens

The data presented indicate that specimens with holes from connecting rivets in comparison with specimens of the same metal with newly formed holes at a loading level above the fatigue limit have a lower durability, i.e. lower survivability $k = \text{tg}\varphi$. This result is explained by the gradual accumulation of irreversible distortions of the crystal lattice of steel in the zone of riveted holes during the service life of the span structure [3]. To assess the dependence of possible distortions of the crystal lattice of the metal of the elements of superstructures on their stress state when loaded with train loads, the value of the calculated stresses in the element of the lower chord of the superstructure with a length of 65.88 m (design standards 1907), the metal of which was studied, was determined. As train loads, four models of the heaviest freight trains and one of the passenger trains were selected, which had been circulating across the bridge for 80 years. Four-axle freight gondola cars and tanks were modeled with a distributed load of 7.2 t/m, passenger cars - with a load of 2.8 t/m. The types of locomotives used in the models of train loads are shown in Table 1. For a comparative assessment of the effect of the considered types of loads on the endurance of a superstructure element, the calculated stresses σ_{-1} are reduced to one characteristic of the cycle $\rho = -1$ in accordance with the relationship [4]:

$$\sigma_{-1} = \frac{\sigma_B \sigma_\rho (1 - \rho)}{(\sigma_B - \sigma_\rho \rho) - (\sigma_B - \sigma_\rho)(-1)} \tag{1}$$

where σ_B – temporary resistance of the considered steel grade, σ_ρ – maximum stresses in the superstructure element at the cycle characteristic ρ .

Table1 – Design stresses (MPa) in the lower chord of a truss with a length of 65.88 m under the influence of train loads

Stress type, MPa	Train load type				
	"FD" +7.2 t/m	"L" +7.2 t/m	"FDp" +2.8 t/m	"E" + 7.2 t/m VL80 + 7.2 t/m	VI22 +7.2 t/m
From temporary load, taking into account dynamic impact	70.7	68.7	57.7	63.6	64.0
From constant load	33.3	33.3	33.3	33.3	33.3
Maximum calculated	104.0	102.0	91.0	96.0	97.3
Cycle asymmetry coefficient ρ	0.317	0.324	0.363	0.346	0.343
Reduced to a symmetric cycle ($\rho = -1$)	42.8	41.5	34.5	37.5	38.1

The calculated values of the endurance limits of these steel grades at various effective stress concentration factors β are given in Table 2. For the calculation, β values equal to 1.3 and 3 were taken, reflecting the ratio of the endurance limits of the base metal and, accordingly, elements with connecting rivets and attachments of structural elements to knot gussets with single-cut rivets [2]. Table 2 shows the calculated values of the cyclic elastic limit σ_y^e [3].

Table 2 – Values of endurance limit and cyclic elastic limit depending on steel grades and values of the effective stress concentration factor

Steel grade	Endurance limit, MPa				Cyclic elastic limit, MPa		
	base metal		compounds at $\rho=-1$		base metal	connections	
	$\rho = 0.1$	$\rho = -1$	$\beta = 1.3$	$\beta = 3.0$	$\beta = 1.0$	$\beta = 1.3$	$\beta = 3.0$
0.8 kp	243.8	163.0	125.4	54.3	103.0	65.4	0
St.3 kp	207.0	125.9	96.8	42.0	65.9	36.8	0
St.0	180.0	108.6	83.5	38.3	48.6	23.5	0

Metallographic analysis of samples made of steel St.3kp made of the element of the lower chord of the truss, which were not subjected to laboratory endurance tests, in the area of the holes from the remote connecting rivets did not reveal significant signs of aging and work hardening of the metal, however, an increase in the microhardness of the steel was noted. In a number of works, a review of which is given in [3], it is shown that in the zone of possible formation of fatigue damages under certain conditions, the microhardness of local volumes of steel increases during cyclic loading. According to [3], an increase in metal hardness under cyclic loading occurs at stresses exceeding the cyclic elastic limit σ_y^e , the value of which is less than the fatigue limit under a symmetric loading cycle σ_w by about 60 MPa. In this case, in the stress range from σ_y^e to σ_w under cyclic loading, a gradual formation of submicroscopic cracks occurs, which, with an increase in alternating stresses above the endurance limit σ_w gradually develop into macrocracks.

Comparison of the data in Tables 1 and 2 shows that the values of the maximum stresses in the superstructure with a length of 65.88 m from the impact of heavy train loads exceed the value of the cyclic elastic limit of

steel St.3kp in the stress concentration zones near holes with connecting rivets. Thus, in the indicated local zones, a gradual formation of submicrocracks occurred, which was the basis for the accelerated growth of macrocracks during laboratory tests with increasing loads and a corresponding increase in stresses exceeding the endurance limit of such joints. At the same time, the effects of passenger and empty freight trains could not lead to irreversible changes in the structure of the metal in such zones of stress concentration.

The linear hypothesis of the accumulation of fatigue damage by elements of bridge structures is applicable with alternating loading cycles with different levels of impact. With a gradual increase in the level of stresses in the metal from alternating loads, the accumulation of fatigue damage does not correspond to a linear law. Cyclic loading of low-carbon steel at stresses below the endurance limit and above the cyclic elastic limit leads to distortion of the crystal lattice and the formation of submicrocracks in the metal structure, which ultimately reduces its vitality and affects the accelerated formation of microcracks at a stress level exceeding the endurance limit.

Test results of steel samples under non-stationary loading conditions

The obtained data are confirmed by the results of endurance tests of three series of specimens under step loading conditions. The studies were carried out on flat specimens made of St.3 steel with stress concentrators in the form of a round hole in the center of each specimen. For the subsequent analysis of the test results under stepped loading conditions, the same specimens were first tested under stationary modes with a cycle characteristic $\rho = 0.1$ (series 1). The endurance limit of these samples at $\rho = 0.1$ was 167.5 MPa with a fracture probability of 50%. Two or three-stage loading modes of samples reflect the tendency of changes in the stress state of certain elements of the main trusses of the operated span structures with an increase in linear train loads from 7.2 to 12 t/m. As a result, the first steps of loading the samples were carried out at stresses below their endurance limit. The loading parameters of the samples and the test results are shown in Figure 2.

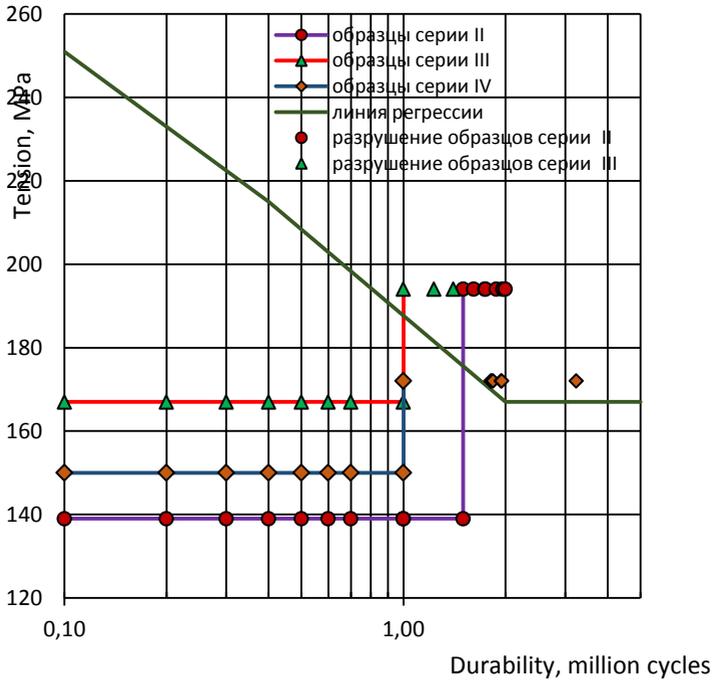


Figure 2 – Results of endurance tests of specimens with a hole under stepped loading conditions

Table 3 shows the number of loading cycles of specimens to the moment of their failure and accumulated fatigue damage calculated by formula (2) based on the linear hypothesis of their accumulation (Palmgren - Miner hypothesis) at a 50% probability of failure

$$v = \sum \frac{n_i}{N_i} \leq v_{np} = 1 \quad (2)$$

In formula (2), n_i denotes the number of loading cycles of the sample at a certain stress level; N_i is the limiting number of loading cycles at the same stress level that the sample can withstand until failure under constant cyclic action. The average value of the sum of damages accumulated by the tested samples at the last stage of loading at stresses above the endurance limit is 0.4.

Analysis of the obtained results

The above results are confirmed by earlier studies [5], showing that the accumulation of fatigue damage in low-carbon steel depends on the history of its loading. The linear hypothesis of the accumulation of fatigue damage by elements of bridge structures is applicable with alternating loading cycles with different levels of impact. With a gradual increase in the level of stresses in the metal from alternating loads, the accumulation of fatigue damage does not correspond to a linear law. Cyclic loading of low-carbon steel at stresses below the endurance limit and above the cyclic elastic limit leads to distortion of the crystal lattice and the formation of submicrocracks in the metal structure, which ultimately reduces its vitality and affects the accelerated formation of microcracks at a stress level exceeding the endurance limit. Taking into account the requirements for the reliability of bridge structures, the limiting value of fatigue damage v_{lim} , accumulated by a certain element of the truss under the influence of heavy train loads should be taken equal to 0.3 when summing these damages in accordance with the Palmgren - Miner hypothesis.

Of the three steel grades considered, lower fatigue resistance is characteristic of steel St.0 with a yield strength of 212 MPa. At the same time, in the area of holes for connecting rivets in the most loaded elements of trusses made of this steel, practically all types of circulating train loads caused the gradual formation of submicrocracks. At the same time, in the manufacture of the same elements from steel 08kp, all other conditions being equal, submicrocracks should not appear in the zone of the indicated holes. However, in the nodal joints with single-shear rivets of the most stressed elements of the main trusses made from the considered steel grades, freight trains circulating on the railways of Russia in the twentieth century caused the formation of submicrocracks in the metal along the edges of the rivet holes. As a result, the commissioning of freight cars with linear loads of the order of 8-10 tf/m and higher will contribute to the accelerated formation of fatigue damage in joints with single-shear rivets.

Conclusions

1. The above research results show that the possibility of fatigue failure of elements of operated steel spans and preliminary formation of submicrocracks in individual zones of joints of bridge structures is influenced by both the properties of the steel from which the bridge structure is made and the stress state of individual sections of the elements, determined by their type, size the concentration of stresses in the connections of the elements and the effect of the train load.

2. When calculating the durability and residual fatigue life of steel superstructure elements, one should take into account those total stresses from constant and temporary loads that exceed the fatigue limit of the considered type of bridge structure connection.

3. In the nodal joints with single-shear rivets of the most stressed elements of the main trusses, freight trains circulating on the railways of Russia in the 20th century caused the formation of submicrocracks in the metal along the edges of the rivet holes. Innovative freight cars with linear loads of the order of 8-10 tf/m will cause higher stresses in nodal joints with single-shear rivets than circulating trains, and, as a result, contribute to accelerated formation of fatigue damage in the zones of riveted holes. In this case, the limiting value of fatigue damage v_{lim} , accumulated by a certain element of the truss when exposed to heavy train loads should be taken equal to 0.3 when summing these damages in accordance with the Palmgren - Miner hypothesis.

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EXPERIENCE IN OPERATING A SOLAR POWER PLANT IN THE SARATOV REGION

Oleg V. Leshtayev

Postgraduate

Natalia A. Stushkina

Candidate of Technical Sciences, Associate Professor

Vladimir I. Zaginaylov

Doctor of Technical Sciences, Full Professor

Russian State Agrarian University - Moscow Timiryazev Agricultural Academy

Abstract. The article is devoted to the description of the operating solar power plant, the analysis of the results of its operation in the conditions of the Saratov region and scientific and technical information on the prospects for the use of solar energy sources in Russia.

Keywords: alternative energy, solar power plant, electricity supply, electricity consumption, electrical load schedules, solar insolation.

Energy consumption in the modern world is constantly growing. For its production, as a rule, non-renewable primary sources are used, stored by the planet for millions of years in the form of coal, oil shale, oil, natural gas and peat [1]. However, by the second half of the 20th century, the problems of traditional hydrocarbon energy became visible. Its main reasons are due to the depletion of fossil resources and significant environmental damage [2] associated with the burning of these resources. Many companies in the world: Tesla, Solar, Impulse, Sharp and others are seriously concerned with the environmental problem and are trying to take the path of alternative energy as soon as possible. In Russia, the development and promotion of solar technologies is carried out by the Havel company. At the moment, four solar power plants built by this company are in operation on the territory of Saratov region.

In order to determine the energy and economic efficiency of the operation of a solar power plant on the territory of Saratov region (51.750065 N, 42.758712 E), an operating solar power plant was built. Taking into account the amendments made to the law [5], for more efficient use of a

private solar power plant, it is economically profitable to design it without a battery with the possibility of supplying surplus generated electricity to the centralized network in order to reduce energy losses during charging/discharging of batteries and save money on the purchase of equipment. its maintenance, repair and replacement. The station was designed and built to supply power to a private house in a rural area.

The choice of the power and the number of solar modules is carried out taking into account the place of construction and operation of the SPP, the annual illumination of the area (the number of sunny days in Saratov region 86, the number of sunny hours 2054), the average daily power, as well as the restrictions specified in the law [5]. For the selected terrain, the orientation of the panels is south, the azimuth is 0, the angle of inclination of the panels is 30°.

Taking into account the load consumed on a daily basis, it was decided to build a micro SPP with an output peak power of 1.1 kW. At the heart of the SES of such power are 4 modern solar monocrystalline panels (SP) of the TW Solar TW310MWP-60-H brand with a power of 310 W each. One panel contains 60 solar cells. This brand of panels was selected due to the PERC (Passivated Emitter Real Cell) technology, which is used in their construction. The main difference between panels with this technology from conventional silicon ones is the presence of a dielectric layer (passivation), which is located over the entire surface of the panel between the silicon base and the back contact. An additional layer is a reflector of solar radiation, which leads to an increase in the efficiency of the panels by up to 20%.

The installation of solar panels was carried out on the roof of the courtyard building. The installation site was chosen based on the direction of the solar panels to the south, the absence of factors affecting the shading of the panels and the convenience of installing and connecting the panels. A wooden beam was chosen as the basis for the construction of the supporting frame of the panels. For each joint venture, its own rigid fixed frame was assembled, providing a panel inclination angle of 30°. The panels are rigidly fixed to the frames, with the possibility of natural ventilation (figure 1).

The panels are connected in series with each other to generate enough power to start and operate the inverter. The panels are connected using standard MC4 connectors. These connectors ensure the tightness of the panel connection, as well as its reliability, speed and ease of implementation.

To convert direct current into alternating current, a Sofar 1100TL-G3 inverter manufactured by Sofar Solar was selected (figure 2). The inverter has a peak power of 1.1 kW.



Figure 1 – Installed solar panels



Figure 2 – Installed Sofar inverter

TL series inverters are unique, as they can independently reduce power at the command of the delimiter (a device that monitors the transfer of electricity to the grid). Delimiter sensors are installed in front of the meter.

The delimiter gives the command to the inverter to reduce the generated power, if an excess of the permitted value of the electricity supplied to the grid is detected. This inverter contains one built-in MPP tracker. The inverter is connected directly to the electrical network of the house through two ABB 16 Amp AC breakers downstream of the electricity meter. The inverter is rigidly mounted on the wall. A prerequisite for its operation is the absence of direct sunlight and the influence of rain and snow. The inverter must be installed vertically with a possible positive tilt angle of not more than 150. Since the inverter is not equipped with an active cooling system (only available, for its normal operation, a free space of at least 50 cm from the front and bottom sides and at least 80 cm from the upper side is required) Data transmission from the inverter about the generated energy, its quality, errors in operation, as well as about the energy input parameters from the batteries are transmitted via Wi-Fi to the Internet to the solarmanpv.com website, where graphs are automatically generated and a daily report on the operation of the entire The average operating time of the station is 14-15 hours per day The average daily power generation is 5.5 kWh per month of operation, the maximum value is 6.8 kWh. The results of electricity generation are shown in figure 3.

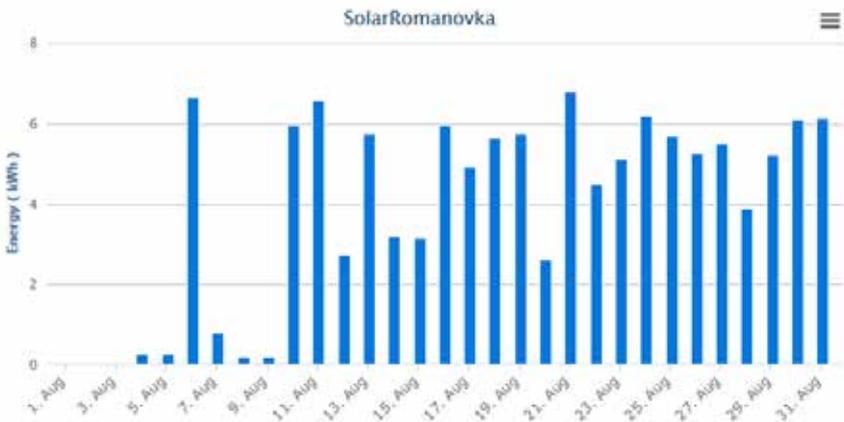


Figure 3 – Electricity generated by the station in August 2020 by days

The results of plant operation during one day are shown in Figure 4.



Figure 4 – Station operation within one day (August 21, 2020)

As you can see from the graph, with uniform illumination throughout the day, the station reaches its peak power in the time interval from 13.00 to 15.00.

The analysis of the load graphs for the year of operation shows that the built SPP on summer sunny days is able to provide up to 100% of the load of a private house and even exceed the electricity required for the house, in autumn and spring days up to 80%. On winter days, when snow falls, the solar panels installed on the roof are turned off.

In accordance with the methodology for calculating the power of the solar power plant [3] and the distribution of solar insolation [4], the payback period of the constructed solar power plant, without accumulating electricity, will be 12-15 years. This allows us to conclude that it is possible to use such systems for power supply of residential and industrial facilities and improve the environment not only in Moscow Oblast, but also in other regions of the country with a high level of solar insolation.

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