SCIENTIFIC RESEARCH OF THE SCO COUNTRIES: SYNERGY AND INTEGRATION

上合组织国家的科学研究：协同和一体化

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参与者的英文报告

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"Scientific research of the SCO countries: synergy and integration"

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这些会议文集结合了会议的材料 – 研究论文和科学工作者的论文报告。 它考察了职业化人格的技术和社会学问题。一些文章涉及人格职业化研究问题的理论和方法论方法和原则。
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These Conference Proceedings combine materials of the conference – research papers and thesis reports of scientific workers. They examines tecnical and sociological issues of research issues. Some articles deal with theoretical and methodological approaches and principles of research questions of personality professionalization.

Authors are responsible for the accuracy of cited publications, facts, figures, quotations, statistics, proper names and other information.

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GEOGRAPHICAL SCIENCES

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Foreword

We thank all participants of our conference "Scientific research of the SCO countries: synergy and integration" for the interest shown, for your speeches and reports. Such a wide range of participants, representing all the countries that are members of the Shanghai Cooperation Organization, speaks about the necessity and importance of this event. The reports of the participants cover a wide range of topical scientific problems and our joint interaction will contribute to the further development of both theoretical and applied modern scientific research by scientists from different countries. The result of the conference was the participation of 56 authors from 7 countries (China, Russia, Uzbekistan, Kazakhstan, Azerbaijan, Tajikistan, Kyrgyzstan).

This conference was a result of the serious interest of the world academic community, the state authorities of China and the Chinese Communist Party to preserve and strengthen international cooperation in the field of science. We also thank our Russian partner Infinity Publishing House for assistance in organizing the conference, preparing and publishing the conference proceedings in Chinese Part and English Part.

I hope that the collection of this conference will be useful to a wide range of readers. It will help to consider issues, that would interest the public, under a new point of view. It will also allow to find contacts among scientists of common interests.

Fan Fukuan,
Chairman of the organizing committee of the conference
"Scientific research of the SCO countries: synergy and integration"
Full Professor, Doctor of Economic Sciences

前言

我们感谢所有参加本次会议的"上海合作组织国家的科学研究：协同作用和整合"，感谢您的演讲和报告。代表所有上海合作组织成员国的广泛参与者都谈到此次活动的必要性和重要性。参与者的报告涵盖了广泛的主题性科学问题，我们的联合互动将有助于不同国家的科学家进一步发展理论和应用的现代科学研究。会议结果是来自7个国家（中国，俄罗斯，乌兹别克斯坦，哈萨克斯坦，阿塞拜疆，塔吉克斯坦，吉尔吉斯斯坦）的83位作者的参与。

这次会议的召开，是学术界，中国国家权力机关和中国共产党对维护和加强科学领域国际合作的高度重视的结果。我们还要感谢我们的俄罗斯合作伙伴无限出版社协助组织会议，准备和发布中英文会议文集。

我希望会议的收集对广大读者有用，将有助于在新的观点下为读者提供有趣的问题，并且还将允许在共同利益的科学家中寻找联系。

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改進用於企業目的的績效審計方法
IMPROVING THE PERFORMANCE AUDIT METHODOLOGY FOR CORPORATE PURPOSES

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抽象。 本研究致力於績效審計的研究及其在公司中的應用。 它基於有效性和效率來分析公司績效。 這項研究形成了將績效審計系統集成到公司部門的前景，並闡述了實施這些技術的關鍵問題。
關鍵詞：績效審計 公司財務控制； 金融資源； 內部和外部控制； 環境指標

Abstract. This research is devoted to the study of the performance audit and its application in corporations. It analyses corporate performance on the base of effectiveness and efficiency. This study forms prospects of integration of the performance audit system in the corporate sector and states key problems in implementation of these techniques.

Keywords: performance audit; corporate financial control; financial resources; internal and external control; environmental indicators

Introduction

The purpose of the study is to analyze the system of corporate financial control using methods of audit effectiveness. It is important to define significance of performance audit for corporate purposes, form its comprehensive methodology in order to improve its implementation in companies. In the study were used general scientific research methods such as analysis, synthesis, induction, deduction, as well as scientific abstraction.

Performance audit is a systematic, organized process of obtaining an expert evaluation of the effectiveness, efficiency and productivity of the economic activi-

ty of the audited entity (business entity, organization, group of organizations, etc.), in order to establish the level of compliance of performance results with stated criteria. Therefore, performance audit expresses an opinion on the effectiveness (efficiency, economy, productivity) of the entity and prepares recommendations on how to improve it. Consequently, this process is created to assess the implementation of stated goals of the entity, verify the compliance with legal regulations, monitor and evaluate activity.

The outcome of an effective audit includes financial statements that present a true and fair view, and advice on how the company's processes may be improved. An effective audit is completed to schedule, and with minimal disruption to the company. Performance audit is a comprehensive independent audit, the purpose of which is to express an opinion on the performance of the audited organization.

To assess productivity, effectiveness and efficiency of the enterprise it is necessary to conduct ratio analysis. There are three main groups of financial indicators, that measures profitability, liquidity, risk of the company. Liquidity ratios measure a firm's ability to meet its current obligations. The essence of these indicators is to compare the amount of short-term obligations of the company and its working capital, to ensure whether firms can afford the repayment of these debts. In our research we use ratios that are presented in Table 1.

Table 1. Key performance indicators

Indicator	*Formula*
Current ratio	CA/CL
Acid test (quick ratio)	(CA - Inventory)/CL
Inventory turnover	Cost of sales/Average inventory
Production cycle	(Average inventory*365)/Cost of Sales
Receivables payment period (DSO)	(Average trade receivables*365)/Sales
Operational cycle	Production cycle + DSO
Payables' payment period	(Average trade payables*365)/Cost of Sales
Financial (Cash) cycle	Operational cycle-payables' payment period
Debt-to-equity (D/E) ratio	Total Liabilities/Total Shareholder Equity
Financial Leverage	Average total assets/Average equity
Working Capital	CA - CL
Days Working Capital	(Average Working Capital *365)/Annual Sales
Asset turnover	Net sales/ Average total assets
Operating profit margin	EBIT/Net Sales*100%

Net profit margin	Net income/Net Sales*100%
Return on Equity (ROE)	NI/average owner's equity
Return on assets (ROA)	Operating profit margin*Asset turnover
Return on Investment (ROI)	Net profit/ (Equity + Long-term debt) *100%

Results

NLMK group is the largest steel company in Russia. It is stated as one of the world's most efficient producers of steel products that are used in various industries like construction, mechanical engineering, power generation equipment, wind installations and others. Production facilities are located in Russia, Europe, and the United States. The company's capacity of steel production exceeds 17 million tons per year.

Table 2. *Results of the ratio analysis for NLMK company*

Ratios	*2019*	*2018*	*2017*	*2016*	*2015*
Current	1,90	2,10	2,36	2,37	2,83
Quick	1,06	1,22	1,42	1,48	1,91
Inventory turnover	4,23	4,16	3,97	3,68	3,97
Production cycle, days	86	88	92	99	92
DSO	41	39	40	45	47
Operational cycle, days	127	126	132	144	138
Payables' payment period, days	56	51	61	71	50
Cash cycle, days	71	75	70	73	89
D/E	0,76	0,70	0,65	0,62	0,74
FL	1,73	1,68	1,64	1,67	1,69
WC	1753	2277	2712	2373,9	2406,7
DWC, days	70	76	92	114	106
Asset turnover	1,03	1,15	0,95	0,80	0,83
OP, %	17,47%	23,06%	18,69%	16,22%	17,04%
NP, %	12,71%	18,62%	14,43%	12,29%	12,09%
ROE, %	22,77%	35,95%	22,41%	16,40%	16,99%
ROA, %	18,05%	26,53%	17,72%	12,93%	14,16%
ROI, %	15,70%	28,50%	16,14%	11,03%	12,73%

Results on ratio analysis of the NLMK for 5 years are presented in Table 2. For 5 years NLMK reduces the current ratio from 3 to 2, thus using its current assets in a more efficient way. The quick ratio of the company is good, and it means that NLMK should not have trouble with paying its short-term debts. Inventory turnover ratio measures how fast a company sells inventory. For 4 years this ratio has been growing which means that the NLMK has weak sales now in comparison with 2016. Therefore, the company does not have very good inventory control.

Production cycle shows the average number of days sales a company is holding in its inventory. From 2016, NLMK decreased its production cycle from 99 to 86 days. NLMK has an overall trend to shorten the period of collection of receivables since 2015. The suppliers of the company introduced a more conservative credit policy in contrast to 2016 after the crisis, thus the NLMK has to pay its current debt faster than previously. Nevertheless, the company has stabilized its cash cycle and it is even less than in 2015, did not change significantly during 2016 - 2019 years.

Debt ratio means that NLMK had 0,76 $ of debt for every dollar of equity. This indicator calculates the weight of total debt and financial liabilities against total shareholders' equity. Debts of the company could be fully equity financed, but it is highly leveraged. Capital structure indicators analyze the risk of bankruptcy of a company due to the use of borrowed funds. The positive or negative impact of financial gearing increases in proportion to the amount of debt capital used by the company. This information is primarily necessary for existing and potential creditors of the company as lender's risk is directly correlated with the shareholders' risk. Creditors also assess the ability of the company to return the borrowed money if it experiences significant difficulties in repaying a long-term loan.

Financial leverage shows how efficiently the company uses its borrowed money to finance the purchase of assets with the expectation that the income or capital gain from the new asset will exceed the cost of borrowing. During 5 years the company has stable financial leverage over 1,7. If this ratio is more than 1, a company has high leverage it means high risk not to be able to pay company's current obligations. Only one half of the assets are financed through equity.

The amount of working capital is free from short-term (current) liabilities, the share of the company's working capital that is financed from long-term sources and that does not need to be used to repay current debt. An increase in the value of net working capital (NWC) means an increase in the company's liquidity and creditworthiness. At the same time, too large working capital values can signal an inefficient financial policy of the company, in turn leads to a decrease in profitability.

The NLMK has decreased its working capital from 2406,7 to 1753 million US dollars. The company has a potential to invest and grow as it has a substantially positive working capital. Days Working Capital (DWC) shows how many days

it takes for a company to convert its working capital into revenue. High value of DWC indicates inefficient usage of the company's resources. At the same time decrease in DWC may be caused by increase in sales. Since 2016 NLMK decreased its DWC by 44 (38,59%) days while sales increased slightly less, by 38,2% or 2917,6 million of US dollars.

The asset turnover ratio measures a company's efficiency to use its assets to generate sales. Shows how many sales are generated from each dollar of company assets. In 2019 NLMK generated 1,03 dollars for every dollar in assets. Asset turnover ratio increased by 28,75% since 2015, which means the company utilizes its resources more efficiently.

Operating profit margin (OP) shows how efficiently a company controls costs, expenses from operating activities. It states the percent of sales left after paying for variables costs (materials, wages, etc.). Up to 2018, operating profit margin raised from 16,22% (in 2016) to 23,06%. In a year, this ratio decreased by 5,59%. Net profit margin indicates how much income the company actually gets from every dollar of sales. NP of the NLMK Group has been increasing during the 2015-2018 period. However, this indicator declined to 12,71% in 2019.

The ROE of NLMK is higher than 10%, thus the management uses the company's assets efficiently to create profits. To increase ROE, companies should increase turnover, reduce interest charges, increase the amount of assets relative to a given level of equity, find ways to decrease taxes, improve profitability margins. In 2019 ROA for NLMK was 18,05%, it means that every dollar that the company has invested in assets generates 3,61 cents of net income.

High value of ROI means that the company gets a sufficient profit in relation to the amount of capital it committed to a project. NLMK has a similar trend for ROA and ROI with the highest value in 2018. These indicators fell in 2016 in contrast to 2015, then increased in 2017 and 2018, and again decreased in 2019. High value of ROI is driven by high profits (due to good margins and low costs), high sales (value and volumes), adequate or low capital employed (no idle assets).

Research in ecological sphere

In addition to ratio analysis, the environmental indicators of the NLMK should be reviewed. In the process of analyzing the reporting of the metallurgical group, it was determined that the main indicators by which it will be possible to compare the environmental performance of their activities are: air emissions, energy efficiency and pollution of water resources.

NLMK is one of the leaders in the implementation of modern environmental and ecological technologies in the global metallurgy. The goal of the company is to minimize permanently the impact of production on the environment and constantly strive to achieve the best environmental standards in the ecology. NLMK production has doubled, while the environmental impact was significantly reduced

due to the introduction of modern technologies and large-scale modernization of equipment.

NLMK approached the level of the best available technologies for energy efficiency. Since 1999, NLMK has implemented 54 major investment projects in the field of energy efficiency with an investment volume of more than RUB 25 billion. 12 MW - annual electricity savings at the Lipetsk area. It is equivalent to the need for electricity in an urban microdistrict or village with 1,000 households.

Since 2007, NLMK Group has reduced its discharges of pollutants with industrial effluents into water bodies by more than 54 times. In 2009, the Novolipetsk Metallurgical Plant completely stopped discharging industrial storm wastewater into the Voronezh River. At the same time, the consumption of river water decreased by 3 times. The reduction of the environmental load was achieved due to the completed large-scale modernization of the technical water supply complex, which provides the reuse of wastewater instead of fresh river water. For this purpose NLMK has built a network of new pipelines, implemented new and reconstructed existing water pumping stations. In 2008, the Berezovsky branch of the Nizhneserginsky Hardware and Metallurgical Plant (now NLMK-Ural) launched a block of treatment facilities for the rolling mill, which still remains an example of an environmentally friendly approach to the use of water and energy resources. Since 2010 NLMK surpasses the world level of the best available technologies of the consumption of water.

Applications

The main ratios to compare the economic effectiveness of metallurgical groups are sales volume, EBITDA and EBITDA margin. In Table 3, we observe steady growth of these indicators in NLMK Group. For 4 years EBITDA increased by 1646 million of US dollars (84,71%). Sales volume in 2018 was 12046 million of US dollars, that is 4038 US $ (50,42%) higher than in 2015.

Table 3. Key performance indicators for 2015 - 2018 years.

Indicator, mln US $	2015	2016	2017	2018
Revenue	8008	7636	10065	12046
EBITDA	1943	1943	2655	3589
EBITDA margin, %	24	25	26	30
Net Profit of PJSC NLMK	967	935	1450	2238
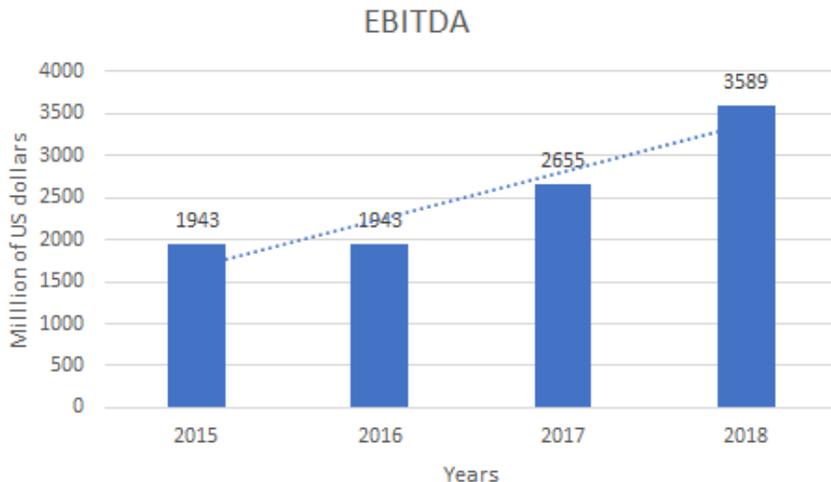
EBITDA

Pic.1. Dynamics of EBITDA growth in NLMK Group from 2015 to 2018.

Revenue
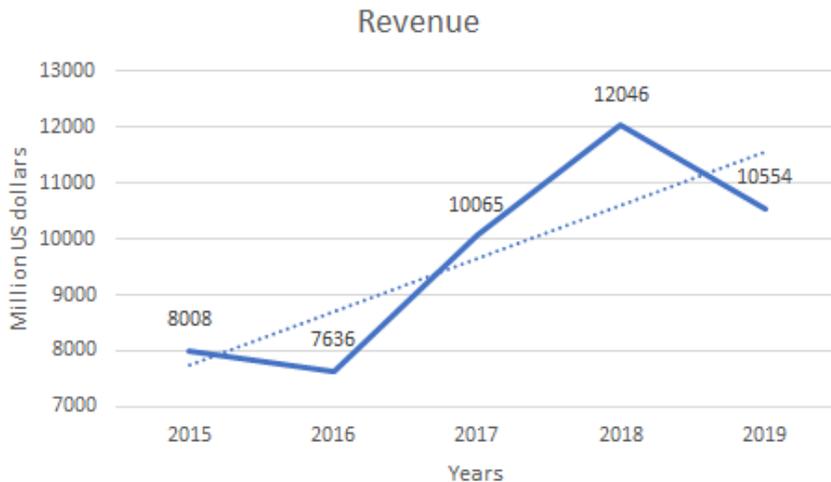
Pic.2. NLMK dynamics of sales for 5 years.

In order to evaluate overall performance of the company we calculate "integrated strategic effectiveness" (ISE). This indicator shows general achievement of the main goals of the enterprise, mission implementation by various stakeholders. ISE is primarily about the effectiveness of the company or group activity.

$$ISE = \frac{Market\ Capitalization * p_1}{Equity * p_2}$$

where p_1 and p_2 are probabilities to attain certain level of market capitalization and company's equity for strategic planning purpose.

Table 4. *Components and calculation of integrated strategic efficiency of the metallurgical group at 31.12.19*

Company	Market Capitalization, mln US $	Equity, mln US $	Integrated strategic effectiveness
NLMK	13842,21	5947	2,63

In Table 4 we see elements that are necessary to calculate the integral strategic efficiency of the company. p_1 and p_2 are equal to 1 as we use actual data and not the forecast one. NLMK group has a good ISE that shows the general results of effectiveness in several spheres: economic, environmental and social.

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蘇聯解體的客觀原因
OBJECTIVE REASONS OF DISINTEGRATION OF THE USSR

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抽象。 列出了導致蘇聯解體的錯誤版本。 確定了三個主要内部原因。
關鍵字：成本社會化行政手段
Abstract. *False versions of the reasons for the collapse of the USSR are listed. Three main internal causes are identified.*
Keywords: *costs, socialization, administrative apparatus*

Foreword

The history of this work is strange to say the least. In it, the author used the fact of the deconcentration (the author's term) of labor in the USSR, the fictitious socialization of production, which he also discovered. The magazine "Alternatives" published an article by Ikhlov, which points out this fact. Ten years passed, and MSU professor A. Buzgalin, in the next issue of the same magazine "Alternatives" in 2001, appropriated the authorship of the discovery and, accordingly, the term, which made Ikhlov publicly appear with the article "Globalization in Russian".

This article was first partially published in the materials of the interuniversity conference "National issue: history and modernity" (Perm, PSU, 1996). However, the university scientific community did not notice this work.

In 2001, the author presented this article at the international conference of the "Alternatives" movement in Moscow, organized by the Buzgalin group. But even after that, this article remained unknown to the general reader. It is understandable that scientists holding the positions of the CPSU or the CPRF "do not notice" the article: it crosses out all the works that have been written on this topic by S.G. Kara-Murza, S.V. Cheshko, M.G. Suslov and others who believe that the main reasons were either external or external, together with the activities of Khrushchev.

Liberal-democratic analysts do not see this work either.

It is even more surprising that Ikhlov's article is not accepted in an environment that considers itself Marxist-Leninist, even in circles close to the Samara

Marxist philosopher E. V. Nikishina. Although the above principled position (in its modern form) was formulated by Nikishina (Ikhlov refers to her in the article). Moreover, this provision was formulated by Lenin, arguing that even 1000 Marx in the government will not be able to manage the country's economy.

Even after the author included this article in his book "Lessons of the Revolution", the scientific community tried not to notice either the article in the book or (with rare exceptions) the book itself.

To this day, there is not a single link to the article in the texts on the Internet, and various researchers continue to explain the collapse of the USSR either by the activity of the CIA and its agent Matthias Rust, or by the subjective moods of the population of the Union republics, or by the betrayal of the CPSU Secretary General, or by the Declaration of Sovereignty. signed by three people in Bialowieza.

Sergey Otdelny, Doctor of Philosophical Sciences, Perm

Part of the material is presented in [1].
Let us list the points of view on the collapse of the USSR.

1) Liberal democrats believe that the origins of national enmity and the collapse of the USSR are in totalitarianism, in the monopolization of the economy, in ideological pressure. It is widely believed that the basis of national enmity is Soviet poverty. The version is doubtful, since national, national-religious and racial conflicts have occurred and are occurring also in developed countries.

The continuation of conflicts after the collapse of the USSR-CPSU is viewed in official journalism as a residual phenomenon of the same totalitarianism.

The liberal point of view appeals to the myth that the USSR stood on the brink of an abyss, "sat on an oil needle," and oil prices collapsed, the external debt reached 80 billion dollars, with gold reserves of $ 20 billion, thus there is another way out. there was no way to destroy the USSR and bring down the economy.

They point to poverty, misery, unemployment, the war in Afghanistan, the decrepitude of the leadership, the cultural influence from outside, the lack of freedom of speech, free elections, the extensiveness of the economy; allegedly in the USSR, the economy was put in the service of the military.

However, in the USSR in 1986 there were only 1.7 million unemployed per 140 million active population, 1.2%, there was no talk of hunger, if workers received 3-4 times less on hand than in the West, they had subsidies from the factory, free medicine, education, owned country houses and land, etc. The decline in oil prices turned out to be a myth. The sale of oil and oil products accounted for only 6% of the USSR budget.

The wars in Vietnam or Iraq did not lead to the disintegration of the United States, the leadership in the person of Biden is just as decrepit, the cultural influence of the USSR was no less, the US military budget is now over 770 billion dollars (Russia is 42 billion), the US national debt has exceeded 20 trillion dollars, there is no freedom of speech and free elections either in the United States or in any other country in the world, in all countries of the world the actions of the authorities are contrary to their declarations. The economy of the USA, Germany or France is no less extensive - in view of the export of capital.

Disinterest in work, apathy are especially highlighted, as if the overwhelming majority of the population was in no way interested in the results of their work.

However, in any country in the world there is a time-based job, and it dominates in comparison with piece-work.

Former head of the Central Bank Gerashchenko claims that "the patient had just a slight runny nose."

2) Almost all the communist parties in the Russian Federation adhere to the position that the collapse of the USSR was due to the influence of the leading capitalist powers (the Zionist conspiracy), and to a greater extent ideological. It is believed that two people are guilty of liquidating the Union - Gorbachev and Yeltsin. Obviously, this point of view is traditional and is caused by the exaggeration of the role of the individual in history.

CPSU ideologists also point to external and internal reasons for the collapse of the USSR. External reasons are Western intelligence services.

Internal - these are agents of influence, "revisionists-anti-Stalinists" who "rocked the boat", the bourgeoisie of the CPSU (mainly under Khrushchev) and the bourgeois working class, betraying the ideals of socialism for the sake of Western goods, the shadow economy (shopkeepers, black-market speculators and others, accumulated capital). In addition, by 1991, ordinary citizens had over 5 billion rubles "in stockings" and on savings books, which played a role in voucherisation and corporatization.

However, in developed countries, instead of the "hand of the CIA" there are much more powerful agents of influence, the Communist Party.

Without a doubt, the influence of Western intelligence services played a large role. But, as the representatives of these special services themselves noted, in order for the provocation to be successful, the ground, the prerequisite underlying the basis, is needed. Moreover, this applies to such an independent state as the USSR.

Of course, it is impossible to ignore external influence and the presence of a "fifth column" in the USSR. However, the influence of the Soviet special services in the "capitalist camp" was no less.

The shadow economy also played a role. But in the collapse of the industry, the young elite of the CPSU played a major role. Thus, one member of the Perm regional committee of the CPSU privatized 4 large stores on the central street of the city, Komsomolsky Prospect, for 50 thousand rubles, at a price of 1 million rubles for each store.

The sons of the leaders of the aircraft industry, the Mikrodin firm, by unknown means acquired 32% of the shares of Perm Motors. In general, the shares fell into the hands of the management of the factories, the general directors - 5% by the order of Yeltsin, the heads of the shops were given privileges for the purchase of shares. Then the workers were delayed in wages and shares were bought for nothing.

3) Many left-wing groups believe that the main reason for the "collapse of the empire" is the class struggle, and specifically the working class, against oppression by the CPSU elite.

Anarchists and Trotskyists put the main emphasis on Stalin's undemocratic character and say that there was a workers' state in the USSR under Lenin, but it was reborn, Stalin with his national policy created the basis for disintegration, as Trotsky had predicted.

However, Argentina and the United States are also multinational states, Argentina is dominated by the Spaniards. In the USA, Negroes and Indians are oppressed.

In 1987, subsidies from the budget of the USSR for one Georgian, Armenian accounted for about 700 rubles, for a resident of the Baltic republics - 1000-1200 rubles, for a resident of the RSFSR - 89 rubles 67 kopecks. About the same for a Ukrainian, a Belarusian, a Tajik, a Kyrgyz, a Turkmen, a Kazakh. At the same time, anti-Russian activity was mainly in Georgia and the Baltic States (however, the demonstrations of the 60s-70s under the slogan "get the Russians out" soon faded away). At the same time, the RSFSR dominated the CPSU leadership in percentage terms.

Undoubtedly, the Stalinist policy of indigenization (including Ukrainization) served as one of the powerful pushing springs, like the Stalinist plan for autonomization, carried out by Stalin after the death of the enemy of this plan, Lenin, the plan implied strengthening the subordination of the republics to the center, in particular, the mandatory presence of Russians at the very top of the republican administrative apparatus. By the time of the collapse of the USSR, Russians were despised and even hated by the Udmurts, Komi, Tuvinians.

However, the centrifugal tendency that Trotsky highlighted worked only after the sectoral chains within each of the republics and between the republics dis-

integrated - in view of the liberalization of prices, the invasion of the dollar and a sharp depreciation of the ruble. All three moments were planned even before Yeltsin and Gaidar. But not in the Politburo (after Gorbachev became president, it lost its second role), but in the government document (which received this second role), signed by Petrakov in April 1990.

During the war, relations with Chechnya were extremely tense, the rebels tried to reunite with the Wehrmacht. Crimean Tatars fought on Hitler's side. According to the directive of the State Committee for Defense, men from the Turkic republics were not called up in the Red Army, that is, relations with the center of these republics were also tense.

After Stalin's death, Khrushchev returned the evicted Chechens and Tatars to their homeland and continued the "divide and rule" policy, populating the Stavropol region with Chechens. "Autonomization" continued to operate: for every 1st secretary of the CPSU Republic Committee, a Russian was to be his deputy.

By the time of the collapse of the USSR, Russians were despised and even hated by the Udmurts, Komi, Tuvinians.

Of course, the provocation of foreign special services with a television center in Vilnius, the organization of the conflict by the Georgian KGB with the use of sapper shovels, and the participation of the MOSSAD in the Moscow events in October 1993 also played a role.

The influence of such factors as the dominance of the Russian nationality in the governing bodies of the CPSU and in the CPSU as a whole (see GSE, article "CPSU"), whipping up anti-Russian sentiments in Georgia or the Baltic states, etc. - was secondary. Thus, conflicts on ethnic grounds did not spill over into broad popular movements; the national Popular Fronts, RUKH, Sayudis and others were too weak and almost disappeared immediately after the collapse of the USSR.

Rallies of many thousands, agents of influence, informal groups, etc. almost did not influence the course of events. It was foam for water, information support, extras. The rallies soon came to naught, and the informals were not supported by their actions either by labor collectives or by the population as a whole.

Likewise, it is difficult to call the division of property across the republics the result of the struggle of the working class: the national theme barely affected workers 'associations, and the national Workers' Unions disappeared even faster than the Fronts. Although the labor movement for some time went side by side with the democratic movement, until the developed class conflict within a republic, the movement did not grow until the collapse of the USSR

4) Engineers and scientists believe that the key role was played by the artificial freezing of technologies, agreed by the top leadership of the United States, Europe and the USSR.

The technology freeze did indeed take place: the world's first computers (first analog) were created in the USSR. However, one can hardly believe that Stalin reached an agreement with Roosevelt and Daladier that genetics would be oppressed in the USSR, and Khrushchev - with Kennedy and De Gaulle on the oppression of cybernetics. In addition, by 1985, in one of the institutes of Moscow State University, a method for creating large integrated circuits, LSI, was discovered by the method of sputtering with a laser, which made it possible to overcome the 15-year lag behind Japan. But perestroika prevented its implementation.

The specificity of the USSR, expressed in the size of the area, of course, leaves an imprint on management, but it cannot be an essential reason. In North America, attempts by several states to secede led to the Civil War. Tibet's desire to secede prompted military action. Centrifugal forces operate in the EU as well, Great Britain left the union, Greece left the union even before the introduction of the euro currency. Scotland tried to secede from Great Britain, Catalonia voted to secede from Spain.

There were also subjective reasons. If it were not for the actions of the top of the SEC, the USSR might have followed the path of China.

The SEC arose long before 19.8.1991, and at the meetings of Yeltsin's team, people asked for time off: "Now the SEC is in session, I want to listen!" Conversely, people from the SEC were present at the meetings of Yeltsin's team.

Even in 1993 there was an opportunity to prevent the collapse of the economy, if Yeltsin had not dissolved the Supreme Soviet of the Russian Federation.

On July 4, a joint meeting was held in Moscow, organized by the government and the RF Armed Forces, at which the head of the Armed Forces, Khasbulatov, announced: "Everyone must obey the laws. We write the laws. So we need to obey. "

Among the documents of the Meeting was the Agreement on Cooperation, signed behind Yeltsin's back by Travkin, Gaidar, Yavlinsky, Gerashchenko and others, that is, representatives of both opposing sides, which could not please Yeltsin.

In 1993, Yeltsin fired Zakharov as head of the Pension Fund (PFR), Berezovsky became his treasurer, an association of 6 Solidarity banks arose on the basis of the PFR (Mamut, Khodorkovsky, Abramovich, etc.) Chernomyrdin took 21 billion rubles from the PFR, returned only 6 billion rubles. Komsomol leader

Chubais became the head of the State Property Committee, the young party-industrial elite seized oil and gas.

However, all subjective reasons are due to the objective, which was the administrative apparatus of the USSR.

Thus, all of the above reasons operate in many countries of the world without causing disintegration.

Competition

Nevertheless, the external impact on the USSR was significant.

Obviously, developed countries could exert a direct influence of a massive nature, and by no means through special services, samizdat or Radio Liberty, on the humanitarian and scientific and technical intelligentsia, which had much greater access to legal information about the West than the working class. Why is information so scary?

"Capitalist production," writes E. Preobrazhensky, "is not scary for subsistence farming when the latter has no points of contact with it ... Subsistence farming simply does not accept battle, since it is not involved in monetary exchange ... And only when this weaker enemy is being dragged out into the capitalist arena by the development of commodity exchange, it is being put on both shoulder blades in the process of free competition. ... For the victory of the capitalist mode of production over the natural or petty-bourgeois mode of production, those economic advantages that each capitalist enterprise had over more primitive forms of economy were quite enough. Violence played mainly an auxiliary role ... The outcome of the battle was decided by the consumer, who, buying a cheaper (or higher quality, B.I.) product, thereby voted for the capitalist mode of production (or for a more developed production, B.I.) and supported it against the craft (or against less developed production), becoming a buyer (or appraiser, B.I.) of capitalist products" [2].

That is, a similar conclusion about the collision of a developed capitalist economy with a less developed one is quite legitimate. The fact that production from the USSR was less developed than in the USA, Europe or Japan is indicated not only by the level of GDP per capita [3], but also by the weak development of computer technologies as the basis of modern production, and the quality of consumer goods, and quality of vehicles. For example, the export of aircraft to the USA in 1985 exceeded the analogous export of the USSR by more than 20 times (see, for example, [4]).

Secondly, we are talking about the comparison of working conditions and wages - as you know, in developed countries the ratio of the incomes of clerks and engineers is inverse than in the CMEA countries (see, for example, [5]).

Third, on the direct exchange of scientific and technical information. Suffice it to mention that the once scientific direction of creating high-temperature superconductors in the USSR was criticized from a high rostrum, at the same time Ronald Reagan declared in his first presidential term: "High-temperature superconductors are the nails with which we will hammer the coffin of socialism."

So, it is obvious that the points of contact between Western-level industry and the so-called "closed society" were mostly in the sphere of intellectual work. Thus, the debates, unfolded in due time by the Communist Parties, about the "betrayal of the ideas of socialism by the intelligentsia" are doubtful.

Thus, it was worth introducing greater independence of factories in the "Law on State Enterprise" and then abolishing the state monopoly on foreign trade introduced by Lenin, as more developed countries began to oust local producers from the market.

Three main reasons

In fact, each republic disintegrated even before the Belovezhskaya Agreement. The latter was only a legal confirmation of the actual disintegration. For example, the textile workers of Ivanovo, "polarized" by the external dollar field, are tearing up the technological chain, selling textiles abroad and leaving Glazov's weavers without raw materials. Short-term interest realized - profit; the rate of profit (reduction in price, modernization of the means of production), as well as long-term interests, remained in the shadows.

It is not common, but the IDENTITY of the reaction to the "field" on the part of managers, intelligentsia, and workers. Why is this happening? In order for the "field" to work, there must be a "charge". Namely.

The construction of the economic system by the state-owner included the centralization of financial capital and management. Thus, the state has "expropriated" all planning functions. Consequently, together with them, it concentrated all long-term interests in itself, removing them from the consciousness of ordinary workers. The exclusion of art workers, workers of creative (dominant concrete) labor, who are both performers and planners of their own labor during the labor process, is not significant, because they are embroiled in a dominant alienation from general management.

At the same time, the concentration of labor was only extensive, quantitative in nature, with the internal fragmentation of production ("atomization of the proletariat"). Since not only technological chains instantly disintegrated, but in the

absence of closed cycles fell apart into separate workshops and giant factories, inside the workshops, various forms of payment provoked a confrontation between pieceworkers and time workers, and capitalist leveling, i.e. payment for materialized labor, created tension between the members of the labor collective within the brigades.

That is, socialization was fictitious. As an example, we can cite the implementation of the synthesis of a certain chemical compound in Perm, for which components were supplied from a dozen cities of the USSR up to Khabarovsk in the presence of the same components in Perm itself. Or the supply for the Perm "bicycle" defense plant (JSC "Velta") steel grades from 35 cities of the USSR, including distant Yerevan, Krasnoyarsk, etc., when metallurgical plants in the Perm region are not loaded (Lysvensky, Chusovsky, Nytvensky), in the presence of metallurgical plants in Perm itself at the factories named after Lenin and named after Sverdlov.

To this must be added the oncoming traffic, the supply of timber from the Baltics to Siberia, cement to Gornozavodsk, where the cement plant is located, etc.

That is, roughly speaking, the Baltic nuts were "socialized" with Khabarovsk bolts, the extensive consolidation of production was accompanied by the deconcentration of labor [6].

Thus, the privatization process is PRIMARY in relation to the process of the collapse of the USSR.

Why does the administrative apparatus need such a structure of the economic system? It is obvious that the transfer of the chief executive to the center from the provinces makes it difficult to strike. Secondly, the unification of workers according to professional interests, according to the "interests" of the technological chain is also difficult due to the scattered production. This means that if the manager loses on the increase in production costs, he gains due to the absence of workers 'performances and, consequently, the absence of redistribution of profits to the workers' wages.

The same method of organizing production is observed in the developed capitalist countries [7]. So, the exorbitant costs of production in fictitious socialization are one of the main political and economic springs of the collapse of the USSR.

The second objective reason is the growth of productive forces.

As already mentioned, planning functions, management functions are concentrated in the capital. That is, the management apparatus mediates all intra-economic ties. As indicated by Nikishina in 1988 [8] and in 1992 by Fukuyama [9], the

development of production leads to an increase in the number of economic ties, and hence to the growth of the administrative apparatus. In the end, the administrative apparatus is faced with a dilemma - either to increase its size even more and lose its privileged position (with Lenin, to make EVERYONE bureaucrats), or to maintain the status quo. That is, a situation when the apparatus is no longer able to cover the entire wealth of economic ties. This means that it is not able to manage.

Therefore, in the conditions of suppression of the economic "creativity of the masses", attempts to form a plan "from below", the administrative apparatus collapses regardless of the desire of the layer of managers, ceases its functions, entrusts them to the capitalist class, where property relations have been reduced from management to ownership (hence the rentier and the export of capital abroad), but, for the most part, forms this class itself.

A number of smaller-scale administrative apparatus are emerging in accordance with the scale of economic structures that each specific apparatus is able to control.

Since the common interest in the newly formed class has not matured, the bourgeoisie appears as a class-in-itself, but not a class-for-itself, insofar as each economic structure declares only a short-term interest, and not a long-term one (previously "expropriated" by the capital). Consequently, these structures do not need the state as a tool for realizing a common interest. Therefore, state property is disintegrating. Because even 1000 Marxes couldn't manage the entire economy.

The same tendencies are valid in the United States, the collapse of which was predicted by Harriman back in the 40s. In the process of the third round of globalization (if we consider the 1st world war as the first, the 2nd world war as the second, and the USSR as a relatively peaceful globalization of the economy in a limited space). Centrifugal trends are being detected today not only by Texas, but also by 17 states that voted for Trump.

As has been shown, centralization of management and the concentration of financial capital has nothing to do with the socialization of production. Thus, globalization cannot be the basis for uniting workers and, as Savas titled his article, "The Transition to Socialism" [10]. There is nothing to applaud for in globalization. On the contrary, instead of uniting the workers, it leads to their disunity.

Thus, the contradiction of capitalism, expressed in the social nature of production and the private form of appropriation, is only a side of the contradiction between the growth of production and the usurpation of production management by a narrow social stratum, no matter if it is a bourgeois class or a class of state officials.

Consequently, the contradiction between labor and capital is not reduced to the withdrawal of surplus value, since the owner does not use the lion's share for his personal consumption, for luxury goods, etc., he is obliged to pay taxes, invest in depreciation and development of production: as in the USA or Germany, and in the USSR. This contradiction mainly lies in the usurpation of the management of this surplus value (development fund or accumulation fund).

Consequently, the content of the oppression of the class by the class is not so much a cut in income, as the reduction of the worker to the role of a cog in the mechanism, his depersonalization through alienation from management.

The basis for such alienation is the social division of labor, first of all, into physical and mental labor. Monotonous, hard, depersonalizing (dominant abstract) labor is oppressive, and not just low wages to restore the workforce. The hired character of labor is generated by the abstract content of labor.

The third objective reason for the collapse is the contradiction between the bourgeois content and the socialist form of classes in the USSR.

Indeed, the working class cannot be both socialist and "bourgeois" at the same time.

On the other hand, management, disposal is the essence of property relations, the manager of the means of production is a capitalist by definition.

A higher place in the social hierarchy, in the production management system, also determines a higher share of social wealth, in accordance with the definition of classes given by Lenin in the article "The Great Initiative".

Since social existence determines social consciousness, the privileged social existence of the managerial class gave rise to their bourgeois consciousness, of course, not in 1956, but immediately after 1917. Therefore, it makes no sense to involve conspiracy theories of the leadership's "betrayal".

Thus, the driving force behind the reforms that led to the collapse of the USSR was the interest of the managerial elite to legalize their position as owners (to "convert" power into money).

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論抽像在勞動中的辯證法
ON THE DIALECTIC OF THE ABSTRACT ON THE CONCRETE IN LABOUR

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抽象。　研究表明，勞動的僱傭性質是由抽象內容在勞動中的主導地位決定的。　研究表明，交換領域中勞動的抽象性是由於生產領域中勞動的抽象內容所致。
關鍵字：成本，勞動力，客觀性

Abstract. It is shown that the hired nature of labor is determined by the dominance of abstract content in labor. It is shown that the abstractness of labor in the sphere of exchange is due to the abstract content of labor in the sphere of production.

Keywords: cost, labor, deobjective

The opposition of the market and the plan is fictitious, since the plan is the product of the centralization of capital and the concentration of labor. At the same time, the idea of the absence of a market in the USSR is incorrect.

This opposition is only an ideologeme for manipulating mass consciousness in order to soften protectionism and facilitate access to domestic markets.

In many respects, the misunderstanding of the topic is due to the mistakes and misunderstandings that exist in the fundamental works of the classics of Marxism.

The controversy of commodity production

In the 1st volume of Capital, Marx defines the use and exchange value:

"The usefulness of a thing makes it a use value ... for example, a dozen hours, an yard of linen, a ton of iron, etc. ... Use values ... are ... material carriers of exchange value. Exchange value is primarily represented as ... the proportion in which use-values of one kind are exchanged for use-values of another kind ... A well-known commodity, for example one quarter of wheat, is exchanged for x boot polish, or for y silk, or for z gold, etc. ., in a word - for other goods in various

proportions. Consequently ... different exchange values of one and the same commodity express something identical ... exchange value must be reducible to this third ... the exchange ratio of goods is characterized precisely by abstraction from their use values."

How does Marx define abstract and concrete labor as well as value?

"As the use values of goods differ ... qualitatively, as exchange values they can have only quantitative differences, therefore they do not contain a single atom of use value. If we ignore the use-value of commodity bodies, then they have only one property, namely, that they are products of labor. But now the very product of labor ... is no longer the product of the labor of a joiner, or a carpenter, or a spinner, or in general any other definite productive labor. Together with the useful character of the product of labor, the useful character of the types of labor represented in it disappears, and, consequently, the various concrete forms of these types of labor disappear; the latter do not differ ... but are reduced to the same human labor, to abstractly human labor ... from the products of labor ... nothing is left but ... a lump of human labor devoid of differences, that is, the expenditure of human labor, regardless of the form of this expenditure ... in relation to commodities, their exchange value appeared to us as something completely independent of their use-values ... that general, which is expressed in the exchange ratio, or the exchange value of goods, is their value."

So, value is what is produced by impersonal labor, labor in general, abstract labor: the expenditure of the physiological energy of a person in a certain social form, averaged

Labor embodied in a commodity creates value and use value. Therefore, every commodity has two properties: use value and value. The use value of a commodity acts as a carrier of its second property - value.

On the other hand, Marx understands the abstractness of labor only in terms of exchange value, in terms of exchange, market.

"How can one measure the magnitude of ... value? Obviously, the amount of labor contained in it ... The amount of labor itself is measured ... by labor time ... it might seem that the value of a commodity is the greater, the more lazy or unskilful the person who produces it, because the more time it takes him to manufacture the goods. But the labor that forms the substance of values is the **same** human labor ... The entire labor power of society, expressed in the values of the commodity world, appears here as one and the same human labor power ... since it has the character of a social average labor power ..., therefore, it uses for the production of a given commodity only the **average or socially necessary labor time** ... which

is required for the production of any use value under existing socially normal conditions of production and with an average level of skill and intensity of labor in a given society. "

Thus, value also arises when abstracting from the individuality of the worker.

Let us make a reservation here that it averages the market, but the monopoly dictates the market conditions, setting the price of labor to a minimum, and the price of the product of labor to the limit of purchasing power. And this is also averaging.

Precisely because Marx put exchange at the forefront, in the third volume of Capital he does not speak about the need to transform socially necessary labor, but only about its reduction under communism to a vanishing little time.

But there are mistakes in the 1st volume of "There is enough capital." For example:

"… A thing cannot be a value without being a commodity. If it is useless, then the labor expended on it is useless, is not considered labor and therefore does not form any value. "

This is only partly true. Social labor is not only a spatial but also a temporal dimension. If physicists are not paid for the **now** useless work yesterday, corpses will not be able to produce useful work today. But the capitalist pays for physics and future utility, even if he is not working with immediate benefit today. The Mössbauer effect was considered purely academic; today it is even used in agriculture. But the mass of inventions or scientific works does not find a consumer, and this mass must be paid for.

Or: "Part of the bread produced by a medieval peasant was given in the form of rent to the feudal lord, and part - in the form of tithes to the priests. But neither bread, alienated in the form of quitrent, nor bread, alienated in the form of tithe, became a commodity only because it was produced for others. In order to become a commodity, a product must be transferred into the hands of the one to whom it serves as a use value through exchange."

And this is only partly true, since the same quitrent was drawn into trade.

Also: "In the process of production, man can only act in the same way as nature itself acts, that is, he can only change the forms of substances ..."

Marx repeats F. Bacon: "In action," writes F. Bacon, "man cannot do anything other than unite and separate the bodies of nature. The rest is done by nature within itself." This, of course, is wrong, according to the level of the Bacon-Marx time. But even at that time it was possible to understand that if you did not combine and did not separate, but at least put it in rotation, you could also get something new.

More: "... in each factory labor is systematically divided, but this division is

not carried out in such a way that the workers exchange the products of their individual labor. Only the products of **separate, independent from each other** private works are opposed to one another as goods. "

It would seem, really: at a plant that produces trucks, steering wheels are not exchanged for bodies. But the cost of both steering wheels and bodies is estimated in hours of working time. On the other hand, a factory can be understood as a monopoly, a state-monopoly conglomerate, and the entire planet as a whole. That is why market relations existed in such a factory as the USSR, albeit in a latent form.

In the work "To the Critique of Political Economy": "... abstraction, which in the social process occurs every day ... no less real abstraction than the transformation of all organic bodies into air." Of course, not into the air, but into minerals, water, etc.

However, let's highlight the main thing. "Comparatively complex labor," writes Marx, "means only simple labor raised to a degree, or rather multiplied, so that less complex labor equals more simple labor. Experience shows that this reduction of complex labor to simple work is constantly being done. A commodity can be the product of the most complex labor, but its value makes it equal to the product of simple labor, and, therefore, itself represents only a certain amount of simple labor. The various proportions in which different types of labor are reduced to simple labor as a unit of their measurement are established by the social process behind the backs of the producers and therefore seem to be the last established custom."

That is, the synthesis of several "works" is a simple addition. It is proposed to approach the work of an engineer, chemist or teacher with the same yardstick. Of course, Marx understands the fundamental difference between mental and physical labor, but here is a characteristic mistake that testifies to ignoring the *content* of labor in this issue.

Now let's dot the i, which for Marx is abstract and concrete work:

"All labor is, on the one hand, the expenditure of human labor power in the physiological sense - and in this quality of its identical, or abstractly human, labor forms the value of commodities. All labor is, on the other hand, the expenditure of human labor power in a special expedient form, and in this quality of its concrete useful labor it creates use values."

That is: concrete labor is labor expended in a certain useful form and creating the use value of a commodity. Such labor is private labor, and its social character is expressed through abstract labor. Abstract labor - the expenditure of labor in general, the productive activity of the human brain, muscular and nervous systems. Abstract labor creates the value of a commodity. Abstract labor is devoid of

concrete definiteness and therefore is universal and homogeneous for all types of labor. He is a social phenomenon.

The capitalist's income and, accordingly, the worker's wages, regardless of his efforts, are determined by the market. The worker receives for his labor power according to the value of his labor power. By category, by minimum wage, by tariff. According to the alienated average, according to social relations, not according to use value, not according to living labor. Labor is specific because it is produced by a specific person. The abstract nature of labor is determined by the sphere of exchange, which alienates the product of labor from the worker and creates averaging.

Because, and only because, such a political economist as the English professor Hillel Tiktin (followed by the professor at Moscow State University, Alexei Gusev), claims that there was no abstract labor in the USSR. For there was no market in the USSR. There was, of course, the alienation of the product of labor. But the alienation that Marx writes about, which occurs under **independent, private producers,** did not exist. If there was no abstract labor, then there was no duality, there was no contradiction between it and concrete labor.

But, firstly, in the USSR there was not only the collective farm market, but also competition between the leading industries, including in the production of means of production for the production of means of production. Second, the market exchange in the USSR existed indirectly. Averaging in the USSR existed in exactly the same form as in any capitalist country: with the help of a system of grades, minimum wages, tariffs. But, secondly, the point is different: Marx studies only one side of the economy: namely, the sphere of exchange, capital. That is why Lenin insisted that textbooks on production had not yet been written.

The official "Soviet" political economy asserts that precisely in this social function of its own, connections through the market, the expenditure of human physiological energy are a specifically historical form of social labor - abstract labor as a source of value. That is, abstractness is expressed only through the market, the sphere of exchange. That is, under communism, abstract labor supposedly will not exist.

If use value is a material property of a commodity, then value is its social property, which expresses the social nature of the labor of commodity producers. Their labor in the conditions of the domination of private property is a private matter, they run the economy separately from each other. Diverse relations of production, division of labor, etc., make the labor of commodity producers social, their mutual dependence is hidden and is realized only through exchange in the market. The basis of this exchange is social labor embodied in a commodity - value.

The form of manifestation of value in the market is exchange value, the proportion in which various goods are exchanged for each other. The dual nature of a commodity is determined by the dual nature of the labor of commodity producers. The use value of a commodity is the result of concrete labor, that is, certain useful labor that creates a thing that satisfies a particular human need. Each type of concrete labor is characterized by a goal typical only for it, the nature of labor operations and tools. Features of this type of specific labor and determine the specific use value of its product.

Labor creates the value of a commodity, but has no value itself. Labor has value. In the conditions of domination of private ownership of the means of production, the dual nature of labor reflects the contradiction between the public and at the same time the private nature of the labor of commodity producers. Concrete labor in the sense of the concreteness of the producer acts as a private, abstract, which expresses the hidden-social nature of labor. The social character of labor requires the commodity producer to supply a socially necessary product to the market. But the private nature of labor makes possible only an indirect, market-based form of identifying demand.

The contradiction of labor is revealed in the market as a contradiction between the use value and the value of the goods. A commodity producer makes a product in order to sell it. This transformation of the material form into money is essentially contradictory. A private commodity producer does not know or does not want to know exactly what consumer values and in what quantity are needed by the consumer in order to receive the monetary equivalent of the value of the goods produced, he can falsify it. The seller's interest becomes opposite to the consumer's interest, not in the sense of the amount of monetary reward, but in the sense of the quality of the product. Moreover, the manufacturer, with the help of advertising and other means, tries to create demand for the product that the consumer does not need. Even if sociological surveys are carried out, if differential equations describing fluctuations in supply and demand are calculated, the picture will not change, the manufacturer's ability to plan runs into concrete implementation of the plan. The limited use value prevents the commodity from turning into money.

This gives rise to difficulties in implementation, a competitive struggle between commodity producers, during which their property differentiation occurs: small commodity producers go bankrupt, and the few with large capital get rich.

The contradiction between private and public labor is manifested in the contradiction between concrete and abstract labor. A commodity contains an antagonistic contradiction between use value and value. It is argued that this contradiction in its embryo is the basic contradiction of a simple commodity economy and is the starting point of all the contradictions of private commodity production.

Abstractness in the content of labor

But the struggle of these opposites is not all in contradiction, another aspect of it is the unity of opposites, use value and value, that is, abstract and concrete labor. Value and use-value are not simply opposed to each other, they are interpenetrating, mutually dependent. If the worker by training increases the use-value of his labor-power, the exchange form of its value must also rise — although the value of the commodity produced may fall. If the administrator of the enterprise cuts the prices (or the market does it for him), the workers break the new equipment, relegating their labor to the previous one. This relationship, which is the law of value in relation to the commodity "labor power", is shown by a lot of examples from the history of industry in the USSR. On the other hand, the sphere of exchange is not a basis, exchange is secondary, it is determined by the sphere of production.

It is possible to distinguish in the sphere of production the nature of labor - wage, but this character is secondary, they are produced by the social division of labor.

Thus, concrete labor does not exist without abstract labor.

Let us consider how, whence, why the abstractness of labor *arises* in the sphere of exchange as a homogeneous "simple","theoretical" labor devoid of differences. Although, as Marx pointed out, this is a very real abstractness ("To the Critique of Political Economy").

On the other hand, as Ilyenkov notes, for various neo-Kantian schools the abstract is only a form of thought, while the concrete is only the form of a sensually visual image. That is, for the neo-Kantian school, concrete work is the work of a concrete, given by name and surname, a visually sensual worker.

Concreteness can be abstract, such as a concrete triangle or abstract painting. "'Concreteness' is neither a synonym nor a privilege of the sensory-figurative form of reflection of reality, - writes Ilyenkov, - just as 'abstractness' is not a specific characteristic of rational-sensory cognition" [1]. In principle, the concept of concrete labor is clearly an abstraction from the labor of a given worker.

We will consider concrete work in the sense that, following Pascal, Marx put into the concept of the concrete as "the unity of diversity."

If the abstractness of labor that arises in the process of exchange is generated in the production process - by simplifying labor, splitting it into unit operations (we will consider a developed form of the abstract), then concreteness is formed by the reverse process - the complication of labor. For understanding, we will give polar situations: the nut produced, one of a thousand identical, is abstract, therefore, the labor of the worker who produces it is abstract. Marx, following Adam

Smith, writes about monotonous, stupefying, *depersonalizing* labor. By this nut it is impossible to judge which worker produced it. In contrast to this, according to the style of work, one can establish the authorship of a scientific article, especially a poem, piece of music or a picture, as A. Fetisov accurately noted in his "Homosapiensology". It is difficult to evaluate poetry or music in the market, they are unique. Their production is not measured by working hours. For example, Alexander Ivanov wrote "The Appearance of Christ to the People" for 20 years, and Repin created "Portrait of Verevkina", lying sick in bed, in half an hour. Moreover, the value of these paintings has changed several times. The nut is instantly assessed by the market, it is not unique, it is comparable - in terms of working hours.

The worker's labor is more abstract, only a couple of thousands of almost identical nuts will be rejected from his mistake. The work of an engineer is more concrete, more socially significant: the shop can stop because of his mistake.

Thus, abstractness is an attribute not only of the nature of work, but also of its content, that is, a concept that expresses the distribution of functions (executive, registration and control, observation, adjustment, etc.) in the workplace and is determined by the totality of operations performed, reflects production - the technical side of labor, shows the level of development of productive forces, technical methods of combining personal and material elements of production, that is, it reveals labor primarily as a process of human interaction with nature, means of labor in the process of labor activity, etc. **The abstract nature of labor is due to its abstract content [2].**

The abstract content of labor will by no means disappear with the disappearance of commodity production, market exchange, i.e. under communism. For example, such a flow of concrete labor into an abstract one, as the replacement of creativity in solving differential equations by monotonic computer programming in analytical functions, has nothing to do with class antagonism. In the same way, say, metal casting at the dawn of mankind was a creative work, with the dominance of not abstract, but concrete content. And vice versa: the labor of a skilled worker develops into a kind of art, into "golden hands".

Thus, abstract labor did not disappear in the USSR either.

The topic of a specific work was developed in the works of Ilyenkov, Batishchev, Bibler.

Marx introduces the concept of universal labor: "... One should distinguish between universal labor and joint labor. One and the other play their role in the production process, each of them passes into the other, but there is also a difference between them. Every scientific work, every discovery, every invention is called

universal. It is conditioned partly by the cooperation of contemporaries, partly by using the labor of predecessors. Joint work presupposes direct cooperation of individuals. … In spiritual production, another type of labor acts as productive… "[3]. Here Marx uses not an essential or even functional, but an attributive definition. That is, it leaves the wording of the definition for the future, when this type of labor appears at the level of the special. Bibler notes that Marx does not specifically consider this work [4]. Although it is obvious that this work cannot but be present in any kind of labor, the most abstract. That is why he is labor, which is not just social, but personal, through awareness, and that differs, as Marx himself points out, from the actions of a bee.

Unfortunately, further research continued in a liberal direction and led to the use of various terms such as creative, reproductive, etc. labor, not as characteristics, but as political economic concepts, and outside the pair of categories "abstract - concrete". Liberalism lies in the fact that, for example, Bibler believes that under capitalism, due to the dominance of abstract labor, "universal labor ... is concentrated exclusively in spiritual production" [ibid.]. It immediately follows from this that the working class cannot break out of the economic struggle on its own. He needs a guide, busy with universal labor, as Bernstein, Kautsky, Bebel formulated.

Bibler does not take into account that the domination of capital, which consisted in the arrangement of abstract content in labor, ends. If earlier the fragmentation of labor led both to a decrease in training costs and to an increase in labor productivity, today this fragmentation inhibits the development of productive forces (which is especially clearly seen in the case of the conveyor belt, strikes against the conveyor system in the late 60s and the emergence of non-conveyor systems with a greater labor productivity, say, in Japan, the kanban system, etc.).

Bibler does not see the process of growth of concrete content in the work of the worker, does not understand that capitalism, as technology develops, increasingly needs a worker with higher education.

Bibler, like Friedrich Schlegel, Andrei Bely or Ortega y Gasset in the demiurge of history, exposes a man of art, a creative, "competent" man. The logical conclusion of this substitution is such a substitution in the relation "class – party", when the party is declared primary, and the class is declared a secondary, obedient instrument in the hands of a reasonable party being [5, 6]. V.V. Orlov cites the point of view of VM Mezhuev, which coincides with the liberalism of Bibler - Glinchikova, that abstract work "by itself cannot generate new ideas that feed the scientific, technical and cultural progress of society" [4]. V.V. Orlov objects that "in relation to concrete labor, abstract labor acts as a powerful revolutionary force" [7]. Nevertheless, in Orlov's work, the abstractness of labor also does not leave the sphere of exchange, and in the class-party pair, saying that abstract labor is

capable of something *only* in combination with concrete labor, he implicitly puts the party as primary.

Lenin in What Is To Be Done follows the line of Bernstein-Kautsky. However, the mass of their articles ("The proletarian revolution and the renegade Kautsky", "The order from the SRT to local Soviet institutions", "The state and the revolution", "April Theses", etc.), the demand to learn from the workers, especially the repetition of Marx's formula "socialism as living creativity of the masses "sharply objects to this line.

The discourse ends with the fact that, say, Glinchikov, seemingly quite in the spirit of the dialectician Marx, who saw the resolution of the contradiction of the old political economy in the emergence of a new type of commodity - labor power, introduces a new type of labor power - creative labor power. And he defines it as such a labor force, "the production process and the reproduction process of which coincide" [8].

It would seem obvious that the growing need for labor in society, of course, not in every way, as the ideologists of the CPSU misunderstood Marx, speaking of the "need" for labor, means that labor becomes a "commodity", enters the consumer basket, serves to restore vitality, develops thinking, spirituality, etc. However, Glinchikova believes that it is this creative labor force that appeared in society by itself, and this is where the development is completed.

In fact, Glinchikova's definition is incorrect. The creative workforce needs food and is sold in the market. According to Glinchikova, the working class has only one destiny - to wither away. Glinchikova does not understand that the new labor force, before throwing off the commodity form, must mature in society from the old, and not free itself behind the back of the whole society, like a separate nobility.

But if abstract labor is so good that it will not go anywhere, how does one social system differ from another? Under communism, the concrete content is **dominant** in the work of the individual, while under capitalism it is abstract. That is, communism is the absence of not only the bourgeoisie, but also the working class, i.e. a class whose work is dominated by abstract content. V.V. Orlov, without deviating from the Marxian meaning of abstract labor, nevertheless, exclaims: "In the USSR, 50% of rough manual labor, what the hell is socialism."

Moreover, dominance does not at all mean temporary dominance. For example, in the work of a physicist or pianist, abstract work dominates in time. But its specific content is defining, subordinating.

So, Marx does not take into account that the products of labor as use values differ qualitatively, forming two classes.

Marx in the first volume of Capital notes: "A thing can be use-value and not be value. This happens when its usefulness for a person is not mediated by labor. These are: air, virgin lands, natural meadows, wild-growing forest, etc. A thing can be useful and be a product of human labor, but not a commodity.

Similarly, poems, scientific articles, palaces, malachite boxes, individual cars, experimental technical samples, architectural or space projects, secret military developments, etc. are produced by labor, but cannot be compared in the market due to their uniqueness, therefore, they do not have an exchange cost. And, just as natural resources or luxury goods, being drawn into the prevailing commodity-money relations, become commodities, unique products of labor, paintings, films, books, classical concerts, etc., acquire exchange value.

It is quite obvious that the division of goods into two classes corresponds to the division of labor into mental and physical, that is, the division of society into classes engaged in mental labor and physical labor.

Marx wrote Capital at a time when the class of engineers, scientists, and artists was still extremely small.

There is no division of hired workers into mental proletarians and workers, physical proletarians, in the Communist Manifesto: "Of all the classes that are now opposed to the bourgeoisie, only the proletariat is a truly revolutionary class. All other classes decline and are destroyed with the development of large-scale industry, while the proletariat is its own product"[9].

Although it is the workers who oppose capital, while creative labor is much freer, much less impersonal. There is no need for representatives of creative professions to eliminate the old social division of labor, on the other hand, the class of these representatives will not decline and will not be destroyed.

On the other hand, despite being drawn into private property relations, the difference between the two types of goods is radical: the value of a worker's product is estimated in hours of labor time, the value of a product of creative labor in hours of labor time cannot be measured.

"At the highest phase of communist society," writes Marx, "after the enslaving subordination of man to the division of labor has disappeared; when the opposition between mental and physical labor disappears along with this; when labor ceases to be only a means of life, but becomes itself the first need of life [10].

However, Marx does not associate the elimination of the contradiction between mental and physical labor with the form of exchange of labor products, on the other hand, Marx refers it only to the stage of communism.

From the idea that value is generated by abstract labor, which arises only in the process of market exchange, it follows that if the market and money are elim-

inated, abstract labor will disappear, and with it value. This is exactly what the Bolsheviks did.

In 1918, during the period of war communism, when money (kerenki) depreciated, Lenin wrote about the exchange of goods in kind. In 1919, Lenin asserted: "Nationalization of banks alone is not enough to combat this vestige of bourgeois robbery. The RCP will strive to destroy money as quickly as possible ... first of all, to replace them with savings books, checks, short-term tickets for the right to receive public goods, etc., the establishment of mandatory keeping money in banks, etc." [11]. That is, there is no call for the immediate cancellation of money, this process should be gradual - but mandatory. In 1920, Bukharin wrote in his book The Economy of the Transition Period: "In the transition period, in the process of the destruction of the commodity system as such, the process of "self-denial" of money takes place. It is expressed in the so-called "depreciation" of money. " [12] The decree of 15.7.1920 prohibited settlements in cash, checks and direct appropriations, instead of checks – "cash-less negotiable transfers". On 8.16.1920, the payment for the carriage of goods by rail was canceled, the Decree of the Council of People's Commissars of 12.23.1920 canceled the payment for fuel for state-owned enterprises and government agencies.

However, the economy immediately collapsed. From October 1917 to June 1921, the money supply increased 120 times, retail prices almost 8000 times. Compared with the pre-war 1913 prices increased by almost 81 thousand times [13]. Businesses stopped.

The proletariat, Lenin believed, ceases to be a proletariat (wage) if it takes ownership of the main means of production.

However, the working class, due to the old social division of labor, does not cease to be a working class in terms of the content of its labor, in which abstract labor dominates. In this, the worker differs from other strata of hired workers.

The abstract content of the worker's labor will inevitably return the hired character of labor after the legal assignment to the working class of ownership of the means of production. On the other hand, since the sphere of production defines the sphere of exchange, the abstract labor of the worker necessitates market relations. That is why commodity-money relations existed in the USSR. The product of labor throws off its commodity form only after overcoming the distinction between physical and mental labor.

Realizing Marx's mistake in practice, Lenin in 1921 introduced the New Economic Policy (NEP). This was not a temporary concession, as the ideologists of the Communist parties now represent. According to Lenin, the NEP was calculated for decades. Stalin began to wind down the NEP already in 1927 and in 1932

he eliminated the standard market relations, which led to a slowdown in the development of production, which manifested itself in a chronic significant lag in labor productivity in the USSR compared to developed countries.

Oppression by labor

To analyze the labor process, Hegel introduces two concepts of objectification and de-objectification.

Objectification is the embodiment in the product of labor of the image of this product in the head of the worker. Disobjectification is the reverse effect of the created product, the production process, on the worker's brain. If a worker, roughly speaking, has been producing the same identical nut for ten years in a row, a stereotype is formed in his mind, similar to this non-unique, that is, abstract nut. This is how an abstract "average", "identical" worker arises in the process of depersonalizing (in the words of Marx) labor.

Just as the abstract content of labor generates its abstractness in the sphere of exchange, it, by virtue of the social division of labor, determines another aspect of labor - its wage character.

Leo Tolstoy believed that the situation could be improved by engaging in self-improvement. After the shift. Stop eating meat, etc. The practice of yoga, American ideology with the thesis "change yourself", etc., profess the same in various forms.

Ilyenkov also quite idealistically believed that the problems existing in the USSR would be solved by the upbringing system [14]. Ilyenkov created a school of upbringing, in which he applied the dialectical-materialist method in a narrowly concrete way, one of his blind-deaf-mute pupils even became a doctor of sciences - but this is only a private, secondary direction.

In the life of a worker, the determining factor is not the sphere of education, but the time during the work shift. In the process of his work, neither philosophy nor political economy is required. Serrated, they will not leave a trace, fade from consciousness under the noise of a lathe. The only knowledge that will be useful to him is the knowledge of how to sell his labor force with the greatest profit. Even if formally the means of production are in the hands of the working class, it - due to the abstract content of labor - will entrust management (command, planning) to a narrow social stratum (capitalist or general director with a CPSU ticket in his pocket, and that, in turn, to the minister). Oppression, therefore, does not consist only in the fact that the worker receives less than he sees as just. Oppressive labor itself, which produces oppression in the form of subordination - as a result of the usurpation of control of a narrow social stratum. Consequently, the way out of the situation lies in something else.

"Influencing ... the external nature," writes Marx, "and changing it, he (man, B.I.) at the same time changes his own nature" [15].

This is - in contrast to the reduction of socially necessary working time to "vanishingly small amount"– **transformation of the most socially necessary time into creative work,** in which concrete content dominates. **The demand for this transformation should ripen at the general level,** and not only as strikes against the conveyor depersonalization, for example, in the United States in the late 60s or in Kuibyshev in the 70s. This process of the formation of science as a productive force is hindered by a new form of contradiction between labor and capital - the contradiction between the growth of the concrete content in labor (the complication of production in its elementary cell and the growth of the variety of economic ties) and the private form of management. This is as trivial as the fact that the solution to this contradiction is the expropriation of the functions of government from the ruling class.

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在國家替代能源生產項目中使用沼氣能源技術
THE USE OF BIOGAS ENERGY TECHNOLOGIES FOR NATIONAL PROJECTS IN PRODUCTION OF ALTERNATIVE ENERGY

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註解。今天，國家的經濟安全在於多樣化和充分利用三種力量："聰明"，"軟"和"強"，這三種力量當然應該涵蓋國民經濟所面臨的全部風險和挑戰。這意味著科學技術革命和碳經濟向更深加工替代原材料來源的軌道轉移，以及它們對未來無碳經濟的環境吸引力導致了社會新儲備的老化。完全自給自足-從能源到消耗和加工產品。我們認為，未來能源領域的高科技基礎之一可能是將傳統的和新的能源生產方法，尤其是作為生物能源主要成分的沼氣生產技術的疊加，適當地結合起來。生態安全地減少經濟以滿足特定人群的需求。

關鍵詞：無碳經濟，沼氣，環境安全，可再生能源。

Annotation. The economic security of the state today consists in diversification and the adequate use of three forces: "smart", "soft" and "strong", those certainly, should cover the entire range of risks and challenges facing national economies. This means that the scientific and technological revolution and the transfer of the carbon economy to the rails of deeper processing of alternative sources of raw materials and their environmental attractiveness for the carbon-free economy of the future leads to the aging of new reserves of society as all-sufficient and self-sufficient - from energy to consumption and processing products. In our opinion, one of the high-tech groundworks for the energy sector of the future could be an appropriate combination of superposition of traditional and new options for

energy production, in particular, the production of biogas, as the main element of bioenergy, capable of ecologically and safely reducing the economy to the needs of particular person.

Keywords: carbon-free economy, biogas, environmental safety, renewable energy sources.

Introduction

The global bioenergy industry lives in conditions of an active change in consumer preferences, the formation of demand for new materials, an increase in environmental standards and the development of a circular economy with the use of recycling, influencing the national development trends of the industry. Many countries are prioritizing the development of renewable energy as the basis for low-carbon economic growth. Eleven million people today are employed in the renewable energy industry around the world and an increasing number of countries are discovering the benefits of renewable energy. National support programs, coupled with cost reduction due to technological progress and the need to respond to the challenges of climate change, stimulated a sharp increase in renewable energy sources and the development of employment in the industry. RES contributes to the development of popular technologies not only in the field of sun and wind, but also in energy storage, the hydrogen cycle, electric transport and e-mobility, energy efficiency of buildings, in the field of "smart" technologies, which ultimately affects the improvement of people's quality of life. At the same time, having reached a serious scale, the development of renewable energy sources around the world also faces serious economic challenges for state budgets and consumers, restrictions on areas for renewable energy sources, issues of equipment disposal, and environmental consequences.

In this regard, the all-Russian competition "Reliable Partner – Ecology"[1] has become a good example and an important tool in Russia for uniting the industry business and the government in terms of identifying the most successful and effective environmental regional practices and projects for their further replication and scaling throughout the country, supported by: the Ministry of Energy of the Russian Federation, the Ministry of Natural Resources and Environment of the Russian Federation, the Ministry of Industry and Trade of the Russian Federation, the Ministry of Construction and Housing and Utilities of Russia, the Ministry of Education of the Russian Federation and the government of Moscow. [2]

Biogas as an alternative source of renewable energy

Biofuel is a source of energy produced from organic matter. Biogas is gasiform biofuel that obtains from anaerobic digestion. In terms of composition and quality, biogas by 50-87% is from methane, by 13-50% is from CO_2, there are minor

[1]http://council.gov.ru/events/multimedia/photo/91564/
[2]https://topecopro.ru/about/

impurities of H2 and H2S. Biomethane is obtained after cleaning biogas from CO2. Biomethane is a complete analogue of natural gas, the only difference is in its origin.[2]

Figure 1. *An example of biogas composition*

Since only methane supplies energy from biogas, it is advisable to refer to methane then the description of the gas quality, gas yield and the gas quantity with its standardized indicators.
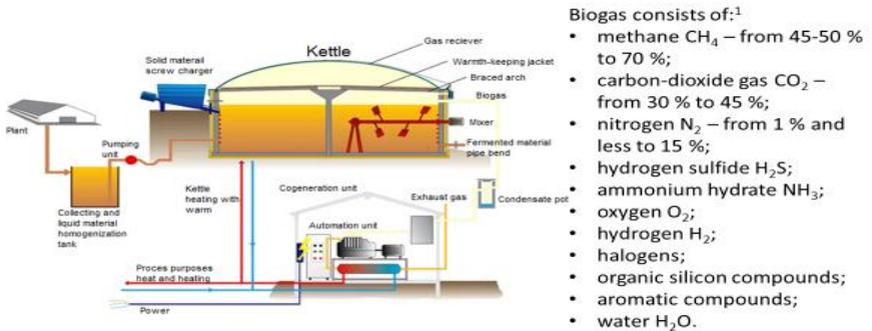
Figure 2. *Chemical composition of biogas and its production technology*

   Biogas composition can be installed as sewage treatment plant on farms, poultry factories, distilleries, sugar factories, meat processing plants.

Table 1. List of raw materials for biogas production by increasing productivity

Feedstock[3]	Biogas outlet m3/kg
Beer grain	0,039 -0,059
Distillery dregs	0,045-0,095
Poultry manure	0,046-0,093
Lactoserum	0,050
Cattle manure	0,070
Sewage water and faeces	0,070
Biological waste of sugar production	0,115
Solid domestic waste	0,180-0,200
Tree leaves	0,210-0,294
Silo	0,210-0,410
Waste of cattle slaughter	0,240-0,510
Grass	0,290-0,490
Winery sewage water	0,300-0,600
Vegetable waste	0,330-0,500
Grain	0,390-0,490
Cereals flower flake	0,432
Mark	0,640

Biogas can be produced, besides the waste described in Table 1 from specially grown energy crops such as silage corn or silphium, as well as algae. Gas output can reach up to 300 m³ from 1 ton of these raw materials.

There are differences between theoretical (physically possible) and technically realizable gas output. Today, the use of enzymes, boosters for the artificial degradation of raw materials (for example, ultrasonic or liquid cavitators) and other devices allows increasing the biogas productivity in the simplest plant from 60% to 95%.

Landfill gas is a type of biogas. It turns out in landfills from municipal waste.

Sustainable biogas production prevents methane emissions to the atmosphere. Methane has a greenhouse effect 21 times more potent than CO2 and has been in the atmosphere for 12 years. Methane capturing is the best short-term way to prevent global warming.

For these purposes, the use of alternative energy sources also applies the stoves for the utilization of industrial waste in domestic production technologies of Ker-

[3]http://www.biogaz-russia.ru/

alite[4], which are designed for disposal by the method of high-temperature combustion of industrial and agricultural waste, including those waste that have a harmful effect on the environment with traditional methods of disposal. The heat in the form of hot air generated in the process of utilization can be used for various technological needs, and slag (ash) formed from fuel combustion can be used in the production of building materials.
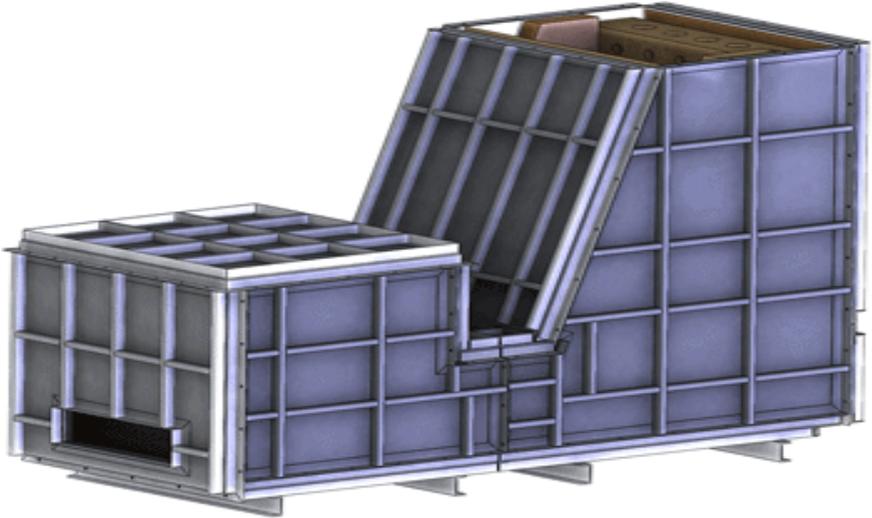
Figure 3. Dynamic design of waste utilization composition.

The production and energy use of biogas has a number of well-grounded and proven advantages in world practice, namely:

• Renewable energy source (RES). Renewable biomass is used for biogas production.

• A wide range of raw materials used for biogas production makes it possible to build biogas plants virtually everywhere in areas where agricultural production and technologically related industries are concentrated.

• The versatility of the methods of energy use of biogas, both for the production of electrical and /or heat energy at the place of its generation, and at any facility connected to the gas transmission network (in case of supplying purified biogas to this network), as well as the motor fuel for cars ...

• Stability of electricity production from biogas during the year allows to cover peak loads in the electric network, including case of using unstable renewable energy sources, for example, solar and wind power plants.

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[4]http://www.keralit.ru/products_solutions/other_units/furnaces-disposal-prom/

• Creation of jobs by forming a market chain from biomass suppliers to the personnel operating with energy facilities.

• Reducing the negative impact on the environment due to the recycling and disposal of waste through controlled digestion in biogas reactors. Biogas technologies are one of the main and most rational ways to neutralize organic waste. Biogas projects reduce greenhouse gas emissions into the atmosphere.

• The agrotechnical effect from the use of fermented mass in biogas reactors in agricultural fields is manifested in the improvement of the structure of soils, regeneration and increase of their fertility due to the introduction of nutrients of organic origin. The development of the market for organic fertilizers, including from the mass processed in biogas reactors, in the future will contribute to the development of the market for environmentally friendly agricultural products and increase its competitiveness.

Scheme 1. The cascade of technological solutions

• So it's a subject of producers' market:
  – The production capacity – **more produced – more to be present at the market – more in the transportation system**
    • Development of technology – **resulting development not only of production capacity but quality of the product - gas**
      – Control system of gas quality - it's purpose to simulate natural gas or to do better?
Simulate -> traditional
Better -> thermal units
or technological solutions (better for customer/environment/production process)?
      • Share of total gas volume in transportation system – **leads to the affect of counterbalance**
… - experience will tell

Table 2. Obvious advantages for storage and use of biogas

Suggestion is to take as nonconventional the gases:	These gases may be classified according to the storage periods:
- produced but not recovered from natural deposit: CO_2, hydrogen; **biogas**	- no expiration date
- recovered but not hydrocarbon gas: helium; CO_2	- long time storage (on demand)
- recovered hydrocarbon gases but not for gas transport system, which serves unified gas supply system: associated gas.	- storage for the purpose to compensate instability of consumption
	- traditional for UGS

International experience and prospects
for the use of biogas technologies as RES

Among the industrially developed countries, the leading place in the production and use of biogas in terms of relative indicators belongs to Denmark - biogas takes up to 18% of its total energy balance. In absolute terms, according the number of medium and large compositions, Germany takes the leading place - more than 8000 installations. In Western Europe, at least half of all poultry farms are heated with biogas.

Biogas buses are popularly used in Bern, Switzerland. Biogas is used as a fuel for the production of electricity, heat or steam, or as an automobile fuel. Volvo and Scania manufacture buses with biogas engines. Such buses are actively used in the cities of Switzerland: Bern, Basel, Geneva, Lucerne and Lausanne. In early 2009, the municipality of Oslo converted 80 city buses to biogas.[5]

In the developing countries of India, Vietnam, Nepal and others, small (single-family) biogas plants are being built. The gas produced in them is used for cooking. Such installations are becoming more and more popular in the world for households. Already, in step with the actual times, the "Home Biogas 2.0" units is actively moving forward.[6]

By the end of the 1990s, China had the largest number of small biogas plants - more than 10 million, which produced about 7 billion m³ of biogas per year, which provided fuel for about 60 million farmers. At the end of 2010, about 40 million biogas plants were already operating in China. According to some reports, more than 60 thousand people are employed in the biogas industry in China.

In Russia, the agricultural complex annually produces 773 million tons of waste, from which 66 billion m3 of biogas can be obtained, or about 110 billion kWh of electricity. The total Russian demand for biogas plants was estimated at 20 thousand enterprises. For 2020, at least every second agricultural and farm enterprise in the Russian Federation does not have its own biogas production station. Despite the complete absence of a shortage of natural gas, Russian agricultural enterprises could conduct a more rational economic policy of their expenditures, using full cycle technologies.

By 2022, two-thirds of the world's renewable energy growth will come from three countries - China, the United States and India.

The European Union is planning to increase the share of renewables in electricity generation to 60% by 2030. The potential of the biogas industry in Germany is estimated at 100 billion kWh of energy by 2030, which will account for about 10% of the country's energy consumption.[7]

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[5]http://blog.wired.com/cars/2009/01/oslos-buses-to.html

[6]https://www.homebiogas.com/Products/HomeBiogas2

[7]https://renen.ru/dolya-vie-v-vyrabotke-elektroenergii-v-es-dostignet-60-k-2030-godu/

Countries such as the Netherlands, France, Austria and Germany can be presented as an example of the most active use of biogas and hydrogen. The volume of uploaded biogas is more than 1.6 billion m3 / year, the capacity of hydrogen Power-2-Gas projects is more than 25 MW, the largest production volumes are located in Germany. The uploading of H2 into the natural gas network is still a topic of discussion for the global gas industry. [3]
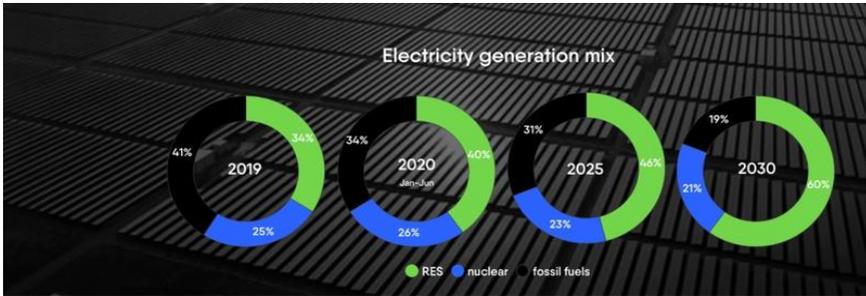
Figure 4. *Forecast of the share of RES growth in the EU by 2030*

The transformation of the energy industry, the change in technologies that surround consumers, require a fundamentally new approach to the creation and implementation of intelligent solutions in energy market activity. The introduction of new technologies can change the very nature of competition in the sales market with the arrival of financial service providers, digital service providers and social networks in this area. This will provide answers to important questions: what technologies in other markets can affect the activities of energy sales companies; what ecosystems can emerge around new technologies and platform solutions; whether banks, social networks, digital service providers or participants in other service markets will become future competitors or partners and co-investors; and what to invest in under conditions of uncertainty so that consumers can experience positive changes in 3-5 years.

Conclusion

Humanity is on the verge of a new technological cycle. The scale of change and the complexity of implementing solutions brought about by the new industrial revolution differs in complexity from all previous global transformations. Given the new realities, demand for electricity will continue to grow, especially among developing countries, while, according to the UN, one in five people worldwide does not have access to electricity. More than a billion people, mostly in rural areas, suffer from "energy hunger". The world community is observing the tendencies of the fourth industrial revolution, suffering from the consequences of the third. Modern countries are forced to find solutions to global energy challenges,

building their energy policies taking into account the rapidly changing technologies and global climate problems. They should determine the ability of scientific and technical potential in the modernization and digitalization of global energy systems, as well as the role of scientists in solving world energy problems. Thus, science can help achieve the UN Sustainable Development Goals in the field of energy in order to go through the necessary stages for a comprehensive digital transformation of the fuel and energy complex and so to obtain new technologies for the extraction, processing and storage of energy resources, while changing the philosophy of their consumption. Then there will be a high probability of the growth of digital technologies in energy and bioenergy and the emergence of breakthrough technologies that can sharply accelerate the development of "clean" energy. It is necessary to build a cheaper and more economically sustainable model of linking the volatility of energy markets and prices for raw materials, including the "shale revolution" of LNG and geoeconomic disputes between Russia, Europe and the United States, which could be overcome comprehensively through the cascade of technological solutions and targeted energy suppling of all potential buyers.[1]

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在兒童中心的暑假
SUMMER VACATION IN A CHILDREN'S CENTER

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抽象。本文討論了在北極教育體系中為兒童的教育和娛樂創造條件的問題。雅庫特地區的北極地區包括幾個地區，例如，阿萊霍夫斯基，阿納巴爾斯基，布倫斯基，下日科林斯基，烏斯季揚斯基，阿比斯基，日甘斯基，蒙斯基，埃文–別坦泰斯基等。現在，在薩哈共和國（雅庫特）北極地區的繼續教育體系的發展中發揮了重要作用，以均衡教育機會：從組織兒童暑期教育娛樂活動到建造現代學校。考慮到該地區的空間，氣候和文化特徵，該材料可用於科學研究領域的北極教育系統比較類型研究，旨在培養和諧發展和具有競爭性的人格。所提出的有關該主題的材料和理論發展對隨後研究北極教育過程的組織中生活條件核算的演變具有一定的價值。
關鍵字：北極兒童，教育，溝通，團隊，培訓，暑假。

Abstract. The article discusses the issues of creating conditions for the education and recreation of children in the educational system of the Arctic. The Arctic zone in the territory of Yakutia includes several regions, for example, Allaikhovsky, Anabarsky, Bulunsky, Nizhnekolymsky, Ust-Yansky, Abyisky, Zhigansky, Momsky, Even-Bytantaysky and others. Now an important role is given to the development of the system of continuous education in the Arctic zone of the Republic of Sakha (Yakutia), to equalize educational opportunities: from organizing summer educational recreation for children to the construction of modern schools. This material can be used in the field of scientific research for a comparative typological study of the Arctic education system, taking into account the spatial, climatic and cultural characteristics of the territory, and aimed at educating a harmoniously developed and competitive personality. The presented material and theoretical developments on the topic are of certain value for the subsequent study of the evolution of the accounting of living conditions in the organization of the educational process in the Arctic.

Keywords: Children of the Arctic, education, communication, team, training, summer vacation.

Introduction

The development of education and its quality are traditionally a priority for Yakutia, and within the framework of the implementation of the development strategy for the Arctic zone, much attention is paid to improving the efficiency of educational institutions in the Arctic and Northern regions. Due to the low population density, high-quality Internet communication is unavailable for the majority, the GSM coverage area is concentrated near settlements, while consumers are offered only voice communication, SMS and Internet using 2G technology. As a result, the state of "digital inequality" of the AZ of the RS(Ya) remains, and electronic services for mobile communications remain unavailable.

Municipal budgetary educational institutions have a wealth of experience in organizing school education and summer recreational work with students. One of the main tasks of any administration of a settlement is the organization of school education, summer recreation and employment of children. Organization of recreation and health improvement of students in the summer provides children with exciting leisure and communication with peers during the holidays. Several tasks are being solved here, such as the prevention of child neglect, the creation of conditions for the development of youth tourism, physical culture and sports, the formation of self-government skills in adolescents, the identification of leaders, and the rallying of student activists.

Main part

The organization of summer recreation for children in health camps at schools in the Arctic fulfills a very important mission: it teaches them how to live in a team, communication skills. The formation of a temporary children's team in the Arctic camp begins long before the onset of warm days. For teachers who work with children during the educational process at schools and summer recreation centers in the Arctic, instructional sessions and consultations are held in advance.

Of great value in organizing the formation of a children's collective are the works of A.S. Makarenko, S.T. Shatskiy and others. For our study, the definition of A.S. Makarenko stages of the collective development: the formation of the collective, the strengthening of the influence of the asset and the flourishing of the collective A collective is understood as an organizational group of people, an association of pupils with a common goal. And by the peculiarities of the temporary team, we assume the short duration of its functioning (from 21-25 days), the composition of different ages and the short cycle of completion of the formation. The authors emphasize the social significance of the team in the sense that the team should have a common socially significant goal, interpersonal relationships of mutual responsibility and mutual subordination, the implementation of various, joint activities and a common elected governing body [4]. A.S. Makarenko emphasizes two conditions - the ability to give instructions and control its implementation. In

this regard, I.P. Ivanov argues that the team should have a common concern for each other, and not rejection, but real deeds ... [3].

The work on the formation of a temporary children's team is also typical in the summer children's Arctic camp. The formation of a temporary children's team in the camp is celebrated for the first three days. At the same time, the following principles are adhered to: a clear rhythm of the day, a high rate of organization, continuity, short duration of activities, the employment of children from morning to night. Even before the summer holidays in the Arctic, the sun does not set, it is in a 24/7 state, and children can easily get confused when day and night falls. On the very first day, you need to start work on observing the regime moments: food, sleep according to the regimen, quiet hour, cleaning, etc. At the end of the day, organize a meeting around the fire in the form of a question-answer, in which the child introduces himself to the new team, and adults make up a clear distribution of responsibilities and choose the camp asset in each unit with the pupils.

The next day can be devoted to identifying the abilities of children and their unity. To do this, it is effective to carry out small joint creative affairs: arrange a detachment place, arrange a concert in which children sing their favorite songs, dance folk circular dances, can hold traditional games of the peoples of the North, organize sports and musical hours, etc. In the Arctic zone of the Sakha Republic (Yakutia), a large layer of cultural traditions of the indigenous peoples of the North is preserved. In places of compact residence, the Evenks, Evens, Yukagirs, Dolgans, Chukchi, Northern Yakuts, the Russian old-time population (Russkoye Ustye People and Pohodchane) are the descendants of the first Russian explorers, Cossacks and polar explorers [1].

On the third day, in a playful way, you can conduct a survey, which clarifies the interests, needs and intellectual and cultural level of children, determine their psychological stability, and also identify status roles and the degree of team cohesion through sociometry methods. Sociometry is a system of techniques that makes it possible to determine preference, indifference or rejection between individuals in the process of interpersonal communication and interaction.

As a result of the interview, it is revealed that the children's collective is ready to cooperate with adults, whether the members of the collective are more enthusiastic about the upcoming life activities and whether they feel an atmosphere of trust and goodwill between the counselors and the guys. As a result, sociometric research will show that team members manage to make friends in this short time.

Thus, the first stage of the formation of the team will take place, the guys in the detachment got to know each other, they feel good, comfortable, willingly perform the regime moments.

The initial period of formation of a temporary team will end when: the team members have satisfied their need to obtain information about the new team, about

comrades, about the teacher, about the camp; presented a long-term plan of general activities, the nature of moral requirements; the detachment developed an atmosphere of interest and readiness to participate in common affairs; the detachment for the child has become a significant environment.

In a given period, the teaching staff will provide for a flexible combination of existing attitudes, modes with the parallel inclusion of children in interesting, active forms of practice. The plan-grid of events for the season is usually hung out in a conspicuous place, since in the Arctic conditions, apart from visual stands, there is nothing special: the network is unavailable, if children have gadgets, they are only for viewing the time, you can also listen to your favorite music or play in it. In the grid plan of this season of the camp, the brightest mass holidays, events and activities using the methods of "immersion" and "infection", active individual and group work on the organization of self-government will be planned in the first three to four days.

During the main period of this season of the camp (from 4 to 22 days), children will be focused on freedom of choice of events. However, in the camp, an intensive educational process, planned activities in a temporary children's association can cause psychological stress in children. The activists and leaders of the camp can help the team to survive the above-mentioned critical period. To prevent dissatisfaction with the life of the camp, it will be advisable to include such forms of organizing the pedagogical process as: excursions, games, where there is more free personal time and impromptu - events where the bulk of the team members would be passive spectators or fans of the competition.

Work is carried out with children within the framework of the main activities of the camp, which combines the development and education of children with health-improving rest; the creative abilities of schoolchildren are developed; communication skills and tolerant attitudes towards others are formed in schoolchildren; they learned to make friends and cooperate between children of different ages and interests; and pedagogical recommendations for raising children were developed for parents.

Further life activities of the camp can be organized through the system of the "duty squad". The duty squad will include in the daily program a collective creative work in the theme of the day. The duty detachment performs the following functions: conducting sanitary raids and releasing "Lightning" with the results of the raid; assistance and help in holding general camp events of the day; report and analysis of the day lived. This form of organization of inter-unit life provides an additional accumulative system of achievements and rewards, supports collective creative deeds.

In the prime of the collective, one of the main methods of working with a temporary children's collective will be stimulation, and we note that the organization

of competition between units has great educational opportunities: competition creates strong emotional stimuli, ensures the attractiveness of activities; the competition reveals the unexpected abilities of children who, in a familiar environment, did not make themselves felt; competition develops a collective spirit.

In the last days of the camp season (3 days), you need to include such events as: "Day in reverse", "Day of bows", "What a delight these fairy tales", "Funny starts", "Miss and Mr. camp season", "Intuition", "Improvisation", "Minute of Glory", "Secret Friend", "Fabulous Relay Race", "Film Expert", etc.

The pedagogical aspect of organizing children's recreation and health improvement is due to the involvement of children in various types of activities: cultural - leisure, sports and recreation, research, play, labor, etc., a variety of socially significant roles and positions of participants in this activity, the novelty of connections and contacts, in which children enter, increased sociability, the collective nature of the activity. At the same time, the social experience that children learn and reproduce in interaction with peers and adults, in direct communication with them, in joint activities is of particular importance.

In the children's day camp, children are divided into teams. Every day, children enjoy playing Operation Comfort, which includes cleaning the territory and setting up the camp. Various events delight not only children, but also their parents, such as "Dad, Mom and I are a friendly family" - a drawing competition on the asphalt; remember the game "Zoological races", minutes of health "Your daily routine for the holidays", water procedures. At the Pole of Cold Oymyakon and in summer there is little sun, there is no swimming or sunbathing here as in warm regions, but children do not get bored. Every day, teachers conduct all kinds of musical games, contests, and quizzes. Excursion "School ecological trail", quiz "Do you know your native land?", Drawing lesson "My native land", minutes of health "Travel to the country of Vitamins" children do not leave indifferent. Conducting competitions for camp championship in various sports (by age group), drawing competition on the asphalt "No war!", Excursion to the library "How to use the catalog correctly", competition of crafts from various materials "Skillful hands" harmoniously combine spiritual and aesthetic, cognitive moments, and children master this in the most direct, natural way.

For the recreation of children in the rural camp, special conditions are created, such as a playground, which has a large number of different games, school supplies, sets for applications and embroidery, sports equipment; this site is divided into several zones: a zone for educational games, a zone for drawing, modeling, embroidery, designing, which allows children to express themselves from different sides; in a specially equipped office there is a gaming computer class; there is also a cinema hall where you can watch your favorite cartoons and full-length films; meetings, discos and competitions, karaoke are held in the assembly hall;

there is a reading room in one of the classrooms at the school. Considering the main task of upbringing is the socialization of students, in the summer the school seeks to organize a wide field of activity for students. It is necessary that life in the camp be eventful, full of events and meetings. It is necessary to use the opportunities for interesting and useful communication between children and adults and among themselves.

Conclusion

Thus, the collective as a specially organized association of students is not formed immediately. Not a single association of people initially shows the essential features that characterize the collective. The process of forming a team is lengthy and goes through a number of stages. At each stage of the formation of a temporary children's team, various methods and forms of work should be used, taking into account the place of residence of the pupils.

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教學中的本地知識原則
LOCAL LORE PRINCIPLE IN TEACHING AND EDUCATION

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抽象。 對教學文學的研究強調了與地方歷史活動有關的問題，表明學校的地方歷史具有自己的歷史，發展階段。 從文學的角度研究這個問題，我們旨在以某種方式系統化地方歷史的問題，其在教學理論和實踐中的應用參數。 這將使我們能夠進一步確定研究在學校當地歷史中的地位。 在研究此問題的同時，我們並非旨在分析該問題的所有研究人員的作品。 讓我們嘗試展示其中最典型的一個，以突出教學文獻中學校地方歷史問題的研究方向。
關鍵字：當地歷史，教育，學校，集體，培訓。

Abstract. *The study of pedagogical literature, which highlights the issue related to local history activities, shows that school local history has its own history, stages of its development. Investigating this issue from literary sources, we aim to somehow systematize the problems of local history, the parameters of its use in pedagogical theory and practice. This will allow us to further determine the place of our research in school local history. Studying this issue, at the same time we are not aiming to analyze the works of all researchers of the problem. Let's try to show the most typical of them in order to highlight the directions in which the issue of school local history is considered in pedagogical literature.*

Keywords: *Local history, education, school, collective, training.*

Introduction

The history of school local history is of considerable scientific interest. Its origins go back to those times when the collapse of feudalism in Western Europe, which was replaced by a new system, was reflected in the development of pedagogical thought. During this period, there was a search for new ways of developing the school and overcoming medieval scholasticism that prevailed in teaching and education. A reflection of these searches was the idea of using a "local element" in teaching, first proposed by the Czech scientist Ya.A. Komensky. It received further development in the pedagogical heritage of J.-J. Russo I.G. Pestalozzi. And

it later found concrete embodiment in German and Swiss schools in the form of a special subject - homeland studies.

Main part

M.V. Lomonosov is deservedly considered to be the ancestor of Russian regional studies, who for the first time tried to obtain information about Russia with the assistance of local people [12]. In the statements of N.I. Novikov, V.G. Belinsky, the attention of teachers was drawn to the need to acquaint children, starting from elementary grades, with the surrounding life, the work of people, and nature. VG Belinsky was depressed that in school education we all look "somewhere into the distance and do not see what is going on under our noses" [2].

The pedagogical expediency of local history in Russia is theoretically substantiated by K.D. Ushinsky. In " Native Word", he assigned a significant place to the "local element", evaluating it as one of the important means of visibility and connection with the surrounding life. He believed that the implementation of the principle of nationality in pedagogy obliges the teacher to turn in the learning process, first of all, to "concrete surrounding material." K.D. Ushinsky has developed a system of familiarizing students with the neighborhood of the school, the street, agricultural labor. His idea is interesting, which has not lost its significance today about the creation of "local manuals" for schools and the involvement of teachers to write such manuals. Leo Tolstoy emphasized the idea of acquainting students with the climate, flora, fauna and economic life of his district. N.H. Wessel argued that the environment gives the teacher "natural, irreplaceable" material for the all-round development of children's abilities.

In the second half of the XIX century, a special trend emerged in Russian pedagogy - "homeland studies". "Homeland scholars" believed that the curriculum for primary and secondary schools should include elements of local geography, history, natural history on the scale of the neighborhood of a school, village, volost, county, and some authors expanded the circle of homeland studies to the scale of the province. Since 1914, the term "local history" has been included in pedagogical circulation. For the first time it was applied by the historian-methodologist V.Ya. Ulanov and the Siberian teacher-geographer I.N. Mankov. Schools began to create museums based on local material. Began to be included in the excursion training system. G. I. Ivanov, E. A. Zvyagintsev, V. E. Gluzdovsky made a valuable contribution to pedagogy on homeland studies. So, E.A. Zvyagintsev put forward the idea of "localization" in pedagogy, the essence of which was that in each academic subject it is necessary to find a place for local material and ensure its knowledge by students.

From scattered ideas, advanced practices of teachers and schools, the system of Soviet school local history is developing, the emergence and development of

which proceeded simultaneously and in conjunction with public local history and pedagogy in the early twenties of the XX century. As the ties of local history with science and life were strengthened, its main goals, tasks and organizational forms were clearly defined. Prominent figures of the People's Commissariat for Education and scientists-teachers A.V. Lunacharsky, N.K. Krupskaya, F.N. Petrov, A.P. Pinkovich. In those years, local history developed in three directions: public, museum and school.

In the pedagogy of the twentieth century, local history has received full recognition as a means of connecting school with life. A.V. Lunacharsky emphasized: "I imagine that a school that has joined the economy of a given area, its historical conditions, its ethnography, is important as a truly living labor school." N.K. Krupskaya also maintained the connection between the school and local history and wrote about this: "A school that will be cut off from life, which will not help children study the life around them, will not be suitable for anywhere… The entire Soviet way of life requires that the school teach the younger generation study life and transform it." She believed that the teacher "should be essentially a local historian."

Despite the fact that in the twenties of the last century "the development of the basic principles of local history as a science" began and later on a certain amount of work was done by local historians, local history continued to be the occupation of enthusiasts. The term "Ushinsky's method" has not taken root in pedagogical theory and practice. Local history was called the method of pedagogical, local history, educational and disciplinary and teaching method. So, A.M. Bolshakov understands local history as a research method, with the help of which students, on the basis of knowledge, study labor activity and construction of the local region and practically participate in it.

In the "Pedagogical Encyclopedia" local history is considered as a principle. It describes the application of the "local history principle" in teaching social science "as a condition for the vital construction of the socially useful work of the school", the basis of which is "the study of the features of the region, which provides material for setting certain tasks for the practical change and improvement of one side or another in a given area" [14]. This understanding of the "local history principle" is based on the idea of combining education with socially useful work and corresponds to the main task of local history - to combine "local history with local construction." B.P. Esipov [14] points out that the principle of local history is combined with the principle of internationalism, since local history "stretches the threads" and reveals to students the connection between the life of the workers of this region with the workers of our country and other countries.

Thus, in the 1920-30s, there was no single definition, a single concept of the local history method in pedagogy. In April 1947, an expanded meeting of the

board of the People's Commissariat for Education was held, dedicated to the experience of studying the local area in schools. S.Barkov, N.P. Kuzin, A.F. Rodin, A.E. Stavrovsky and others joined the methodological work on school local history. In the 60s, the Academy of Pedagogical Sciences published a number of collections, which highlighted the advanced experience of teachers in local history. Articles about the pedagogical value of tourism and local history have appeared. A.A. Sveshnikov, I. N. Pilat and other authors revealed the goals and objectives, content and methods of working with young local historians and tourists. APS RSFSR published the collection "Local History and Tourism in Extracurricular Activities" (M., 1962). The book shows the role of tourism and local history work in the implementation of the connection between school and life, reveals an important side of the educational impact of local history and tourism on students. Its problems are most fully covered in the studies of I.I. Beskorovainy, P.V. Ivanova, V.G. Lipinaka, I.T. Prus and N.V. Rubanova.

A deep substantiation of the principle of local history as a general didactic rule is given in the monograph by P.V. Ivanov. The author is resolutely opposed to considering the principle of local history only as a special case of the general didactic rule "from close to far", from "known to unknown". He motivates this by the fact that geographically close, local is not always accessible and understandable; only in the light of the general, studied in the teaching process, it becomes clear, accessible. Based on the theoretical and practical experience of the school, P.V. Ivanov understands the use of materials about the nature, economy, culture, history of the region in the educational process, revealing their significance and role in the life of the region, the whole country. In the definition of V.P. Ivanov reveals the essence and necessity of the principle of local history in teaching.

The works of A.S. Potresov, M.I. Kraiman and A.A. Ostapts-Sveshnikov should be especially highlighted. In them, the fusion of tourist and local history activities of students has found its methodological embodiment. Scientists pedagogues have found that school local history contributes to the development of students' curiosity, cognitive interests, gathering activity, that it helps teachers to activate the educational process, use possible meta-subject connections, and create problem situations in the classroom. They indicate that the study of local history was of a systemic nature and was not represented by a set of various disparate information reported in the lessons and extracurricular "events" that are not related to each other, do not have a unifying scientifically and pedagogically grounded goal. The circle and content of local history knowledge, topics and forms should be determined by the teacher, taking into account the age characteristics of students and accessibility from the pedagogical and local practical sides. Participation in expeditions and trips to explore their native land, collecting materials for school museums should enrich students with new knowledge so that they learn

more about the surrounding life, master the necessary skills of work and organization of life.

School local history is an important area of school work in terms of education and personality formation of students. The problem of using local history material as a means of education is considered in the studies of D.V. Katsyuba, A.V. Stavrovsky, M.D. Yanko. Various forms of local history activity of schoolchildren are reflected in the works of A.A. Berga, I. Izosimova, R.S. Itkina, V.A. Kotova, V.A. Malakhovsky, N.I. Romas.

Published articles and research materials of recent years touch upon such aspects as the formation of cognitive interests, cognitive activity and creative activity in the process of local history (G.A. Grishina, V.V.Dranishnikov), the use of local history information on Russian literature in the educational process and extracurricular activities (T.F. Posadskova), a number of works summarize the experience of schools in the military-patriotic education of students (F.I.Gogova, R.P. Denisov, M.G. Zairova). Some works consider activities in summer sports camps, sea and river flotillas, clubs of cosmonauts and rocket scientists, detachments of red pathfinders (I. Georgadze, N. Demidov, S. Ya. Zaitsova, Ya.I. Idelchik, etc.).

The experience of the school, especially in recent years, proves the need to use local history in teaching and educating students. We do not share those points of view that recognize local history only as a general didactic principle. As can be seen from the analysis of pedagogical literature, school local history was considered by researchers not only in didactic, but also in general pedagogical terms. Already in the 20s, the theorists of school local history A.I. Dzens-Litovskiy, A.M. Bolshakov understood it as a means of teaching and educating schoolchildren. In recent years, Academician A.S. Barkov has provided substantiation of local history as a general pedagogical principle. Scientific research in recent years considers school local history as an important means of moral and patriotic education of students.

Under the principle of local history in education and upbringing, many researchers understand the reliance on the available local history information, the skills and abilities of students, their systematic expansion in the process of educational work in order to foster social activity, initiative and independence of schoolchildren. In this regard, scientific and practical value, in our opinion, are works that consider certain aspects of the use of local history material for the formation of personality. Among the works devoted to the use of the national fine arts in the educational work of the school, we should note the candidate dissertations of A.S. Meliksetyan "Aesthetic education in secondary school by means of decorative applied arts (mosaic)", R. Khasanov "Folk decorative applied arts of Uzbekistan as a means of aesthetic education of primary school children" and E.Kh. Muradova "Kyrgyz fine art as a means of aesthetic education of students", in which national

art is considered as a factor in the education of aesthetic taste, the development of creative abilities of children. So, E.H. Muradova in her research, giving a large place to the decorative arts of the Kyrgyz people, focuses on the organization and methods of conducting classes in applied arts. EI Balcytis in his Ph.D. thesis "Questions of the development of music perception among schoolchildren (based on the material of Soviet musical compositions)" emphasizes the need for systematic familiarization of students with the national characteristics of the music of their people. In the method of selecting works for listening, he attaches great importance to their content, which contributes to the formation of a certain worldview in schoolchildren. V. Harutyunyan's dissertation "Ideas of education in Armenian folk tales" examines the educational possibilities of folklore, indicates that the pedagogical ideas reflected in folk art are the richest material for the education of patriotism in children.

It should be noted that school local history is often artificially divided into literary, historical, geographic, etc., which leads to the loss of schoolchildren's holistic understanding of the cultural and historical originality of the region. So, in a number of schools, historical local history, as a rule, is divorced from the study of the nature of the native land, its art, literature. This approach destroys the continuity in the cultural environment that has developed over many centuries, in which the present and the past are intertwined in the most complex way. And a person who grew up outside the cultural environment does not fully possess a sense of pride in the history of his homeland, does not have respect for the traditions, peculiarities of the region, its best people. In this regard, the tendency that has emerged in a number of schools to solve problems of local history comprehensively, on the basis of metasubject connections and the unity of teaching and upbringing, deserves approval.

We adhere to the point of view that considers local history as a general didactic means of teaching and upbringing, although we admit that local history can be both a form of organizing the educational process, and one of the provisions that reveal the content of the principle of the connection between education and upbringing with life.

Conclusion

Local history activity at school gives an effect when it is carried out constantly, in an integral system. Its integrity presupposes, along with the collection, study of the history, nature, and culture of the region, an expedient selection of the content, forms and methods of introducing schoolchildren to the traditions of their people, taking into account their level of development, individual and age characteristics, needs and interests.

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雅庫特民族歌曲中的轉型過程
TRANSFORMATIONAL PROCESSES IN THE YAKUT FOLK SONG

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抽象。雅庫特傳統歌曲創作一直保持其古老特色，直到十八世紀。自十八世紀以來，雅庫特北部人民的音樂文化相互影響的過程已發生了變化：Evens，Evenks，Yukagirs。因此，雅庫特民歌得以豐富。同時，雅庫特（Yakut）歌曲傳統中形成了區域風格。在二十世紀，在俄羅斯歌曲的影響下，雅庫特民歌開始掌握歐洲的音樂基礎：音調系統，寬廣的語調轉向。二十世紀末，由樂團演奏者和雅庫特流行音樂創作的歌曲開始影響薩哈人的歌曲文化。此時，雅庫特民歌的許多現象消失了。在二十一世紀，雅庫特（Yakut）歌曲創作的全球化進程受到大眾媒體和青年亞文化的負面影響。雅庫特族裔的歌唱有不可逆轉的變化，雅庫特族民歌的整個層次都消失了。這種消極的過程導致了歌曲傳統的崩潰。因此，保存薩哈人的某些民間音樂遺物的問題尤為嚴重。

關鍵字：歌曲，流派，音色，相互影響，文體學，傳統樂曲，循環舞，專業集體歌曲，創新，轉型過程

***Abstract.** Yakut traditional songwriting retained its archaic features until the XVIII century. Since the XVIII century, changes have taken place in it associated with the processes of mutual influence of the musical cultures of the peoples of the North of Yakutia: Evens, Evenks, Yukagirs. Thanks to this, the enrichment of the Yakut folk song takes place. At the same time, regional styles were formed in the Yakut song tradition. In the XX century, under the influence of Russian song, the Yakut folk song begins to master European musical foundations: a tonal system, wide intonation turns. At the end of the XX century, songs created by melodists and Yakut pop music began to influence the song culture of the Sakha people. At this time, many phenomena of the Yakut folk song disappear. In the XXI century, the period of globalization processes on Yakut songwriting is negatively influenced by the mass media and the youth subculture. There are irreversible changes in*

the ethnic singing of the Yakuts, whole layers of Yakut folk songs disappear. Such negative processes lead to the breakdown of song traditions. Therefore, the issue of preserving certain relics of folk music of the Sakha people is especially acute.

Keywords: song, genre, timbre, mutual influence, stylistics, traditional tunes, circular dance, professional mass song, innovation, transformation processes

Introduction

Yakut musical folklore in the second half of the XX and early XXI centuries, under the influence of objective and subjective reasons, changes and departs from the archaic of performing traditions. To a greater extent, this process affected the melodies of *degeren yrya*, to a lesser extent - *dyeretiy yrya*. If in the XIX and early XX centuries the enrichment of the folklore musical cultures of the peoples of Yakutia was associated with the process of mutual influence, then in the 20th-XXI centuries, innovations in the traditional musical creativity of the Sakha people have different foundations.

The novelty of the topic. The nature and formulation of problems determines the novelty of the presented work. For the first time in ethnomusicology, the issues of traditions and transformations in the song folklore of the Yakuts are considered.

Methodology. The methodological basis of the research was formed by the musicological works of E.E. Alekseeva "Problems of harmony formation. Based on the material of the Yakut folk song" [1], M.N. Zhirkov "Yakut folk music" [4], M.Ya. Zhornitskaya "Folk dances of Yakutia" [5], A.A. Kuzmina "To the problem of transformation processes in the genre of olonkho: aspects of pragmatics and po-etics" [8]. The works of A.S. Larionova "Beatboxing as an innovative element in the epic singing of the Yakuts" [9], "The interaction of the cultures of the peoples of Yakutia (on the example of ritual music)" [10] and "Traditions and innovations in the ethnic singing of the Yakuts" [11].

Methods. The basis for the development of the topic is the comparative study and the comparative method. A comparative-historical approach was necessary when comparing recordings of folklore material that differed in time.

The aim of the work is to study the traditional archaic Yakut tunes and transformation processes in the Yakut folk song.

Influence on the Yakut song tradition of the tunes of the northern peoples of Yakutia

Oral musical and poetic creativity of the Sakha people is a unique phenomenon of world culture. The Yakut folk song is a genre of oral and poetic creativity of the Sakha people, in which specific types of intonation are inherent in tunes of ancient origin. The regional specificity of the performance of Yakut songs is distinguished by the stylistic diversity, which is characterized only by their inherent features in the use of certain expressive means of the musical language. Up to the XVIII cen-

tury, Yakut folklore songs retained their archaic features. In the XVIII and early XX centuries, a departure from the archaic began and in the song culture of the Yakuts there was an enrichment of folk tunes, which was associated with the mutual influence of the musical cultures of the northern peoples inhabiting Yakutia. According to A.F. Middendorf, already in the XIX century among the Yakuts, the acceleration of the ritual circular song-dance *osuokhai* towards the end of the performance was influenced by the dance music of northern ethnic groups. The same process of mutual influence is also indicated by G.A. Grigoryan. He writes: "The metro-rhythmic unit in Even music is specific and in this sense is more related to the second group of Yakut songs -"Degeren yrya""[2, p. 77]. In general, the influence of the musical culture of the Evens, Evenks, Yukagirs can be found in many ritual and non-ritual genres of the song culture of the Sakha people.

The variety of genres of the Yakut song culture is associated both with the regional performing tradition and with expressive means, which are a criterion for distinguishing one or another genre. Expressive means associated with timbre are especially important in various traditional song styles and genres of the Yakuts. Their performance is associated with special techniques of using original specific methods of singing, which differ from singing in an ordinary voice. The specific ways of singing, apparently, were introduced into Yakut music under the influence of the culture of the autochthonous ethnic groups of Yakutia, since in them, as in the Even traditional song genre *nirgen* or in the *Seedye* dance, an important role is played by the methods of singing with inhalation and exhalation, which convey the ferocious sound of a deer.

Among many peoples of Yakutia, ritual circular songs and dances have become widespread. They are associated with sun worship and were performed during ceremonial celebrations. For the Evens it is – *seedye*, for the Evenks it is – *leho, gesunge, osoray, deveide*, for the Yukaghirs it is – *londol*. M. Ya. Writes about the mutual influence of the Even *seedye* and the Yakut *osuokhai*. Zhornitskaya: "Yakut influence is noticeable in the performance of this version of the Even dance. Perhaps the singing part of the dance was borrowed from the Yakuts"[5, p. 81]. The dances of the peoples of the North are similar in structure, with the obligatory invitation to dance at a slow or moderate pace and its acceleration towards the end. In the dances of different ethnic groups of Yakutia, consonant nonsensical words are also found: the Evenk *kolie* resembles the Yakut *kali*, and among the Olekmin Evenks the exclamation *ogokai* is akin to the Yakut term for a song-dance.

Each region of Yakutia and even naslegi up to the 50s-60s of the XX century had their own performing characteristics of various song styles and genres of folklore. In the Vilyui tradition of performing *osuokhay*, a 3-part form is characteristic. Thus, the 2nd version of the *osuokhay* "Tyhulge toyuga" ("Festive chant") by S.A. Zverev-Kyyl Uola under № 12 in M.N. Zhirkov during the Vilyui expedition of

1943 consists of 3 parts: 1 part - "Koulahyran toyuk (ohuokhai)" ("Voice chant (circular song-dance osuokhai)") at a slow pace, 2 part - "Ayana" ("Run slowly trot") at a moderate pace, part 3"Kyotyuute"("Flight") at a quick moderate pace [3, L. 4]. At the same time, the Olekminsky *osuokhay*, like the Prilensky, do not have a slow entry.

Other song genres had similar regional traditions. So, for the folk songs of the Olekminsky ulus, the most indicative is the predominance of other stylistic dialects, unusual for Yakut folk songs, a three-beat meter based on iambic structures, for example, the popular song "Kyylaakh aryy" ("Island Kyllah") [7, p. 41]. While in other stylistic traditions the basis of the songs is a two-beat meter with a choreic rhythm. Similar to the version of Olekmin's melody "Kyllaakh ary" ("Kyllaakh Island"), the song of this regional style of performance "Uchuutalga" ("Teacher") sounds to the words of S. Ellai [ibid., 38]. The melodies and metro rhythms of these tunes have a similar structure. In the same three-beat meter, the song "Yhyy yryata" ("Sowing song") is presented [ibid.]. Intonationally, all three songs of the Olekmin style of performance are close to one of the tunes of the Evenk dance № 45, performed by L. Tournin, in the musical transcript of S.A. Kondratyev [6, p. 45]. Apparently, the songs of the Olekmin tradition of singing songs were influenced by the traditional music of the Evenks, who have lived in this region together with the Yakuts for many years.

In general, the folklore genres of the peoples of Yakutia have many common elements, which speaks in favor of the fact that due to the mutual influence of cultures, the process of enrichment of the cultures of one or another ethnic group took place. Such processes did not negatively affect the development of Yakut traditional songwriting. They, most likely, led to the formation of the characteristics of regional and traditional performing traditions.

Innovations in the Yakut traditional songwriting in the XX century

In the XX century, there are innovative changes in the development of Yakut songwriting. Already in the middle of the XX century M.N. Zhirkov noted that "the Yakut youth sang then (ie in the 20-30s of the XX century - *L.A.*) the verses of local poets on distorted, half-Russian, half-Yakut melodies which completely displaced folk songs from circulation"[Zhirkov, 1981, 23]. The processes of innovation are reflected in the formation of new genres and, especially, in the emergence of the newest means of musical expression. The development of the song culture of the Sakha people at the end of the XIX and the first half of the XX centuries is associated with the expansion of its scale, the complication of the modal organization and the enrichment of the metro rhythm under the influence of songs sung by the visiting Russian population, which led to the creation of melodist songs, and through them to the formation of the Yakut mass songs. M.N. Zhirkov discovered a large number of Yakut folk songs that are basically close

to Russian songs and even the Marseillaise. So, during the creation of a socialist state in Russia in the 20-30s of the XX century, "all the familiar poems of Yakut poets were performed by the youth based on the motives of "Korobushka", "Khas bulat daring","Partizanskaya", "Marseillaise", "Bravely, comrades in leg", "Drank tea, samovar", "Mother accompanied me", "Blacksmiths", ditties" [4, p. 24]. In the Yakut environment, revolutionary and Yakut Soviet mass songs are created, which enriched the ladomelodic and metro-rhythmic spheres.

A reworking of the peculiarities of Russian and Yakut songs is also revealed by E.E. Alekseev in the song "Bieste ester bintiepkem" ("Five-shot rifle"), popular in the 20-30s of the XX century, to the words of Kyun Dyiribine. This song combined the familiar tunes of the Osuokai with the clear, catchy line of a daring ditty. E.E. Alekseev writes: "Few people in Yakutia do not know this sweeping battle melody, and its Russian folk dance roots are not a secret for anyone. Brightly diatonic turns of this melody became widespread, wandering from one mass Yakut song to another. Therefore, the borrowing was organic" [1, p. 256].

The genre of ditties is especially vividly reflected in the work of the famous Yakut melodist of the middle and second half of the XX century Kh.T. Maximova. So, the Song "About the native village of Tabalah", recorded from D.G. Sleptsov (born in 1935) from the Verkhoyansk ulus under № 13.87 from the collection of the complex expedition to Yakutia IYALI YANTS SB AS USSR, OIIFiF SB AS USSR and FC SK USSR 1986-1987[1] is intonationally close to songs of H.T. Maximov. The Verkhoyansk melody is clearly rhythmic, has a periodic structure, and a flexible tempo with a slowing down of the tempo in the last measure of the song. The structure of the melody is based on the verse form of 8 verses. Each verse is represented by a period of 10 bars of 2 sentences. The expansion of the sentence is associated with the threefold repetition of the last word. The song is based on a variable meter, where two parts prevail, alternating with three parts when the last word of each verse is repeated. In rhythm, the rhythmic structure of summation is predominant: two sixteenths and one eighth. This rhythm has an obligatory accent and emphasis on the first sound of this rhythmic group, which gives the melody a special character and element of singing "with bounces". The three-bearing scale of the song c^1-d^1-e^1 is presented in volume b.3. The intonation model of the melody constitutes a motive that is constantly repeated throughout the song. In the cadence sections, the lower reference tone c^1: is fixed: in the first sentence with a quarter duration, and in the second - half. The initial of each verse is characterized by intonation mobility. The Verkhoyansk melody is closest to the song of Kh.T. Maksimova "Yoryune" ("Irina") [12, p. 21-22]. They are almost identical, especially in the first measure of the song.

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[1]The recording of the song is kept in the Audiovisual Archive of the Department of Folklore and Literature of the Institute for Humanitarian Research and Problems of Indigenous Peoples of the North of the Siberian Branch of the Russian Academy of Sciences.

The gradual professionalization of song genres in Yakutia in the XX century can be conditionally divided into two periods. The first period, which begins in the 20s of the last century, marks the emergence of songs that are intonationally close to Russian folk and revolutionary songs, but retaining the Yakut basis of *yrya* tunes. The Yakut Soviet mass song also begins to form. The second period begins from the second half of the XX century, when the Yakut mass song was formed. At the same time, songs of melodists, pop music and pop music begin to exert a great influence on the Yakut songwriting. Especially these innovations affected the adoption of new intonational modifications in the tunes of the Sakha people. At the end of the XX century, the impact of pop and pop music on the Yakut folk song opened up wide opportunities for influencing the Yakut singing of modern musical processes, which, in turn, contributed to the mixing of genres and styles, blurring the boundaries between them.

Transformational processes in the traditional song of the sakha people in the late XX – early XXI centuries

According to A.A. Kuzmina: "The XX century was marked for Yakut folklore, including olonkho, by the era of changes and transformations caused by profound socio-cultural changes in the life of the Yakuts" [8, p. 135]. Such changes are associated with the process of globalization, which is taking shape especially harshly in Russia at the beginning of the XIX century. Transformational processes also take place in the Yakut songwriting at the beginning of the XIX century, which from that time, under the influence of objective and subjective reasons, often begins to undergo irreversible changes. By the end of the XX century, in an era of social changes, the musical folklore of the Sakha people begins to acquire new properties uncharacteristic for their tradition, and with each round of their development these new properties begin to persist and acquire forms that are already destroying these traditions.

The disappearance of whole layers of song culture is gradually observed. For example, there are no longer such genres as *menerik yryata* (menerik song), *khabar5a yryata* (throat song), *hongsuo yryata* (nasal song), *enelegen yryata* (groan song), *kyo5yutyuyu yryata* ('back songs' that dull the pain), others. In addition to genres, stylistic features of Yakut singing disappear, such as the Olekminsky, central (Prilensky) singing styles. The central (Prilensk) *degeren yrya* gradually disappeared. Only the Vilyui style of singing is preserved everywhere. *Degeren yrya* of the Vilyui style of performance is characterized by the use of *kylysakh* in this type of singing, while *kylysakh* - is a distinctive feature of *dyeretiy yrya* chants. Song №1 from the materials of the Vilyui expedition of M.N. Zhirkova 1943[2] contains grace notes, reflecting kylysakh, practically in every step [3, L.

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[2]The name of the song by M.N. Zhirkov is not recorded.

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11]. The predominance of the Vilyuy performing tradition in Yakutia is associated with the active promotion of this style of singing in the media, as well as the activities of the Vilyuy folklore carriers, who promoted, taught and continue to teach their singing style to representatives of the ulus belonging to other stylistic groups.

Now, due to the expansion of communication opportunities, Western mass culture has a huge impact on the Yakut folk song. There is a breakdown of the traditions of Yakut performance. Onomatopoeic moments and specific overtones are exploited by young performers, which is associated with the influence of hip-hop culture. Various newest modern performing techniques of beatbox culture and rapper music emerged. Thus, already in the XIX, due to the globalization processes and the aggressive influence of mass culture, the traditions of Yakut folklore singing are being lost.

Conclusion

So, the historical process of transformation took place in 3 major periods. The first period is associated with the processes of influence on the Yakut song of folk tunes of the Evens, Evenks and Yukagirs. Thanks to this, the process of mutual enrichment of musical cultures took place. The second period is associated with innovative changes that took place under the influence of Russian, and through it European musical culture. At the beginning of the XX century, the formation and formation of the Yakut Soviet mass song took place, in which the modal-intonation structure of the Yakut folk song also changed. The third period (late XX - early XXI centuries) under the influence of globalization processes is the transformation of Yakut ethnic singing. The layers of styles and genres of Yakut folk singing are disappearing. She is overwhelmed by the mass and youth subculture. With such a massive disappearance of the phenomena of the Yakut traditional musical culture, which occurs in the XXI century, there is still hope that relics of disappeared tunes are still preserved in the Yakut outback, due to which a revival of archaic tunes of the Sakha people will probably come.

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在老年病學中選擇抗氧化劑的方法
A METHOD OF SELECTING ANTIOXIDANTS IN GERONTOLOGY

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抽象。 簡要概述了老年學趨勢。 分析了作為生命物質發展源的維生素和細胞凋亡的相互作用。 提出了對老年學分類法的修改。 對使用低分子量肽和將陽離子引入線粒體的現有策略提出了批評，強調了使用抗氧化劑的缺點。

考慮了DNA的準晶體模型，並證實了使用放射防護劑保護DNA免受損傷積累的策略。 已經提出了新的補充。

關鍵字：自我修復，自由基，輻射，PMX，禁區

Abstract. *A brief overview of trends in gerontology is given. The interaction of vitauct and apoptosis as a source of development of living matter is analyzed. A modification of the taxonomy of gerontology is proposed. The criticism of existing strategies for the use of low molecular weight peptides and the introduction of cations into mitochondria is given, the disadvantages of using antioxidants are emphasized.*

A quasicrystalline model of DNA is considered, and a strategy for protecting DNA from damage accumulation using radioprotectors is substantiated. A new supplement has been proposed.

Keywords: *self-repair, free radicals, radiation, PMX, forbidden zone*

Introduction

There are many versions of aging - Rubner, Loeb, Bütschli, Mechnikov, Pavlov, Mühlmann, Parkhon, Brown-Séquard, etc., the theory of aging due to the accumulation of mutations by L. Szilard (1954), the theory of accumulation of cellular debris by D. Harman, Williams' theory of antagonistic pleiotropy (1957), the theory of aging due to cross-linking between protein molecules by J. Bjorksten, the version of autoimmune aging by Takashi Makinodian (1969), see [1-3]. Nevertheless, a systematic approach to the problem of life extension and youth has not yet been developed.

At the time of the emergence of gerontology, it was associated with the treatment of elderly patients, respectively, its directions were gerontopsychology,

which studied the psychological and behavioral characteristics of elderly and elderly people, geriatrics - the doctrine of diseases associated with involutional changes, as well as the features of treatment and prevention of diseases in the elderly. and old age, hygiene, which studied the issues of general and special hygiene of people of older age groups.

In recent decades, the science of slowing aging and rejuvenating organisms has been developing.

1) Natural (hormones, vitamins) and synthetic substances are offered as geroprotectors, which, according to their mechanism of action, are divided into antioxidants, metabolism regulators, signaling pathway regulators, senolytics (selectively initiating the death of aged cells), CR-mimetics (creating changes in cell metabolism, imitating calorie restriction), peptide drugs.

2) Another area of focus is gene therapy, life-prolonging mutations.

3) The third includes cloning and organ replacement and cryopreservation.

4) The fourth area includes injections of various stem cells. The increased activity of the RhoGTPaseCdc42 protein causes blood stem cells to age faster. In experiments on mice, it was possible to show that a slowdown in the activity of this protein leads to reorganization and subsequent stable rejuvenation of blood stem cells. Thus, the aging process at this point can be made reversible (Hartmut Geiger, 2014). However, this rejuvenation procedure - with as yet unexplored consequences, it is also used to treat some diseases, but it can generate malignant neoplasms.

Difficulties in the systematics of gerontology are associated with the fact that a person is an open system, an individual is not a separate, but a socio-biological substance. This determines the variability in the definition of the command nodes of the organism in terms of gerontology.

To approach the solution of the problem, it is necessary to classify the approaches that exist in the topics of adaptation of organisms, in the theory of vitauct, in gerontology and in radiobiology.

Materials and methods

We will modify the systematics of gerontology at the level of its current state, which will allow us to isolate and combine some complex approaches.

1. Systematics

The causes of aging include internal and external.

External causes of aging include external: natural (ambient radiation, temperature and pressure drops, disasters, etc.) and artificial (air pollution, including radio emission, water, the spread of microbes, falsified food, stress, wars, production). For example, A.S. Presman associated acceleration, which leads to a reduction in life expectancy, with the spread of radio [4, 5], the frequency range of GSM-1900 mobile communication of one of the upper boundaries (1.91 GHz) exactly coincides (turns out to be resonant) with the natural frequency of torsional vibrations

of the DNA helix of the 1st chromosome [6].

Due to external reasons, the cooking of meat on fire and the transition to cereal and vegetable food, further thanks to the introduction at the beginning of the twentieth century of environmental (including at the workplace, for example, hoods) and hygiene measures, the introduction of vaccinations, the use of antibiotics, programs of correct food, etc. the life span of Homo sapiens has increased 5 times from an average of 15 years.

Internal causes operate at the molecular, cellular, physiological and population levels.

The molecular level is the breakdown of proteins, changes in the concentration of hydrogen ions, etc. Separately - changes in the genome: a certain aging program, apoptosis, telomere contraction, accumulation of uncorrected damage in DNA (L. Orgel, 1963), etc., in particular, due to the action of free oxygen radicals (FO). By old age, the rate of DNA self-repair decreases; in the cells of old animals, DNA damaged by X-ray or ultraviolet EMF is repaired more slowly.

At the cellular level, aging occurs in the cell nucleus, in mitochondria, enoplasmic reticulum - due to hypoxia, due to the action of FO, peptide peroxide, the action of xenobiotics, aldehydes, changes in the concentration of hydrogen ions, the accumulation of peptide residues, the activation of phospholipases, the appearance of proteins that damage the cell, rupture of lysosomes with active proteolytic enzymes, age-related changes in the microsomal oxidation system, membrane stability, microtubulls. In addition, the cells develop inflammation and other diseases.

At the physiological level, aging is associated with the separation in time and space of various links of biological systems. Some cells die, organs physically wear out, etc. Accordingly, the extension or limitation of a person's life occurs in view of two types of impact: external and internal.

The internal mechanism for increasing life expectancy determines the phenomenon of vitaukt. Frolkis V.V. (1969), Vanyushin B.F., Berdyshev G.D. (1977) put forward a gene-regulatory hypothesis of aging, according to which the primary mechanisms of aging are associated with a change in the regulation of gene activity, regulation of their expression and repression, and also put forward the theory of vitaukt, according to which, in the course of evolution, along with aging processes, the mechanism of active antiaging works [7].

The genotypic manifestations of vitaukt depend on the functioning of the genome, an example is DNA self-repair. The phenotypic mechanisms of vitauct are realized during the life of organisms. They are represented at the molecular, cellular, physiological, population, social levels.

Vitaukt counteracts the extinction of anabolism and metabolism (metabolism) and changes in individual functions of organs, contributes to their preservation or resists their abrupt change.

One of the mechanisms of vitauct is the antihypoxic system.

Vitaukt also acts on 3 levels: population, physiological and molecular (genome).

For Homo sapiens, the first level in terms of competition for food sources and in terms of reproduction was transformed into a population-social one.

In previous views, social gerontology (E. Stiglitz, 1940) is designed to solve demographic, socio-economic problems of aging, but the socio-economic aspect is understood one-sidedly, in an outdated form. The directions of social gerontology include the study of the influence of old age on the personality, on the change in values, needs of a person, his behavior and lifestyle in old age, the study of the position of an elderly person in a group, interaction in a family, a team, with friends, as well as the study of the specifics of groups consisting of older people, the study of older people in society as a whole. The elderly are seen as a certain demographic community and it (community) influences social processes and itself is influenced by social processes; the study of the effect of various medications on certain functions of the body in different age groups, which allows prescribing drugs for the elderly, based on a number of important factors.

However, it is clear that production relations and the content of labor have a decisive influence on life expectancy. Thus, the life expectancy of those employed in highly intellectual work increases significantly and sharply decreases in those employed in harmful (list №1) and heavy or monotonous industries.

Consequently, it is necessary to reformulate the directions in gerontology: geriatrics (getting rid of diseases associated with aging), hygiene, gerontopsychology, as well as functional gerontology and sociogerontology that have not yet been developed (sometimes it is included in gerontopsychology) and molecular gerontology.

Thus, the realm of gerontological research encompasses the social, population, physiological, cellular and molecular (genetic) levels.

2. Molecular level. Genome. Strategy

In molecular gerontology, from all phenomenology, we will single out the occurrence of defects in macromolecules, and from all macromolecules we will isolate DNA. From the aging models we choose the FO-theory, inside it - the model of accumulation of errors in DNA.

First, the molecular level of anti-aging Vitauct is associated with DNA replication and self-repair. In mammalian cell DNA, approximately 0.65 single-strand break damage occurs per second, plus oxidative damage. The self-repair system eliminates almost all the defects formed, but some remain.

A number of studies have established a positive correlation between the lifespan of a vila and the rate of DNA repair damaged by ultraviolet or ionizing radiation [8, 9].

With age, the effectiveness of the self-repair system decreases. The NAD+ metabolite, nicotinamide adenine dinucleotide, plays a key role in the recovery process, and its concentration decreases with age for unknown reasons. It is present in every cell of the body and regulates the interaction of proteins, which is responsible for DNA repair. An NMN preparation based on NAD + was injected into mice, which increased the ability of cells to repair DNA after damage [10].

1) During replication, telomeres at the ends of the DNA are lost, and the DNA is shortened. Thus, for non-somatic body cells that divide (skin cells, intestinal epithelium), the number of divisions is limited to 52 divisions (Hayflick limit). In some organisms, due to vitauct, the cells express the telomerase enzyme, which restores telomeres at the ends of DNA. If telomerase were expressed in the cells of the human body, it would be possible to increase the lifespan up to 200 years.

There are developments with the aim of artificially expressing telomerase in the cells of the human body by introducing sirtuin proteins. This is the first strategy in the theory of the accumulation of errors in DNA.

However, it should be remembered here that cell death is an evolutionary phenomenon that has arisen in multicellular organisms, with the "purpose" of preventing its endless growth, the process of programmed cell death - apoptosis (J. Kerr, E. Wiley, A. Kerry, 1972).

In addition, one of the main functions of apoptosis is the destruction of defective (damaged, mutant, infected) cells.

In the body of an average adult, apoptosis causes about 50-70 billion cells per day to die. For the average child aged 8-14 years, the number of cells that die by apoptosis is 20-30 billion per day. The total mass of cells that undergo destruction during 1 year of life is equivalent to the mass of the human body. Replenishment of lost cells is provided through proliferation (an increase in the cell population through division).

Organisms with extensive defects caused by impaired apoptosis die at the early stages of ontogenesis. Pathological processes develop in the case of suppression or enhancement of apoptosis.

Again, with the "goal" of limiting the infinite growth of the population, the apoptosis mechanism works in all eukarites, starting with the protozoa, and even in prokaryotes.

The search for ways to turn off the apoptosis mechanism is focused, in particular, on inhibitors of apoptosis proteins. Since the late 90s, attempts have been made to model apoptosis, which lead to a system of complex integro-differential equations, but there has been no success in this direction so far.

2) The second strategy in the direction of gerontology, which is associated with the 1st molecular level and, in particular, with the protection of DNA, is the introduction of specific cations into mitochondria, which contribute to the healing

of damage in mitochondrial DNA. The Skulachev Gerontological Center is engaged in this strategy.

However, the introduction of charged particles itself is unsafe; on the other hand, the binding of free oxygen radicals leads to hypoxia, especially since the generation of free radicals decreases with old age.

3) The third strategy is the use of a number of low molecular weight peptides that express some DNA genes (Havinson center). However, the accumulation of peptide residues, peptide peroxides accelerates aging, on the other hand, a decrease in the tension of the genome slows down the rate of age-related changes, and vice versa.

4) An attempt to use substances that bind FO of oxygen leads to the fact that the cell itself begins to produce FO of oxygen, which are necessary for metabolism. Therefore, the strategy of direct protection of DNA after its attack by FO oxygen is more effective.

Antioxidants are used to implement this strategy, but it turns out that, for example, in some cases, vitamin C or alpha-tocopherol are useless. That is, specific antioxidants are needed to interact with DNA.

The fourth strategy that we propose is a fundamentally new one; it is associated with the use of radioprotectors, which were previously used to protect both mitochondrial and nuclear DNA from radiation damage, as geroprotectors.

Various protectors are used to protect against damage by penetrating radiation. One type of protector is those that target DNA. They are designed to heal the damage to DNA from the effects of radiation, donating an ionized electron as a result of the ingress of a gamma quantum into the DNA molecule.

It is possible to describe the effect of gamma radiation on DNA from the point of view of the band theory, according to which the DNA macromolecule is represented as a quasi-periodic crystal. The system of energy levels of the DNA molecule is formed by the contribution of individual bases, and during the interaction of bases, each level is blurred, forming a zone. Transitions occur mainly between zones of bases of the same type. The relative displacement of the base levels is negligible. The approximate band gap is approximately 3.83 eV (calculations were performed in the π-approximation), according to experimental data - 4 eV.

When exposed to gamma radiation, after relaxation of levels, the π--electron system of DNA is excited. In this case, electrons from the highest occupied level of the π-system pass to its lowest unoccupied level, or ionization of the molecule occurs. After the cessation of the action of radiation, excitation migrates along the DNA and leads either to the recombination of electrons and holes, or to damage to the molecule. The role of DNA n-levels is similar to the role of impurity levels in semiconductors, where deep impurity levels lying near the middle of the forbidden

band - between the valence band and the conduction band of the crystal - have the greatest effect on the recombination rate (this band is absent for metals). With distance from the middle, the probability of transition (donation) decreases. That is, n-levels are required to protect against excitation of the DNA π-system.

In a free state, DNA bases are unstable to gamma radiation. It follows that the cooperation of electron shells plays a major role in the action of the safety mechanism.

By the iterative PMC method, the electronic levels of a number of known radioprotective agents with high radioprotective activity, the target of which is DNA, were calculated: thiourea, mercamine, ethyron and their derivatives. It turned out that the energies of their valence n-levels correspond to the middle or lie close to the middle of the forbidden zone of the π- system of DNA. Moving away from the middle leads to a decrease in radioprotective activity, going beyond the forbidden zone (serine, paraphenylenediamine, urea, etc.) reduces the activity to zero.

For confirmation, a number of radioprotectors were taken, the target of which is DNA.

Protectors were injected into hybrid mice of the line (CBAxC57B16) F1 weighing 13-20 grams, 20 mice per experiment, intraperitoneally 20 minutes before irradiation, in 2% starch solution at equimolar doses of 0.1-0.25 lethal dose of LD16. Irradiation was performed with the isotope Po-210 (5.3 MeV, on the "IGUR" installation with a power of 0.8 Gy/min) for 10 min.

The maximum radioprotective activity was found by selenorotic acid at LD95/30 and thiorethylglycine at LD60-70/30.

Table 1.

compound	30-day survival to control,%
orotylglycine	27
thiorethylglycine	80
orotic acid	20
thiotic acid	18
selenorotic acid	60

The ratio of effective and toxic doses for them is 60-70%.

Calculation using PMX showed that their n-levels most closely of all the listed protectors are located in the middle of the DNA band gap.

Earlier it was assumed that the presence of electron-donor properties of a compound is a necessary (although not always sufficient) condition for the implementation of a radioprotective action by filling an electron vacancy with a donor protector in biological macromolecules. It was believed that knowing the energy of the highest filled molecular orbit, we thereby obtain the value of the ionization

potential, which can serve as a measure of the electron-donor ability of the molecule, and the radioprotective activity increases with an increase in the number of donor radicals in the molecule [11, 12] This approach refutes these views.

Preliminary calculations were made in 1984 [13].

Later calculations in a similar approach by other authors [14] are incorrect. For example, it indicates the band gap of 9.56 eV. This corresponds to short-wave ultraviolet-C: 4.43 - 12.4 eV, such energies are not noted in the DNA spectrum, while energies (7.56 - 11.56) eV should have been listed as resonant. This energy does not correspond to the experimental data on measuring the band gap. In addition, the authors were unable to correctly describe the mechanism of DNA damage healing.

A partially similar approach is found in [15], where the mechanism of antiradiation protection of DNA against double breaks by the formation of intrastranded covalent crosslinks of the protector with a biopolymer, stabilizing the structure of the double helix, was investigated. However, it concerns only double breaks in DNA, in our case, the protector counteracts any possible damage to the electronic structure of DNA, and no crosslinking with a biopolymer is required.

The question of the mechanism of the convergence of the protector with the target is obvious: the convergence of DNA and protector has a statistical (Brownian) character and is due to hydrogen bonding, possibly with the formation of an excimer.

Selenorotic acid is extremely toxic, the more effective thiorethylglycine is even more toxic.

We studied the body's reactions to the introduction of oral, as a dietary supplement, 100 μg of selenium and 2 mg of orotic acid in 50 subjects daily for a month. In 42 subjects (experimental group and control), the tone increased, in 7 people, the rate of tissue regeneration after a cut increased by 1.5 - 2 times. At the same time, separate use in the control group had no effect. If earlier in medical practice selenium was combined with vitamin E, it is proposed to combine it with hypovitamin - orotic acid.

The defense mechanism of such a non-toxic and sufficiently effective radioprotector as indralin is associated with vasospasm and circulatory changes in blood supply in radiosensitive organs and tissues, as a result of which hypoxia develops, which determines the protection of these tissues, they do not fit into the proposed strategy.

The type of non-toxic antioxidants include resveratrol (it is used as a geroprotector, but it is known that it is also a radioprotector, which confirms the correctness of the strategy), also lutein, lycopene, tryptophan, propionate, metmorphine, melatonin, cysteamine, cystamine, serotonin, mexamine. The calculation using the IPMX method shows that the electronic levels of these compounds are at a distance of 0.2 eV or more from the middle of the band gap of the DNA quasicrystal.

Conclusion

The causes and mechanisms of aging and an increase in life expectancy indicated above are intertwined in a complex way. It is obvious that the most effective combined use of all four strategies together with the use of EMF at the physiological level.

It should be noted that an increase in life expectancy depends on many factors, age, physical characteristics (height, weight, etc.), on race, gender, climate, radio telephone, water and air quality, on the nature of work, on past diseases, including hereditary, etc. Accordingly, to develop a therapeutic complex, it is necessary to passportize the genome.

Let's say that 10^6 people live in the region, the number of chromosome sets is 23, the number of cells in the body is 10^{14}, 7×10^{10} cells are renewed daily, 105 of the brain cells die daily. There are 4 types of tissues in the human body, each of them is differentiated, the number of nucleotide pairs in human DNA ranges from 0.5×10^7 to 2.5×10^8. According to estimates, to calculate, for example, the frequency of conformational vibrations of DNA at a speed of 10^{15} operations per second, the most powerful Chinese supercomputer will take about 3-4 days, for a speed of 10^{18} operations/sec - respectively, up to 1 hour.

The proposed approach does not deprive DNA of its normal life under the influence of radicals: the protector acts on the DNA itself, in which damage occurs.

The proposed method does not require strong antioxidants that could reduce the activity of oxygen radicals, antioxidants with a large difference from prooxidants, but those whose electronic structure is suitable for DNA bases.

The proposed method does not require cations, the introduction of which itself has a negative effect on the cell. In this case, the concentration of the antioxidant protector can vary over a wide range. In addition, with the use of many used geroprotective antioxidants, serious side effects are observed: an increase in the incidence of adenomas of the islets of the pancreas (beta-carotene), an increase in carcinogenesis in the colon (vitamin E), an increase in cholesterol concentration and an increase in its deposition in the aorta (selenium), induction of liver tumors (dehydroepiandrosterone). Thus, the search for more effective geroprotectors can be continued with this method. It is possible to simulate protectors of other series of non-toxic antioxidants with predetermined properties, which would be easy to obtain, and whose n-levels would be embedded in the middle of the forbidden zone of the DNA molecule.

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長期異體腎移植受體適應性細胞免疫指數的評估
EVALUATION OF ADAPTIVE CELLULAR IMMUNITY INDICES IN ALLOGENEIC KIDNEY TRANSPLANT RECIPIENTS IN THE LONG-TERM PERIOD

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抽象。 致力於異體腎移植（AKT）免疫耐受形成機制研究的大多數出版物都提到了移植後的即刻時期。 研究適應性細胞免疫的指標，特別是介導AKT長期接受者獲得免疫耐受的因素，是一個迫切且研究不足的問題。

Abstract. Most of the publications devoted to the study of the mechanisms of formation of immunological tolerance in allogeneic kidney transplantation (AKT) refer to the immediate post-transplant period. The study of indicators of adaptive cellular immunity, in particular, the factors mediating the achievement of immunological tolerance in recipients in the long-term period of AKT, is an urgent and insufficiently studied problem.

Materials and methods: Assessment of adaptive cellular immunity was carried out in 24 patients who underwent AKT; 20 practically healthy individuals were examined as a control group. At the time of the examination, there were no signs of renal transplant rejection. The observation period for the patients ranged from 1 to 7 years. Determination of the subpopulation composition of peripheral blood lymphocytes, T-regulatory cells with different phenotypes was carried out by 4-color flow cytometry (2-laser flow cytometer FACSCalibur (Becton Dickinson, USA) using monoclonal antibodies (MAT) to lymphocyte differentiation antigens (Biosci, USA). The number of cells expressing the antigens CD3, CD4, CD8, CD19, CD16, and CD56, the expression of activation and costimulatory molecules CD25, CD28, the number of T-regulatory cells with phenotypes CD4+CD25+(hi)CD127- and CD8+CD28-CD62L+ were evaluated.

Results. Patients 1 year after transplantation showed a significant ($p = 0.001$) increase in the content of "VETO" -cells with the CD8+CD28-CD62L+ phenotype

(52.6 ± 10.8%) compared with practically healthy individuals (26.1 ± 2, 7%). In the subsequent periods of observation (4-7 years), their number decreased, but did not reach normal values. In patients 5 - 7 years after transplantation, a significant decrease in the number of T-helper lymphocytes expressing the receptor for IL-2 (CD4+CD25+), a decrease in the number of B-lymphocytes (CD19+) were revealed; an increase in the number of NKT cells (CD3+CD16+CD56+), an increase in the absolute number of T-reg. cells (CD4+CD25+hiCD127-). With progressive deterioration of renal function and chronic transplant nephropathy, the decrease in B-lymphocytes was more pronounced. Calcineurin nephrotoxicity inhibitors (CNI) was characterized by a significant increase in the content of a subpopulation of effector cytotoxic T-lymphocytes (CD8+CD28+), NKT-lymphocytes and a significant increase in the subpopulation of **induced T-regulatory cells with the CD8 + CD28- phenotype.**

Conclusion. The study of cellular immunity parameters in patients after AKT in long-term periods provides valuable information about the functional state of KAT and / or about the nephrotoxic effect of immunosuppressive drugs. Partial immunological tolerance to the graft in the late postoperative period is maintained due to the presence of a larger number of T-regulatory cells with phenotype CD3+CD4+CD25+(hi)CD127-, and also due to induced T-regulatory CD8+CD28-CD62L+ cells.

Prevention of kidney allogeneic transplant (KAT) rejection is achieved by the combined suppression of certain mechanisms of the immune response to donor alloantigens. All the reasons for the loss of KAT are associated with the imperfection of immunosuppressive therapy, which can cause disorders of hematopoiesis, lipid metabolism, promote the development of post-transplant diabetes mellitus, and have a direct nephrotoxic effect on the graft. Most of the publications devoted to the study of the mechanisms of the formation of immunological tolerance in allogeneic kidney transplantation (AKT) refer to the immediate post-transplantation period, the study of the role of T-regulatory cells [1, 3]. The study of indicators of adaptive cellular immunity, including factors mediating the achievement of immunological tolerance in recipients in the long-term period of AKT, is an urgent and insufficiently studied problem.

Purpose of the study: assess the parameters of adaptive cellular immunity in the conditions of immunosuppressive therapy in patients in the long term after AKT in comparison with the data of clinical monitoring.

Materials and methods: The prospective randomized cohort study included 24 patients after single-group cadaveric kidney transplantation. There were 13 men and 11 women aged 45.9 ± 10.5 years. At the time of the examination, there were no signs of renal transplant rejection in any patient. The observation period for the patients ranged from 1 to 7 years, on average 4.5 ± 2.0 years. The obtained

indicators were compared with similar ones during the examination of 20 practically healthy persons. Immunophenotyping of PC lymphocytes was performed by 4-color flow cytometry using CellQwest software and monoclonal antibodies to lymphocyte differentiation antigens (BD Biosciences, USA). The number of cells expressing the antigens CD3, CD4, CD8, CD19, CD16 and CD56, the expression of activation and costimulatory molecules CD25, CD28 on T-lymphocytes, the number of T-regulatory cells with the D3+CD4+CD25+(hi)CD127- phenotype were evaluated. Isolation of the region of lymphocytes was carried out by expression of the panleukocyte antigen CD45 against the SSC lateral light scattering channel. The population and subpopulation composition of lymphocytes was estimated as a percentage of the gate of all lymphocytes, the content of a subpopulation of T-regulatory cells was calculated as a percentage of the subpopulation of T-helper lymphocytes (CD3 + CD4 +). The intensity of antigen expression was assessed by the parameter of mean fluorescence intensity - Mean Fluorescence Intensity (MFI), expressed in arbitrary units (Units).

As reference values, we used the results of 20 apparently healthy individuals - blood donors, examined according to similar indicators.

For the statistical analysis of two independent samples with a normal distribution, the unpaired Student's t test was used taking into account the equality of variances. Data are presented as mean ± standard deviation (M ± SD). Statistical processing of the results was performed using the SPSSv.23, GraphPad Prizm 8 software.

Results. The parameters of cellular immunity in patients depending on the observation period are presented in table 1.

Table 1. Parameters of cellular immunity in renal allograft recipients depending on the time after transplantation

Indicator	1 year N=5	3-4 years N=9	5-7 years N=10	Virtually healthy individuals n=20
T-lymphocytes CD3+	77,5+-2,4	78,4+-6,3	79,01+-3,3	75,7+-1,65
T-helpers CD3+CD4+	46,3+-1,5	46,9+-3,3	44,4 +-2,06	45,2+-1,4
T-cytotoxic CD3+CD8+	31,3+-2,7	30,4+-5,7	32,0+-3,3	27,1+-1,6
Ratio index,CD4+/ CD8+	1,56+-0,2	1,7+-0,28	1,64+-0,28	1,8+-0,12
NK CD3-(CD16+56+)	12,5+-3,3	12,5+-6,5	13,0+-2,9	11,6+-1,5
NKT CD3+(CD16+56+)	5,0+-0,8	9,1+-4,7	**10,2 +-1,6***	6,2+-0,8
B-lymphocytesCD19+	9,5+-1,75	7,7+-2,05	**5,9 +- 0,7***	11,0+-0,7

CD4+/ CD28+	42,2+-3,3	41,9+-3,97	40,3+-2,3	42,4+-4,8
CD4+CD25+ (% of CD3+ lymphocytes)	**25,7+-1,9***	18,6+-6,6	**16,4 +-2,3***	20,7+-1,6
T-reg CD4+CD25hiCD127- (% of CD4+T-Lc)	2,42+-0,3	2,7+-1,05	1,6+-0,1*	3,09+-0,9
CD8+CD28+, (% of all Lc)	19,5+-3,7	13,6+-1,4	13,2+-1,4	16,1+-1,1
CD8+CD28-, (%of all Lc)	**14,7+-3,2 ****	23,1+-6,2	**28,6+-3,3***	16,6+-1,5
VETO-cells CD8+CD28-CD62L+, (% of CD8+CD28-)	**52,56+-10,8***	31,9+-10,4	31,4+-7,2	26,1+-2,7

Notes; *   p <0.05 compared with practically healthy individuals;
       ** p <0.05 compared with recipients 1 year after transplantation;

During 1 to 5-7 years of observation in AKT recipients, the relative content of the T-population of lymphocytes, natural killer cells (NKC) (CD3-CD16+CD56+), T-helper (CD3+CD4+), T-cytotoxic (CD3+CD8+) of lymphocyte subpopulations, their ratio did not differ from normal values. Patients 1 year after transplantation showed a significant (p = 0.001) increase in the content of "VETO" -cells with the phenotype CD8+CD28-CD62L+(52.6 ± 10.8%) compared with practically healthy individuals (26.1 ± 2.7%). In the subsequent periods of observation (4-6 years), their number gradually decreased, but did not reach normal values. "VETO" -cells are induced T-regulatory cells included in the population of T-lymphocytes with suppressive activity of CD8+CD28-. In patients 5-7 years after transplantation, the following **statistically significant changes** were revealed when compared with similar indicators of practically healthy individuals: a decrease in the number of T-helper lymphocytes expressing the IL-2 receptor (CD4+CD25+), a decrease in the number of B-lymphocytes (CD19+) ; an increase in the number of NKT cells (CD3+CD16+CD56+). The level of T-regulatory cells with the phenotype CD4+CD25+hiCD127- in terms of relative values did not statistically differ from the reference indicators, however, when assessing the absolute values, significant differences were revealed (p = 0.024). The concept of the leading role of T-regulatory cells in the development of the phenomenon of immunological tolerance in kidney transplantation is currently the main one according to a number of researchers [4].

One of the reasons for the long-term loss of a transplanted kidney is chronic transplant nephropathy, which is understood as nephrosclerosis, which is clinically manifested by a steady decline in the function of the graft with an outcome in end-stage chronic renal failure. Currently, puncture biopsy is the "gold standard" for diagnosing the pathology of a transplanted kidney, and it is necessary in all cases of late graft dysfunction in order to correct treatment approaches [2].

When comparing the parameters of the immunological reactivity of recipients with renal function (Table 2), it was found that in the group of patients with progressive deterioration of

Table 2. Parameters of cellular immunity in renal allograft recipients depending on renal function

Indicator	Impaired kidney function / progressive deterioration n=3	Kidney function is stable and normal n=21	Virtually healthy individuals n=20
T-lymphocytes, CD3+	78,4+-5,4	78,8+-2,4	75,7+-1,65
T-helpers, CD3+CD4+	41,07+- 3,6	46,3+-1,4	45,2+-1,4
T-cytotoxic, CD3+CD8+	34,2+-3,8	30,9+-2,5	27,1+-1,6
Ratio index, CD4+/ CD8+	1,25+-0,2	1,9+-0,1	1,8+-0,12
NK CD3-(CD16+56+)	14,3+-6,8	12,5+-2,6	11,6+-1,5
NKT CD3+(CD16+56+)	5,6+-2,0	8,9+-1,5	6,2+-0,8
B-lymphocytes, CD19+	**4,7+-1,2 ***	**7,7+-0,7****	11,0+-0,7
CD4+/ CD28+	36,6+-7,2	39,8+-5,5	42,4+-4,8
CD4+CD25+	21,3+-7,4	18,9+-2,3	20,7+-1,6
T-reg CD4+CD25hiCD127- (% of CD4+T- Lc)	2,0+-0,15	1,8+-0,2	3,09+-0,9
CD8+CD28+ (% of all Lc)	12,9+-2,97	15,2+-1,4	16,1+-1,1
CD8+CD28- (% of all Lc)	29,4+-10,9	22,7+-2,6	16,6+-1,5
VETO cells CD8+CD28-CD62L+ (% of CD8+CD28-)	34,8+-18,8	37,1+-5,7	26,1+-2,7

Notes; *   p<0,05 in comparison with practically healthy individuals;
          **   p<0,05 between compared groups of patients

Comparing the results of immunological studies with the results of kidney biopsy, the following data were obtained (Table 3):

Table 3. Parameters of cellular immunity in renal allograft recipients depending on the results of kidney biopsy

Indicator	Chronic transplant nephropathy 1.2, 3 degrees n=10	Nephrotoxicity of calcineurin inhibitors (CNI) n=5	Virtually healthy individuals n=20
T-lymphocytes CD3+	82,7+-3,9	86,0+-5,5	75,7+-1,65
T-helpers CD3+CD4+	45,6+-1,8	45,8+-2,7	45,2+-1,4

T-cytotoxic, CD3+CD8+	34,6+-3,7	**42,4+-7,6***	27,1+-1,6
Ratio indexCD4+/ CD8+	1,51+-0,19	1,2 +-0,3	1,75+-0,12
NK CD3-(CD16+56+)	**6,5+-3,9***	7,9+-3,2	11,6+-1,5
NKT CD3+(CD16+56+)	7,7+-2,5	**17,1+-3,3***	6,2+-0,8
B-lymphocytes CD19+	**5,8+-1,1***	**4,6+-2,1 ***	11,0+-0,7
CD4+/ CD28+	43,3+-4,2	38,5+-1,9	42,4+-4,8
CD4+CD25+	16,9+-3,2	**8,97+-1,8***	20,7+-1,6
T-reg CD4+CD25hi CD127- (% of CD4+T- Lc)	1,85+-0,2	1,2+-0,2	3,1 +- 0,9
CD8+CD28+ (% of all Lc)	17,1+-2,5	15,9+-1,8	16,1+-1,1
CD8+CD28-, (%of all Lc)	20,6+-3,7	**31,5+-6,4***	16,6+-1,5
VETO-cells CD8+CD28- CD62L+, (% of CD8+CD28-)	42,0+-10,4	37,8+-14,9	26,1+-2,7

Notes; *   p<0,05 in comparison with practically healthy persons;
         **   p<0,05 between compared groups of patients

In chronic transplant nephropathy of 1-3 degrees, a statistically significant decrease in the content of B-lymphocytes and NKC was observed.

Nephrotoxicity of Calcineurin Inhibitors (CNI) was characterized by a significant increase in the content of a subpopulation of effector cytotoxic T-lymphocytes (CD3+CD8+), NKT-lymphocytes and, most importantly, a significant increase in the subpopulation of induced T-regulatory cells with the CD8+CD28- phenotype. At the same time, there was a significant decrease in the content of B-lymphocytes and activated CD4+CD25+T-lymphocytes.

Conclusion. Study of cellular immunity parameters in patients after AKT in long-term follow-up periods can provide preliminary valuable information about the functional state of KAT and / or about the nephrotoxic effect of immunosuppressive drugs:

1. Low levels of B-lymphocytes and NKC may indicate impaired or progressive deterioration of kidney function, as well as chronic transplant nephropathy;

2. An increase in the content of a subpopulation of effector cytotoxic T-lymphocytes, NKT-lymphocytes, a decrease in the content of B-lymphocytes and activated T-helper lymphocytes may indicate the nephrotoxic effect of calcineurin inhibitors.

3. A decrease in the number of B-lymphocytes dictates the study of the level of serum immunoglobulins and is a predictor of the development of infectious complications.

Partial **immunological tolerance to the transplant in the late postoperative period** is maintained due to the presence of a larger number of T-regulatory cells with the CD3+CD4+CD25+(hi) CD127- phenotype, as well as due to T-lympho-

cytes with suppressor activity (or induced T-regulatory cells) with the phenotype CD8+CD28-CD62L+.

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重度燒傷毒血症期間脈搏血壓的晝夜節律動態
DYNAMICS OF THE CIRCADIAN RHYTHM OF PULSE BLOOD PRESSURE DURING TOXEMIA IN SEVERE BURNS

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抽象。在第一天，PBP晝夜節律標誌與所有年齡組的標準指標均無差異。在毒血症期間，PBP晝夜節律的中膜變化呈波狀發生，第1 – 9,6,5,5,6,6組，第2 – 8,4組波動。第3天-5、4、4、5、6、5天。 PBP晝夜節律的每日變化在較晚的日期普遍存在（第14組在第14天后，第2組-在第8天，在第3組-在有毒血症的14天后），這表明導致血液動力學障礙的因素之一不夠有效的抗炎，糾正血液動力學功能的療法。最活躍的代償性血流動力學反應顯示在40歲以下。在燒傷疾病毒血症期的較晚日期（3-4週），發現超過61歲的患者出現最不穩定的血液動力學趨勢。

關鍵詞：脈搏血壓的晝夜節律，毒血症時期，嚴重燒傷

Abstract. On the first day, the PBP circadian rhythm mesors did not differ from the normative indicators in all age groups. During the period of toxemia, changes in the mesor of the circadian rhythm of PBP occurred in a wave-like manner with a period of fluctuations in group 1 – 9,6,5,5,6 days, in group 2 – 8,4 days, in group 3 - 5,4,4,5,6,5 days. Daily changes in the PBP circadian rhythm prevailed at a later date (in group 1 after 14 days, in group 2 - on day 8, in group 3 - after 14 days of toxemia), which suggests that one of the factors leading to hemodynamic disturbances is insufficiently effective anti-inflammatory, correcting hemodynamic function therapy. The most active compensatory hemodynamic reactions were revealed at the age of up to 40 years. The most pronounced tendency to destabilize hemodynamics was found in patients over 61 years of age at a later date (3-4 weeks) of the period of burn disease toxemia.

Keywords: circadian rhythm of pulse blood pressure, period of toxemia, severe burns

Relevance

Pulse blood pressure (PBP) should normally be between 30 and 50 mmHg. With the standard BP 120/80, the normal PP is 40 mmHg [1]. Pulse pressure is determined by the ratio of the value of the stroke volume to the reserve capacity of the arterial system. Any changes in hemodynamics that affect these two factors also affect the magnitude of the pulse pressure. With aortic stenosis, the opening diameter with open aortic valves is significantly reduced compared to the norm. The pulse pressure in the aorta also decreases, since there is a decrease in blood flow through the stenotic valves. In case of non-closure of the arterial (botallova) duct, about half of the stroke volume of blood, which should enter the aorta from the left ventricle, immediately enters the pulmonary artery and the pulmonary vascular system through the wide open duct. This is accompanied by a significant drop in diastolic pressure before each subsequent heartbeat. With aortic valve insufficiency, the aortic valves are absent or incompletely closed. Therefore, after each heartbeat, the blood that has entered the aorta immediately returns to the left ventricle. As a result, the aortic pressure drops to zero during diastole. Pathologies leading to a decrease in heart systole cause a decrease in PBP, and this is an alarming symptom. The causes of decreased PBP are directly related to the condition of the heart and kidneys and, as a rule, require immediate etiopathogenetically justified correction [1-3]. However, there are no data in the literature on changes in pulse blood pressure and its circadian rhythm in burn disease, which was the reason for studying the features of changes in the circadian rhythm of pulse blood pressure in severe burns in adults.

Purpose

Study the dynamics of the circadian rhythm of pulse blood pressure during toxemia in severe burns.

Material and research methods

The results of monitoring the PBP indicator of 25 patients admitted to the Department of Cambustiology of the Republican Scientific Center of Emergency Medicine due to burn injury were studied. After recovery from shock, anti-inflammatory, antibacterial, infusion therapy, correction of protein and water-electrolyte balance disorders, early surgical, delayed necrectomy, additional parenteral nutrition, syndromic, symptomatic therapy were performed. The dynamics of PBP was studied by monitoring the hourly continuous recording of the indicator in patients with severe thermal burns in three age groups - group 1, 12 patients aged 20-40 years, group 2 - 7 patients aged 41-60 years, group 3, 6 patients - 61-78 years. The division into groups was dictated by the well-known characteristics inherent in each age group, described in detail in the literature.

Table 1

Patient characteristics (25)

	Age, years	Height, cm	Weight, kg	Total burn area,%	Burn of 3B grade	IF, units	Days in the ICU
Group 1	27,3±5,6	174,9±5,7	73,0±22,2	59,4±13,5	21,3±13,3	119,4±38,4	22,4±14,6
Group 2	50,7±7,1	165,8±6,3	73,8±14,3	54,3±16,5	11,9±8,9	92,5±20,8	13,3±2,4
Group 3	71,3±7,0	165,3±8,4	73,3±8,9	40,8±5,8	21,7±6,7	86,7±12,8	18,8±9,5

As can be seen from Table 1, the age groups were significantly different and averaged 27.3 ± 5.6 years in group 1, 50.7 ± 7.1 years in the second, and 71.3 ± 7.0 years in the third. The total area and area of deep skin burn lesions did not differ significantly between the groups. The highest index of IF was revealed in group 1, which led to the longest intensive therapy in ICU conditions in the youngest group 1. Thus, the most pronounced burns in terms of area and depth were found in patients in group 1.

Results and discussion

Table 2

Dynamics of the mesor of the circadian rhythm of pulse pressure

Days	Group 1	Group 2	Group 3
1	45,0±1,9	49,6±2,5	47,4±3,1
2	45,4±1,7	47,5±1,6	48,6±2,7
3	48,0±1,9	46,7±1,6	54,1±3,0*
4	51,6±1,0**	49,4±2,3	53,2±2,1
5	51,6±1,1**	52,6±1,8	45,9±3,6*
6	52,9±2,0**	51,7±3,2	48,1±2,5
7	52,7±1,9**	53,5±2,4	52,5±1,7
8	53,4±2,0**	49,0±2,6	46,2±4,2
9	51,0±1,7**	50,9±1,5	46,9±3,5
10	51,6±1,5**	43,9±2,3	47,2±3,4
11	53,1±2,7**	50,1±3,3	53,5±3,1
12	52,1±1,6**	50,4±1,4	42,8±4,3*
13	50,5±2,1		51,1±3,6
14	56,5±3,4**		44,5±4,4*
15	49,9±2,9		43,3±4,8
16	55,0±2,5**		42,3±3,8*
17	55,9±2,6**		41,0±3,8*
18	55,3±3,5**		46,0±2,2*
19	56,9±1,7**		50,1±3,5

20	53,8±1,8**		51,9±3,1
21	55,4±3,4**		47,5±2,7
22	61,5±2,5**		48,1±5,6*
23	54,1±2,8**		44,3±5,6
24	55,3±3,7**		47,0±5,7
25	53,0±1,6**		45,6±7,3
26	49,1±3,2		46,7±4,8
27	52,1±2,0**		41,1±5,6
28	52,9±2,5**		42,7±4,3*
29	54,1±2,6**		45,8±4,5
30	50,3±2,6		42,8±4,7

*- reliable relative to the indicator in group 1

**- reliable relative to the indicator on the first day

As can be seen from the data presented in Table 2, on the first day, the PBP circadian rhythm mesor did not differ from the normative indicators. Group 1 showed a reliably significant increase in the mesor of the circadian rhythm PBP on days 4-12 of the toxemia period by 13-17% (p <0.05), remaining elevated throughout the observation period up to a maximum increase on days 22 by 36% (p < 0.05) relative to PBP on day 1 of toxemia. Attention was drawn to the relative stability of the mesor of the circadian rhythm PBP in patients of group 2, which was most likely due to a smaller burn area of grade 3B than in groups 1 and 3, 11.9 ± 8.9%. Also, in group 3, the PBP mesor of the circadian rhythm did not differ from the indicator on the first day during the period of toxemia. However, comparative analysis made it possible to establish a reliably significant difference between the results of patients in group 3 and those in patients in group 1. So, on the 3rd day, the mesor of the circadian rhythm PBP of patients of group 3 was higher than in group 1 by 12.5%, on the 5th day less by 14%, on the 12th day less by 17%, on the 14th day by 21%, by 16 -18 days by 22%, 22 days by 21%, remaining less than the same indicator for 28 days less by 19% (table 2). Thus, despite the absence of a significant difference from the normative data in patients over 61 years old, it was revealed after a short-term increase in the PBP mesor on day 3 with a decrease in the PBP mesor of the circadian rhythm on day 5 and with a tendency to progression in the third week and the entire subsequent period of the toxemia period. burn disease. The revealed difference in the results of PBP monitoring in groups 1 and 3, apparently, is directly related to the state of the heart, respectively, required etiopathogenetically justified correction.
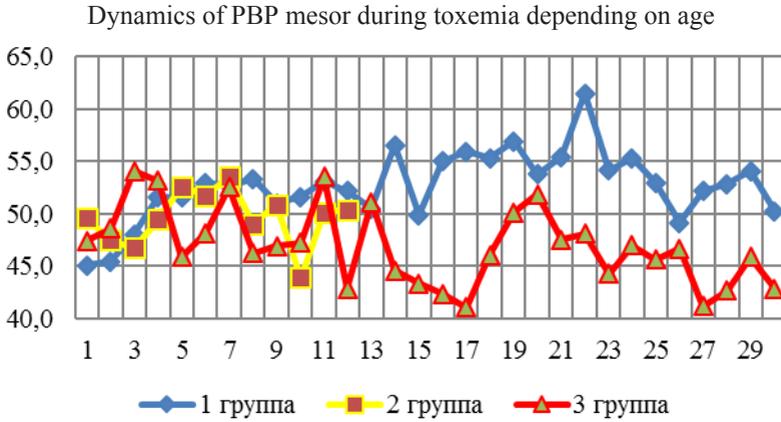
Dynamics of PBP mesor during toxemia depending on age

Fig.1

Changes in the mesor of the PBP circadian rhythm occurred in waves with a period of fluctuations in the 1st group - 9,6,5,5,6 days, in the 2nd group – 8,4 days, in the 3rd group - 5,4,4,5,6,5 days. That is, in the process of adaptation, the stress response of the PBP circadian rhythm was also expressed in a change in the wavelength of PBP around-week fluctuations, fitting into the 4,5,9 days sinusoids (fig. 1).

Changes in PBP in acrophase during toxemia
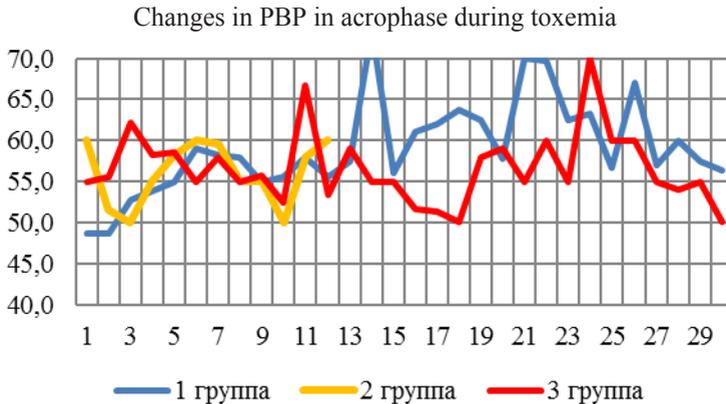
Fig.2

Also, the PBP parameters in acrophase (fig. 2) and bathiphase (fig. 3) changed in waves.

There was no synchronicity in fluctuations in the PBP values of the mesor with those in the acrophase and bathiphase.

PBP dynamics in the bathyphase of the toxemia period
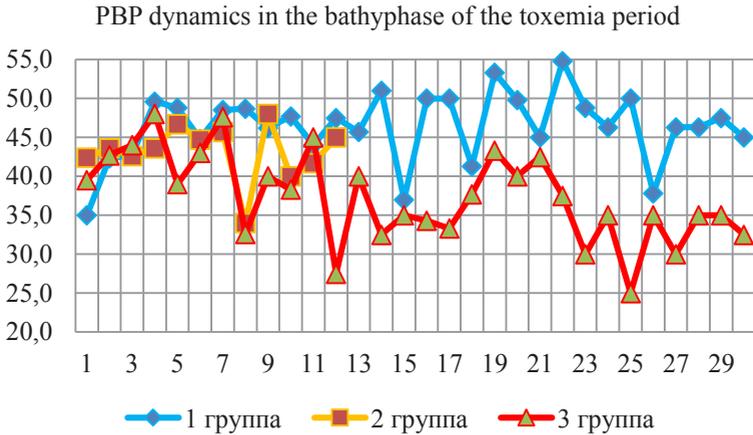
Fig.3

Correlation links of parameters of the circadian rhythm of pulse pressure during toxemia
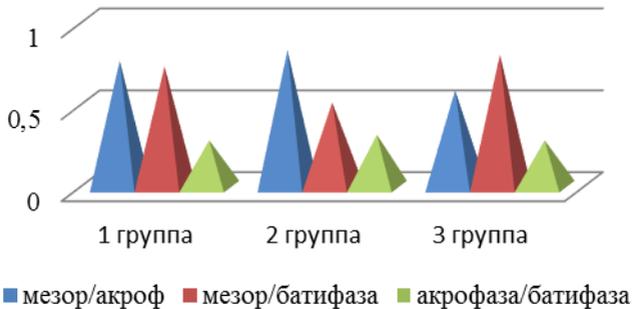
Fig.4

Thus, a reliably significant correlation was found between the parameters of the mesor and the PBP value in the acrophase in groups 1 and 2 (table 3), between the mesor and bathiphase in groups 1 and 3, while the correlation between the PBP indicator in the acrophase and bathiphase was insignificant in all three groups of patients (fig. 4).

Table 3

Correlations between PBP circadian rhythm parameters during toxemia

Parameters	Group 1	Group 2	Group 3
mesor/acrophase	0,7715	0,8341	0,5900
mesor/bathiphase	0,7361	0,5147	0,8072
acrophase/bathiphase	0,2831	0,3173	0,2831

Changes in the mesor of the PBP circadian rhythm occurred in waves with periods of fluctuations in group 1 – 9,6,5,5,6 days, in group 2 – 8,4 days, in group 3 – 5,4,4,5,6,5 days.
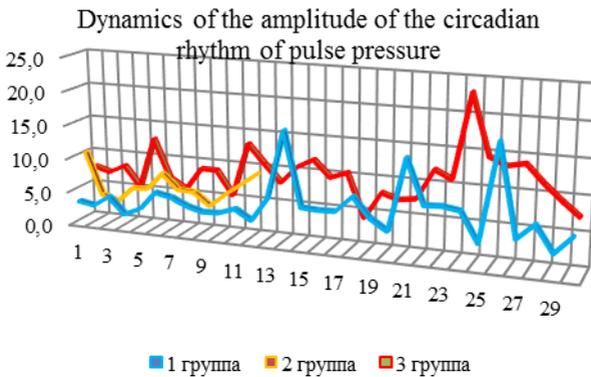
Fig.5

Changes in the amplitude of daily PBP fluctuations differed in group 1 by values (8-3 mmHg), increasing by 14, 19, 23 days to 16 mmHg, while the amplitude of diurnal fluctuations in group 2 was 4-10 mmHg, that is, PBP in group 2 was stable. And in group 3, a tendency towards the increase of the amplitude of the daily fluctuation of PBP was found on the 5, 11, 17th day with an increase on the 23rd day to 23 mmHg, which characterized the most pronounced instability of hemodynamics in elderly patients in the late periods of the toxemia of burn disease (fig. 5).

Dynamics of the range of daily fluctuations of pulse pressure

■ 1 группа ■ 2 группа ■ 3 группа
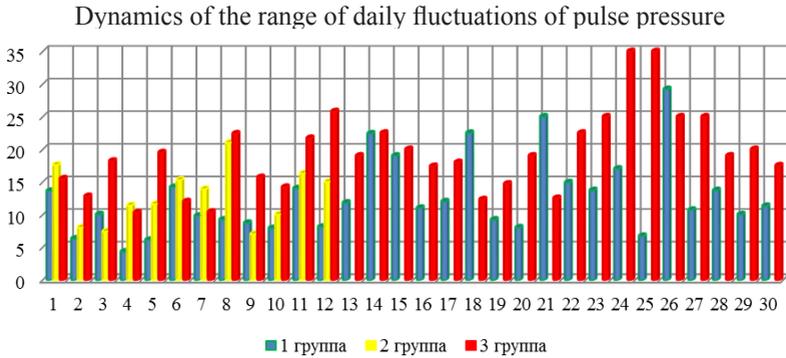
Fig.6

Changes in the daily range of fluctuations in the circadian rhythm of PBP in group 1 indicated the prevalence of more significant changes in PBP at 14 (22 mmHg), 18 (22 mmHg), 21 (24 mmHg), 26 (28 mmHg) days of the toxemia period. While the maximum range of the daily fluctuation of PBP was found only on day 8 (20 mmHg). In patients of group 3, the range of daily changes in PBP was detected on days 12 (20 mmHg), 24 and 25 days (34.8 mmHg). Thus, daily changes in the circadian rhythm of PBP prevailed at a later date (in group 1 after 14 days, in group 2 - on day 8, in group 3 - after 14 days of toxemia), which suggests that one of the factors leading to violation of hemodynamics is the lack of effectiveness of anti-inflammatory, correcting hemodynamic function of therapy, more pronounced in groups 1 and 3 of patients.

During the period of burn disease toxemia, a direct correlation of SBP and PBP mesor on body temperature (0.693; 0.598, respectively) was found only in group 1, a strong direct correlation between SBP and DBP in group 3 (0.689), as well as a strong direct correlation between PBP and SBP in Group 1 (0.7747), gradually weakening in 2 (0.6598) and 3 (0.5643) groups of patients.
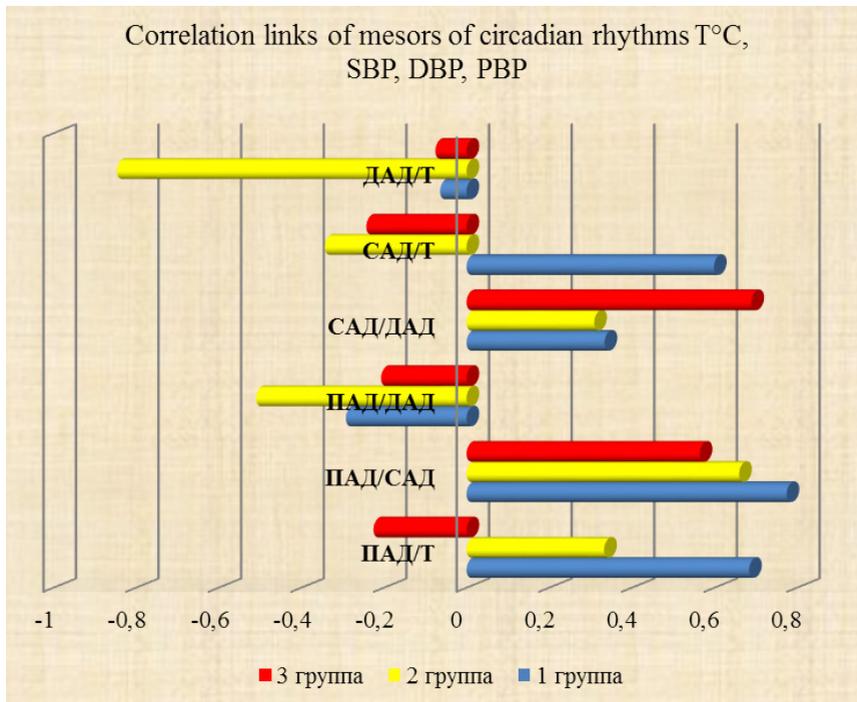
Fig.7

A strong negative correlation between DBP and body temperature (-0.8462) characterized a decrease in the tone of peripheral vessels in response to an increase in body temperature, which is characteristic of the physiological reaction of hemodynamics to the systemic inflammatory response of the body with burns with a total area of 54.3 ± 16.5%. 3 B degree 11.9 ± 8.9% and IF indicator 92.5 ± 20.8 units. Thus, the most active compensatory hemodynamic reactions were found in group 1. The most pronounced tendency to destabilize hemodynamics was found in patients over 61 years of age at a later date (3-4 weeks) of the period of burn disease toxemia.

Conclusions

On the first day, the PBP circadian rhythm mesors did not differ from the normative values. During toxemia, changes in the mesor of the circadian rhythm of PBP occurred in waves with a period of fluctuations in group 1 - 9,6,5,5,6 days, in group 2 – 8,4 days, in group 3 - 5,4,4,5,6, 5 days. Daily changes in PBP prevailed at a later date (in group 1 after 14 days, in group 2 - on day 8, in group

3 - after 14 days of the toxemia period), which suggests that one of the factors leading to hemodynamic disturbances is insufficient efficiency anti-inflammatory, corrective hemodynamic function of therapy, more pronounced in groups 1 and 3 of patients. The most active compensatory hemodynamic reactions were found in group 1. The most pronounced tendency to destabilize hemodynamics was found in patients over 61 years of age at a later date (3-4 weeks) of the period of burn disease toxemia.

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成人燒傷毒血症期間中風量的畫夜節律
CIRCADIAN RHYTHM OF STROKE VOLUME DURING BURN TOXEMIA IN ADULTS

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抽象。在第2組患者中發現最接近正常的SV指標，其總燒傷面積為54.3±16.5%，3 B級為11.9±8.9％。第1組和第3組的3B級皮膚表面燒傷面積增加至21.3±13.3％和21.7±6.7％，導致第1組的心輸出量增加14-29％，第3組的SV節律幾乎在整個毒血症時期內，血脂增加了16-26％。在SV ／ PBP之間發現了很強的直接相關性，這使人們可以斷言成年人毒血症期間SV和PBP的變化具有協同作用。在第3組患者中，在毒血症晚期，心輸出量變化的嚴重性增加證明了心肌功能活動的不穩定，這可能是由於該年齡組的伴發疾病（冠心病，高血壓）。必須考慮後者，而不能忽視繼續治療背景疾病的個體療法。
關鍵詞：畫夜節律，中風量，成人燒傷毒血症

Abstract. The closest to normal SV indicator was found in patients of group 2 with a total burn area of 54.3 ± 16.5%, grade 3 B of 11.9 ± 8.9%. An increase in the area of the skin surface burn of grade 3B in groups 1 and 3 to 21.3 ± 13.3% and 21.7 ± 6.7%, caused an increase in cardiac output in group 1 by 14-29%, in group 3 the SV rhythm was increased by 16-26% almost throughout the entire period of toxemia. A strong direct correlation was found between SV/PBP, which allows one to assert the synergism of changes in SV and PBP during toxemia in adults. An increase in the severity of changes in cardiac output in the late periods of toxemia in patients of group 3 testified to the instability of the functional activity of the myocardium, possibly due to concomitant diseases characteristic of this age group (coronary heart disease, hypertension). The latter must be taken into account, without neglecting the continuation of individual therapy for background diseases.

Keywords: circadian rhythm, stroke volume, adult burn toxemia

Relevance. In victims of fires, after 12-24 hours, changes in the heart were constantly observed. Very often, the heart muscle even looked altered macroscop-

ically. So, almost always there was a sharp plethora of the heart, the presence of small hemorrhages under the epicardium, in some cases - turbid swelling of the myocardium. Hyperemia of the arterial, venous and capillary network, stasis phenomena and small perivascular hemorrhages were present in the left ventricle, in the right, and in the atria. The early appearance of dystrophic changes in muscle fibers, granular myocardial dystrophy, expressed more or less sharply, were almost always noted. A significant part of the muscle fibers was swollen, without clear boundaries, there were small areas of muscle tissue necrosis, where the fibers merged into a homogeneous fine-grained pink mass devoid of nuclei. Fragmentation and decay of muscle fibers were seen in places. These dystrophic-necrotic processes are conventionally called in the literature "damage" of the myocardium (M. Schle-sinper, L. Reiner, 1955, etc.) [4,5,6]. Attention was drawn to early arising degenerative-necrotic changes in the heart. The authors have shown that the age of patients over 50 years old, the presence of coronary heart disease with circulatory failure are risk factors for the development of SMSV. Small cardiac output syndrome can develop in burn shock despite stable blood pressure. The high mortality rate of severely burned patients during the period of burn shock or after recovery from it indicates that the issues related to the therapy of their circulatory disorders are far from being resolved [1,2,3].

Purpose of the work. Study changes in the circadian rhythm of the stroke volume during the period of toxemia of burn disease in adults.

Material and research methods. The results of monitoring the stroke blood volume (SV) index of 25 patients admitted to the Department of Cambustiology of the Republican Scientific Center for Emergency Medicine due to burn injury were studied. After recovery from shock, anti-inflammatory, antibacterial, infusion therapy, correction of protein and water-electrolyte balance disorders, early surgical, delayed necrectomy, additional parenteral nutrition, syndromic, symptomatic therapy were performed. Changes in the circadian rhythm of the stroke volume (SV) of the heart were studied by monitoring the hourly continuous recording of hemodynamic parameters in patients with severe thermal burns in three age groups - group 1, 12 patients aged 20-40 years, group 2 - 7 patients aged 41-60 years, Group 3, 6 patients - 61-78 years old. The division into groups was dictated by the well-known characteristics inherent in each age group, described in detail in the literature. The calculation of the stroke volume index was carried out according to the formula: SV=PBP*100/MAP.

Results and discussion. As can be seen from tab.1, the age groups were significantly different and averaged 27.3 ± 5.6 years in group 1.50.7 $\pm$ 7.1 years in the second, and 71.3 ± 7.0 years in the third. The total area and area of deep skin burn lesions did not differ significantly between the groups.

	Age, years	Height, cm	Weight, kg	Total area of the burn,%	Burn of 3B grade	IF, units	Days in the ICU
Group 1	27,3±5,6	174,9±5,7	73,0±22,2	59,4±13,5	21,3±13,3	119,4±38,4	22,4±14,6
Group 2	50,7±7,1	165,8±6,3	73,8±14,3	54,3±16,5	11,9±8,9	92,5±20,8	13,3±2,4
Group 3	71,3±7,0	165,3±8,4	73,3±8,9	40,8±5,8	21,7±6,7	86,7±12,8	18,8±9,5

The highest index of IF was revealed in group 1, which determined the longest duration of intensive therapy in ICU conditions in the youngest group 1. Thus, the most pronounced burns in area and depth were found in patients of group 1. The study of the mean value of the mesor of the circadian rhythm SV during the period of toxemia made it possible to detect normal SV values during the day in patients of group 2 (tab. 2). While in group 1, cardiac output was significantly higher both in the daytime and at night than in group 2, on average by 30% (tab.2). No significant differences in the mesor of the SV circadian rhythm depending on the age on the day of admission were found (tab.3). However, during the period of toxemia in group 1 of patients, a reliably significant increase in the level of the mesor of the SV circadian rhythm was found during the first 12 days.

Gr.	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	1	2	3	4	5	6	7
1	56±6	56±5	57±5	56±5	55±5	55±4	56±6	58±5	57±6	57±5	56±6	57±5	57±5	57±5	56±5	56±5	57±5	57±5	58±6	58±5	58±5	58±5	58±4	58±5
2	42±2*	42±2*	42±3*	42±2*	41±3*	41±3*	41±2*	42±3*	41±2*	42±2*	42±2*	42±2*	41±2*	42±2*	42±2*	43±2*	42±2*	45±3*	43±3*	42±3*	43±3*	43±3*	42±2*	41±2*
3	49±5	49±5	48±5	50±5	48±5	47±5	48±5	49±5	51±5	49±5	51±5	52±6	48±5	50±6	49±5	50±7	50±6	51±4	49±4	49±5	50±5	50±5	50±5	49±5

*- reliable relative to the indicator in group 1

Table 3

Dynamics of the SV circadian rhythm mesor depending on age

Days	Group 1	Group 2	Group 3
1	47,8±1,9*	41,7±2,5	48,5±2,9*
2	50,4±2,1*	39,9±1,2	48,2±3,7*
3	49,6±1,6*	39,7±1,4	53,8±2,9*
4	53,3±1,4*	41,3±1,7	52,9±2,7*
5	53,3±1,4*	43,1±1,4	45,8±3,7
6	53,2±1,8*	41,9±2,3	50,2±2,8*
7	51,7±1,7*	45,1±1,6	53,7±2,9*
8	53,2±2,2*	42,2±1,5	49,0±2,2*
9	50,9±1,9*	45,0±1,3	47,7±3,4
10	53,0±1,8*	39,0±1,6	47,8±2,9*
11	54,9±2,8*	44,3±2,4	56,4±3,1*
12	53,2±2,0*	41,4±1,1	48,2±4,5
13	50,7±2,3		54,4±3,5
14	56,5±2,9		47,4±4,9
15	50,3±2,5		47,4±4,1
16	56,4±3,0		48,3±4,5
17	62,3±3,3		44,1±3,5
18	61,0±2,5		50,7±2,7
19	57,7±1,7		54,4±4,1
20	65,1±3,1		54,7±3,4
21	63,8±3,9		50,4±4,4
22	66,4±2,2		50,0±5,8
23	61,9±3,2		49,0±5,3
24	65,1±3,6		46,8±3,9
25	59,9±1,9		53,0±8,1
26	55,6±2,3		51,9±7,0
27	60,1±2,5		40,6±4,8
28	61,4±2,9		43,4±4,8
29	62,9±3,1		49,0±6,3
30	60,4±2,7		41,6±3,4

*- the difference is significant relative to the indicator in group 2

The SV indicator closest to the norm was found in patients of group 2 (tab. 3). In group 1, the circadian rhythm mesors were increased by 14 - 29% (p <0.05, respectively) throughout the entire period of toxemia, while in elderly patients of group 3, a decrease to the normative SV indicator by 5,9,12 days was revealed. The rest of the time, SV of elderly patients was increased by 16-26% (p <0.05, respectively). The revealed differences were most likely associated with a larger

area of deep 3B degree burns (fig. 1). Thus, the 3B burn area of the skin surface in group 2 was $11.9 \pm 8.9\%$, while in groups 1 and $3.21.3 \pm 13.3\%$ and $21.7 \pm 6.7\%$, almost twice as much, which led to an increase in cardiac output, which was not only compensatory in response to increased oxygen demand under conditions of a more pronounced systemic inflammatory reaction, but also an increase in the need for detoxification through accelerated blood flow, maintaining the required level of capillary perfusion under conditions of hypermetabolism. Thus, the increase in SV is primarily associated with the size of deep grade 3B burns, which contribute to the formation of a hyperdynamic type of blood circulation, in which stroke output of the heart is of leading importance in adults.

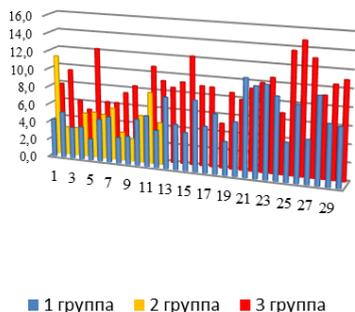Dynamics of the amplitude of the circadian rhythm of the SV, ml

Fig.1

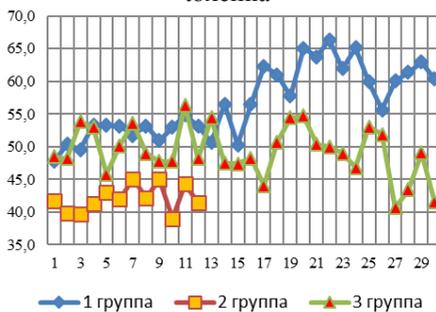Changes in the mesor of the circadian rhythm of the SV during the period of toxemia

Fig.2

Dynamics of the range of daily variations in the circadian rhythm of the SV, ml
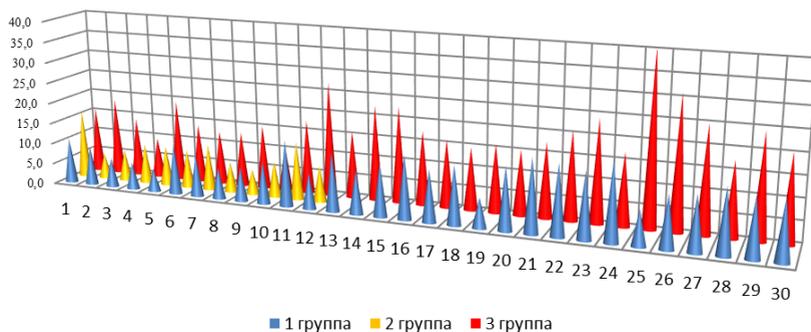

Fig.3

One of the parameters of the circadian rhythm, characterizing the adequacy of the compensatory reactions of the circadian rhythm of hemodynamics, is the amplitude of the daily fluctuations of the studied indicator. Comparative analysis made it possible to state the maximum values of the amplitude of the SV circadian rhythm in group 3, especially in the third-fourth week of toxemia (fig. 2), when the amplitude of daily SV fluctuations reached 12-14 ml, the range of daily SV changes reached 27 ml on the 12th day, 25th day 40 ml. An increase in the severity of changes in cardiac output (fig. 3) in the late periods of toxemia testified to the instability of the functional activity of the myocardium in group 3 patients, possibly due to concomitant diseases characteristic of this age group (coronary heart disease, hypertension). The latter must be taken into account, not missing the continuation of the usual therapy for background diseases.

Correlations of mesors of indicators of hemodynamic parameters and body temperature
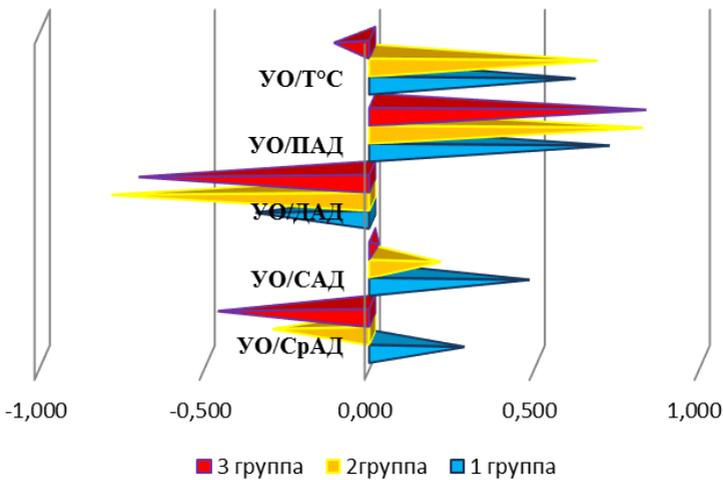
Fig.4

Significant correlations were found between the mesors of hemodynamic parameters in three groups SV/PBP (0.721; 0.821; 0.831, respectively), inverse between SV/DBP in groups 2 and 3 (-0.789; -0.708), which significantly decreased in patients of group 1 (-0.353). That is, in response to an increase in cardiac output in groups 2 and 3, the tone of peripheral vessels decreased compensatory, while in group 1 this mechanism of compensatory response indicated the disappearance of relaxation of the vascular wall in response to SV growth, which was most likely

associated with excessive stress response in case of grade 3B burn 21.3 ± 13.3%, IF 119.4 ± 38.4 units. There was a moderate direct relationship between SV and body temperature in groups 1 and 2 (0.617; 0.683, respectively). A strong direct correlation was found SV/PBP (0.721; 0.821; 0.831, respectively), which allows us to assert the synergism of changes in SV and PBP during toxemia in adults.

Duration and degree of displacement of the acrophase
of the circadian rhythm of the SV
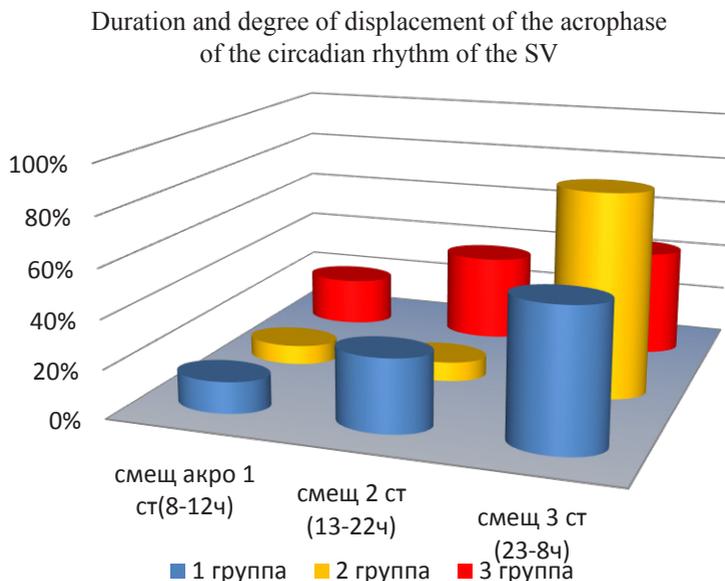
Fig.5

Inversion of the SV circadian rhythm turned out to be the longest, accounting for 84% of the duration of toxemia in patients of group 2, slightly less in group 1 - 57%, and in patients of group 3, a displacement of the acrophase of the SV circadian rhythm was observed during 44% of the duration of intensive therapy in ICU (fig. 5). The shift in the maximum cardiac output at night was most pronounced with less, compared with groups 1 and 3 of traumatized burn injuries, which indicates a more active participation in the adaptive rearrangement of the phase structures of the SV circadian rhythm (shift of the acrophase peak to night hours) with a burn area of 3B degree 11.9 ± 8.9%.

Conclusion. The SV indicator closest to normal was found in patients of group 2 with a total burn area of 54.3 ± 16.5%, grade 3 B of 11.9 ± 8.9%. An increase in the area of the skin surface burn of grade 3B in groups 1 and 3 to 21.3 ± 13.3% and 21.7 ± 6.7%, caused an increase in cardiac output in group 1 by 14-29%, in group 3 the SV rhythm was increased by 16-26% almost throughout the entire

period of toxemia. A strong direct correlation was found between SV/PBP, which allows one to assert the synergism of changes in SV and PBP during toxemia in adults. An increase in the severity of changes in cardiac output in the late periods of toxemia in patients of group 3 testified to the instability of the functional activity of the myocardium, possibly due to concomitant diseases characteristic of this age group (coronary heart disease, hypertension). The latter must be taken into account, without neglecting the continuation of individual therapy for background diseases.

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2014–2019年莫斯科工作年齡以上人群因肺癌反復致殘的特徵
CHARACTERISTICS OF REPEATED DISABILITY DUE TO LUNG CANCER AMONG PEOPLE OVER WORKING AGE IN MOSCOW FOR THE PERIOD 2014-2019

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抽象。在2014-2019年間，對莫斯科超過工作年齡的人因肺癌反復致殘的研究表明：經過重新診斷為殘疾的超過工作年齡的人的數量趨於增加；由於這些原因，這一年齡組在RRD的結構中占主導地位，並有增加其份額和殘疾程度的趨勢；男性占主導地位，殘疾水平呈上升趨勢；在男性中按殘疾群體劃分的殘疾結構中，第二類殘疾人占主導地位，傾向於增加其比例和殘疾水平；第一組的殘疾人傾向於減少他們的份額和水平。第三類殘疾人在婦女中占主導地位，有增加其份額和水平的趨勢；注意到男性中廣泛和密集的再殘疾率更高。

發病率和殘疾之間有著千絲萬縷的聯繫，反映了因果關係的統一性。在這方面，由於惡性腫瘤導致的殘疾是公共衛生的指標之一，需要進行認真而有針對性的研究（1、2、4）。包括肺癌在內的主要癌症形式的殘疾水平是醫學和社會意義的重要指標之一，並表徵了向該組患者提供的醫療和預防保健的質量（3、5、6、7 ）。

關鍵詞：肺癌，反復殘疾，性別特徵，殘疾群體，年齡大於殘疾年齡。

Abstract. The study of repeated disability due to lung cancer among people over working age in Moscow in 2014-2019 showed that: the contingent of people over working age who have been re-diagnosed with disability tended to increase; the predominance of this age group in the structure of RRD from these reasons with a tendency to increase their share and the level of disability; the predominance of males and the trend towards an increase in the level of disability; in the structure of disability by disability groups among men, disabled persons of the II group predominated with a tendency to increase their share and the level of disability; disabled people of group I had a tendency to decrease their share

and level. Disabled persons of the III group predominated among women with a tendency to increase their share and level; higher extensive and intensive rates of re-disability were noted among men.

Morbidity and disability are inextricably linked and reflect the unity of cause and effect. In this regard, disability due to malignant neoplasms as one of the indicators of public health requires careful and purposeful study (1, 2, 4). The level of disability in the leading nosological forms of cancer, including lung cancer, is one of the important indicators of medical and social significance and characterizes the quality of medical and preventive care provided to this group of patients (3, 5, 6, 7).

Keywords: lung cancer, repeated disability, gender characteristics, disability groups, older than the disabled age.

Purpose of the study: study of repeated disability due to lung cancer among people over working age in Moscow, taking into account gender characteristics and the severity of disability for 2014-2019.

Materials and methods: The research is continuous. The information database of EAVIIAS MSU PKU "GB MSU in Moscow" of persons with disabilities due to lung cancer of persons older than working age reexamined in the MSU bureau, the state statistical observation form № 7-Sobes were used. Research methods: data copying, descriptive statistics (absolute, extensive, intensive indicators, confidence indicators, average error). Statistical analysis. Research period: 2014-2019

Results and discussion: The number of persons re-recognized as disabled by the ITU Bureau due to lung cancer among the adult population in Moscow in 2014 was 723 people, in 2015 - 661 people (loss rate - 8.6%), in 2016 increased to 760 people (growth rate + 14.9%), in 2017 their number was 900 people, (growth rate + 18.4%), in 2018 - 952 people (+ 5.8%), in 2019 - 957 people (+0, 5%). Their absolute number was 4953 people during the study period, an average of 826 people per year. In the total contingent of people with disabilities due to lung cancer, they ranged from 40.5% to 50.1% in 2014-2019, on average, their share was 45.7%. The level of repeated disability due to lung cancer among the adult population was characterized by a growth trend from 0.63 ± 0.02 to 0.90 ± 0.01, averaging 0.78 ± 0.02 per 10 thousand adults. (table 1).

In the structure of persons re-recognized as disabled (RRD) due to lung cancer, the disabled over working age were 453 people in 2014, their share was 62.7%, in 2015 their number decreased to 422 people (the rate of decline was 6.8%), the total share was 63.8%. In 2016, their number was 526 people (growth rate + 24.6%), in the RRD structure it was 69.2%. In 2017 - 591 people (+ 12.4%), with a share equal to 65.7%. In 2018, their number was 644 people (growth rate + 8.9%), in 2019 - 662 people (+ 2.8%). Their absolute number for the period 2014-2019 was 3298 people, on average 550 people per year. Their share in the RRD structure

averaged 66.3%. The level of repeated disability due to lung cancer among people older than working age was recorded in dynamics with a growth trend from 1.35 ± 0.17 to 1.89 ± 0.15, averaging 1.67 ± 0.16 per 10 thousand of the corresponding population.

In the gender structure of repeated disability due to lung cancer among people over working age in Moscow, men predominated. Their total number has increased over time from 317 people to 400 people, in total, it was 2075 people, on average 346 people per year. Their share in the dynamics of the RRD structure for these reasons decreased from 70.0% to 60.4%, averaging 63.3%. The level of repeated disability due to lung cancer among men fluctuated within the range of 2.8 ± 0.27 - 3.6 ± 0.24, averaging 3.3 ± 0.26 per 10 thousand of the corresponding population (table 2).

The number of RRD women in this age group also increased from 136 to 262 people. Their absolute number was 1223 people, an average of 204 people per year.

As follows from Table 3, in the structure of RRD due to lung cancer among people over working age in Moscow among men in 2014, disabled people of group I-40.1% prevailed with a level equal to 1.35 ± 0.30 per 10 thousand of the corresponding population. In 2015, disabled people of groups I and II accounted for 38.2% with levels equal to 1.1 ± 0.30. Since 2016, the leading position has been taken by persons with disabilities of the II group, their share was 42.9% with a growth rate of 1.36 ± 0.30 per 10 thousand of the corresponding population. In the dynamics, there is a slight decrease in their share to 39.7% in 2018, in 2019 an increase to 49.8%. On average, for 2014-2019, their share was 41.8% with a level equal to 1.41 ± 0.29 per 10 thousand of the corresponding population. The absolute number of RRDs among men in group II was 875 people, on average 146 people per year.

The second place in the RRD structure among men was taken by disabled people of group I. Their share in the dynamics decreased from 40.1% in 2014 to 22.8% in 2019, averaging 34.7%. The level of repeated disability of group I among men tended to decrease from 1.35 ± 0.30 in 2014 to 0.80 ± 0.04 in 2019, averaging 1.16 ± 0.29 per 10 thousand of the corresponding population, which is lower than the intensive indicator of disabled persons of group II ($p < 0.05$). The smallest proportion among RRD men was group III disabled. Their share in the RRD structure varied from 22.4% to 27.4%, on average it was 23.5%, which is lower than the extensive indicator of I-II disability groups ($p < 0.05$). The level of repeated disability of group III among men fluctuated within the range of 0.66 ± 0.06 - 0.97 ± 0.02, on average it was 0.77 ± 0.05 per 10 thousand of the corresponding population, which is significantly less than the intensive indicators of disability I -II groups ($p < 0.05$). The absolute number of persons with disabilities of the III group was 491 people, on average 82 people per year.

Among women of this age group, disabled persons of the III group predominated. Their number in dynamics varied from 13 people to 107 people with a tendency to increase. Their absolute number was 448 people, an average of 75 people per year. Their share in the RRD structure from these reasons was also recorded with an increase from 31.6% to 40.8%, averaging 35.9%. The level of repeated disability of group III among women was lower than among men, varied from 0.20 ± 0.05 to 0.45 ± 0.05, averaged 0.33 ± 0.05 per 10 thousand of the corresponding population and was 2.3 times lower than the intensive indicator of group III disability among men ($p < 0.05$).

The second place in the structure of RRD among women due to lung cancer is taken by disabled persons of group II. In dynamics, there is an increase in their number from 43 people in 2014 to 87 people in 2019, their absolute number was 410 people, on average 68 people per year. The share of disabled people of group II fluctuated within the limits of 31.6% - 36.2%, on average it was 33.6%, which is lower than the extensive indicator of group II disability among men (41.8) $p < 0.05$. The level of repeated disability of group II among women is significantly lower than among males, it tended to increase from 0.20 ± 0.06 in 2014 to 0.37 ± 0.05 in 2019, averaging 0.30 ± 0.06 per 10 thousand of the corresponding population, which is significantly lower than the intensive indicator of group II disability among men ($p < 0.05$). Disabled group I in the structure of RRD due to lung cancer among women amounted to 365 people, on average 61 people per year. Their share tended to decrease from 36.8% in 2014 to 26.0% in 2019, averaging 30.5%, which is lower than the extensive indicators of disability groups II-III ($p < 0.01$). The level of repeated disability of group I of this contingent of disabled people varied from 0.22 ± 0.06 to 0.32 ± 0.05, on average 0.27 ± 0.06 per 10 thousand of the corresponding population, which is lower than the intensive indicator of disability of group I among male by 4.3 times ($p < 0.05$).

Conclusion: The study of repeated disability due to lung cancer among people over working age in Moscow for 2014-2019 showed that:

• The contingent of persons over working age who have been re-established as disabled tended to increase.

• The prevalence of this age group in the structure of persons re-recognized as disabled from these reasons with a tendency to increase their share and the level of disability.

• The predominance of males and the trend towards an increase in the level of disability.

• In the structure of disability by disability groups among men, disabled persons of the II group predominated with a tendency to increase their share and the level of disability; disabled people of group I had a tendency to decrease their share and level. Disabled persons of the III group predominated among women with a tendency to increase their proportion and level.

• Higher extensive and intensive rates of re-disability were noted among men.

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Table 1

Dynamics of repeated disability of the adult population over working age due to lung cancer in 2014-2019 (absolute number,%, per 10 thous., $M \pm m$)

Years	Total RRD due to lung cancer			Of them older than working age		
	abs. number	spec. gravity	level	abs. number	spec. gravity	level
2014	723	100,0	$0,69 \pm 0,02$	453	62,7	$1,48 \pm 0,17$
2015	661	100,0	$0,63 \pm 0,02$	422	63,8	$1,35 \pm 0,17$
2016	760	100,0	$0,72 \pm 0,02$	526	69,2	$1,63 \pm 0,16$
2017	900	100,0	$0,85 \pm 0,01$	591	65,7	$1,78 \pm 0,16$
2018	952	100,0	$0,90 \pm 0,01$	644	67,6	$1,88 \pm 0,15$
2019	957	100,0	$0,90 \pm 0,01$	662	69,2	$1,89 \pm 0,15$
Average value	826	100,0	$0,78 \pm 0,02$	550	66,3	$1,67 \pm 0,16$

Table 2

Gender structure of RRD due to lung cancer among people over working age in Moscow in 2014-2019. (absolute number,%, per 10 thousand, M ± m)

Years	Total RRD among people over working age			Sex					
				Male			Female		
	abs. number	spec. gravity	level	abs. number	spec. gravity	level	abs. number	spec. gravity	level
2014	453	100	1,49 ± 0,17	317	70,0	3,4 ± 0,27	136	30,0	0,64 ± 0,04
2015	422	100	1,35 ± 017	270	64,4	2,8 ± 0,27	152	36,0	0,71 ± 0,04
2016	526	100	1,63 ± 0,16	322	61,2	3,2 ± 0,26	204	38,8	0,92 ± 0,02
2017	591	100	1,78 ± 0,16	371	62,8	3,5 ± 0,24	220	37,2	0,97 ± 0,01
2018	644	100	1,89 ± 0,15	395	31,3	3,6 ± 0,24	249	38,7	1,1 ± 0,19
2019	662	100	1,89 ± 0,15	400	60,4	3,5 ± 0,24	262	39,6	1,1 ± 0,19
Average value	826	100	0,78 ± 0,02	550	66,3	1,67 ± 0,16	826	100,0	0,78 ± 0,02

Table 3

Gender structure of repeated disability due to lung cancer among people over working age, taking into account the severity of disability for 2014-2019. (absolute number,%, per 10 thousand, M ± m)

Years	Sex:	Disability group								
		I			II			III		
		abs. number	spec. gravity	level	abs. number	spec. gravity	level	abs. number	spec. gravity	level
2014	male	127	40,1	1,35 ± 0,30	119	37,5	1,27 ± 0,30	71	22,4	0,76 ± 0,05
	female	50	36,8	0,24 ± 0,03	43	31,6	0,20 ± 0,06	43	31,6	0,20 ± 0,05
2015	male	103	38,2	1,1 ± 0,31	103	38,2	1,1 ± 0,30	64	23,6	0,66 ± 0,06
	female	47	30,9	0,22 ± 0,06	55	36,2	0,26 ± 0,06	50	32,9	0,23 ± 0,06
2016	male	112	34,8	1,10 ± 0,31	138	42,9	1,36 ± 0,30	72	22,3	0,71 ± 0,05
	female	61	29,9	0,28 ± 0,06	67	32,8	0,30 ± 0,06	76	37,3	0,34 ± 0,05
2017	male	135	36,4	1,29 ± 0,28	159	42,9	1,51 ± 0,28	77	20,7	0,73 ± 0,05
	female	65	29,5	0,29 ± 0,06	77	35,0	0,34 ± 0,05	78	35,5	0,34 ± 0,05
2018	male	141	35,7	1,30 ± 0,28	157	39,7	1,44 ± 0,28	77	24,6	0,89 ± 0,03
	female	74	29,7	0,32 ± 0,05	81	32,5	0,35 ± 0,05	94	37,8	0,41 ± 0,05
2019	male	91	22,8	0,88 ± 0,04	199	49,8	1,76 ± 0,27	110	27,4	0,97 ± 0,02
	female	68	26,0	0,29 ± 0,06	87	33,2	0,37 ± 0,05	107	40,8	0,45 ± 0,05
Average Value	male	118	34,7	1,16 ± 0,29	146	41,8	1,41 ± 0,29	82	23,5	0,77 ± 0,05
	female	61	30,5	0,27 ± 0,06	68	33,6	0,30 ± 0,06	75	35,9	0,33 ± 0,05

甲醛對大鼠的毒性作用下肺和支氣管結構特徵
CHARACTERISTIC OF LUNGS AND BRONCHI STRUCTURE UNDER TOXIC EFFECT OF FORMALDEHYDE ON RATS

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抽象。　甲醛對各種實驗動物的作用已進行了足夠詳細的研究，但大多數是在急性實驗中進行的。　這項研究表明，長時間暴露於該物質的蒸氣中，支氣管肺系統的結構發生了變化。
關鍵詞：甲醛，肺，BALT，實驗動物，實驗。

Abstract. The effect of formaldehyde has been studied in sufficient detail on various laboratory animals, but mostly in acute experiments. This study shows changes in the structure of the bronchopulmonary system during prolonged exposure to the vapors of this substance.

Key words: *formaldehyde, lungs, BALT, laboratory animals, experiment.*

Introduction
Formaldehyde has a general toxic effect on all organs and systems. It is proved that it affects the nervous system, respiratory tract, liver, kidneys, and eyes, and also has a sensitizing, carcinogenic, teratogenic, embryotoxic and mutagenic effect [1]. In addition, formaldehyde causes various skin diseases. [2,3]. Reproductive system dysfunctions have been reported in women exposed to formaldehyde, that manifested by menstrual irregularities, spontaneous abortion [4,5]. Tong et. el., 2007 revealed the hematotoxicity of formaldehyde [6]. A number of authors also noted the effect of this substance on the immune mechanisms [1,7–11].

Ingestion of formaldehyde leads to the development of degenerative liver damage, atrophy, hemorrhage and necrosis of the gastric mucosa, as well as acute renal failure with a fatal outcome within 24 hours [12–15].

Inhalation of formaldehyde vapors irritates the upper respiratory tract. Wang, 2000 noted a decrease in the ventilation function of the lungs, when examining factory workers in contact with formaldehyde in a concentration 3,07±5,83 mg/m³ [16]. While some other authors, Z. Hong 2007, do not tell about such changes [17]. Also, there are a growing allergic reactions [18–20].

Several authors have indicated a link between various organs cancer development and the effect of formaldehyde, and the duration of its exposure [21–27].

Recently, there has been a tendency to reduce the hazard class of working conditions, but the effect of formaldehyde on the body remains the same. And a one-time short air sample in the working zone may incorrectly reflect the overall exposure to chemicals, in particular formaldehyde, therefore, the determination of such substances in an inner environment of human body is more relevant than their sampling and determination in the air [28].

Based on the literature data reviewed, which describes the effect of formaldehyde on the humans and laboratory animals [5,29], the study was carried out to define changes in the bronchopulmonary system after exposure to formaldehyde vapors of different concentrations.

Materials and methods

The experiment was carried out on 25 male laboratory albino rats of the same age (1 year) and weight (≈300 ± 20 g), obtained from the vivarium of the Northern State Medical University (Russia, Arhangelsk), where they were kept on a standard diet.

To create the conditions for assessment of the formaldehyde vapors effect, rats were kept in 3 identical closed boxes with a transparent cover and ventilation holes for minimum air exchange. Two boxes contained two experimental groups of 10 rats each, the third contained 5 rats from the control group. In boxes of experimental groups placed the container with formaldehyde solution (90% and 50%) with vapor-passing holes (twice a week replacement). The concentration of formaldehyde vapors in the air that the rats were breathing was not measured. The experiment lasted 6 months.

At the end of the time, the material was taken, processed by standard methods, after optical microscopy was performed.

Results

In the lungs of rats exposed to toxic vapors at 50% formaldehyde was revealed epithelioid cell granulomas with giant cells of the Langhans type (fig. 1), vascular congestion, and tendency to sclerosis and hyalinosis of the pulmonary parenchyma (fig. 2).

Also there were pronounced bronchus-associated lymphoid tissue (BALT) hyperplasia (fig. 3), which has been studied and described in different healthy animals [30–32], accompanied by formation of lymphoid follicles with light centers (fig. 4). There were vascular congestion with intra-alveolar hemorrhage (fig. 5), bronchospasm with desquamation of the epithelium and the basement membrane denudation, peribronchial sclerosis with a tendency to hyalinosis of the small vessels walls (fig. 6) and calcification of bronchial cartilage (fig. 7). For comparison, you can see the structure of the intact rat lung from the control group (fig. 8).

In the lungs of rats exposed to vapors at 50% formaldehyde was revealed more pronounced pathological changes in the lungs: all rats had extensive areas of sclerosis with a tendency to hyalinosis (fig. 9), granulomatous inflammation with giant cells of the Langhans type, pronounced BALT hyperplasia (fig. 10). In this group of rats occurred more pronounced vascular congestion (fig. 11), some rats had focal emphysema (fig. 12).

Conclusions

The revealed pathological manifestation in the lungs shows an obvious toxic effect of formaldehyde vapors, leading to extensive inflammatory changes in the lung parenchyma, hyperplasia of BALT. Sensitization and vascular congestion of lung tissue occured. With prolonged exposure, the process is chronized, manifested by the presence of extensive areas of sclerosis, hyalinosis, and calcification of cartilage tissue. The speed and manifestation degree of pathological changes directly depended on the concentration of formaldehyde vapor. That corresponds to the literature data.

Appendix
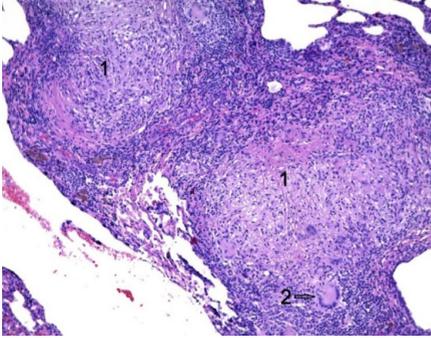
Figure 1. The structure of the rat lung (exposure to vapors of 50% formaldehyde). Epithelioid cell granulomas (1) with giant cells of the Langhans type (2). Hematoxylin-eosin. Ob. 10, oc. 10
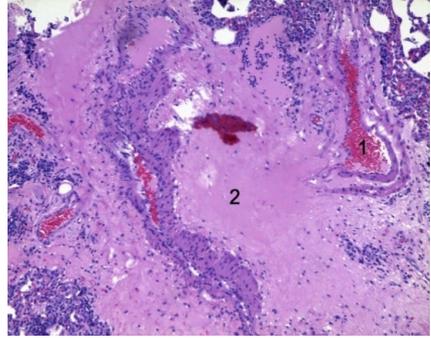
Figure 2. The structure of the rat lung (exposure to vapors of 50% formaldehyde). Vascular congestion (1), sclerosis and hyalinosis of the pulmonary parenchyma (2). Hematoxylin-eosin. Ob. 10, oc. 10
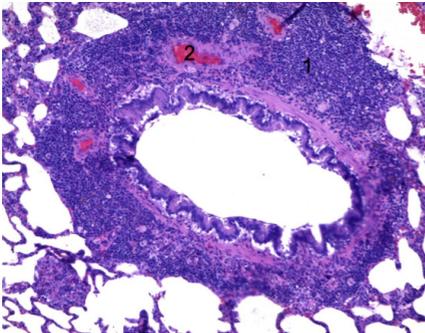
Figure 3. The structure of the rat lung (exposure to vapors of 50% formaldehyde). Pronounced BALT hyperplasia (1), vascular congestion (2). Hematoxylin-eosin. Hematoxylin-eosin. Ob. 10, oc. 10
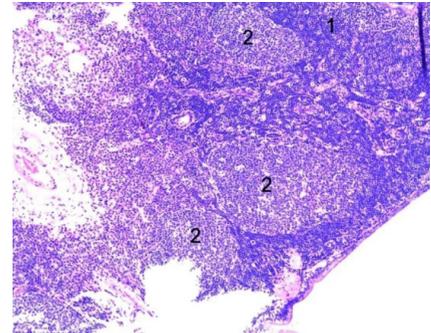
Figure 4. The structure of the rat lung (exposure to vapors of 50% formaldehyde). Pronounced BALT hyperplasia (1) with the formation of lymphoid follicles with light centers (2). Hematoxylin-eosin. Ob. 10, oc. 10

Figure 5. *The structure of the rat lung (exposure to vapors of 50% formaldehyde). Vascular congestion (1) with intra-alveolar hemorrhage (2). Hematoxylin-eosin. Ob. 10, oc. 10*

Figure 6. *The structure of the rat lung (exposure to 50% formaldehyde vapor). Bronchospasm with desquamation of the epithelium and the basement membrane denudation (1), peribronchial sclerosis (2) hyalinosis of the small vessels walls (3). Hematoxylin-eosin. Ob. 10, oc. 10*
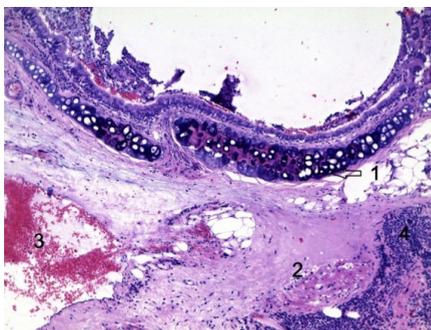
Figure 7. *The structure of the rat lung (exposure to 50% formaldehyde). Calcification of bronchial cartilage (1), peribronchiolar sclerosis of the lung tissue with a tendency to hyalinosis (2), vascular congestion (3), BALT hyperplasia (4). Hematoxylin-eosin. Ob. 10, oc. 10*

Figure 8. *The structure of the rat lung (control group intact lung). Absence of BALT hyperplasia. Hematoxylin-eosin. Ob. 10, oc. 10*

Figure 9. *The structure of the rat lung (exposure to vapors of 90% formaldehyde). Extensive areas of sclerosis with a tendency to hyalinosis. Hematoxylin-eosin. Ob. 10, oc. 10*
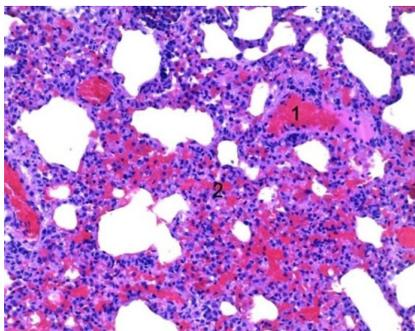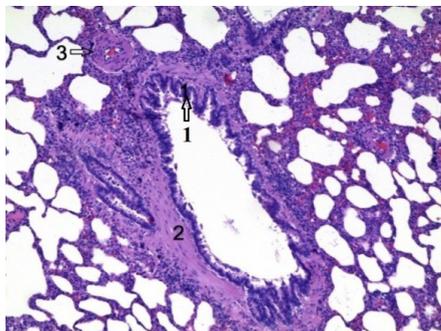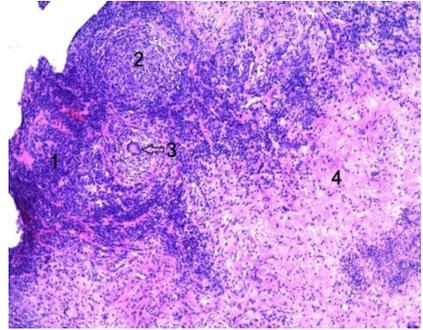

Figure 10. *The structure of the rat lung (exposure to vapors of 90% formaldehyde). BALT hyperplasia (1), epithelioid cell granulomas (2) with giant cells of the Langhans type (3), extensive areas of pulmonary parenchyma sclerosis (4). Hematoxylin-eosin. Ob. 10, oc. 10*
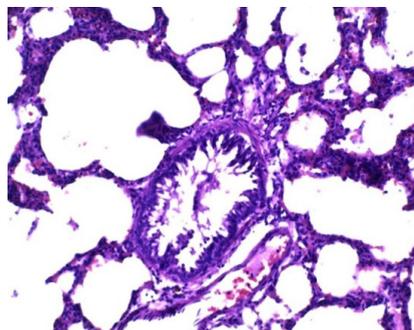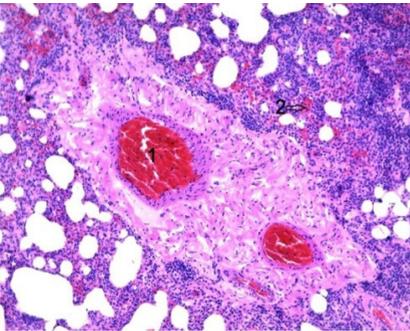

Figure: 11. *The structure of the rat lung (exposure to vapors of 90% formaldehyde). Pronounced vascular congestion (1) with hemorrhages (2). Hematoxylin-eosin. Ob. 10, oc. 10*
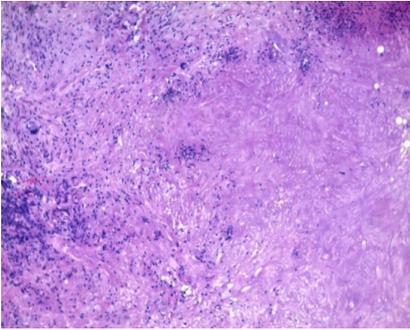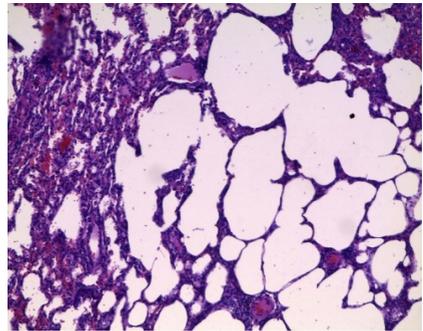

Figure: 12. *The structure of the rat lung (exposure to vapors of 90% formaldehyde). Areas of focal emphysema. Hematoxylin-eosin. Ob. 10, oc. 10*

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缺血性心肌病的鑑別臨床和實驗室體徵
DIFFERENTIAL CLINICAL AND LABORATORY SIGNS OF ISCHEMIC CARDIOMYOPATHY

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抽象。

目的是確定與冠心病患者相比，缺血性心肌病（ICMP）的血液成分（半乳糖凝集素3，白介素（IL）-10，非經典單核細胞的含量）的獨特特徵和臨床狀況（ CHD）無心肌病。

材料與方法。共有52例心力衰竭和CHD（II-IV功能性心絞痛）伴或不伴ICMP的患者（分別為30和22例）入組。對照組由15名年齡和性別分佈可比的健康人組成。用ELISA法測定血漿galectin-3和IL-10（IL-10）的濃度。通過流式細胞術（通過CD14和CD16的表達）評估外周血中非經典單核細胞的含量。

結果。結果表明，在ICMP患者中，存在非經典單核細胞缺乏症（5.43 [3.44；7.86]％，p = 0.003），IL-10過多（30.00 [27.00；36.00] pg / ml），p = 0.049），並且與沒有ICMP的CHD患者相比，血液中半乳糖凝集素3的含量增加（分別為8.00 [7.20；9.20]和6.10 [4.30；7.48] ng / ml，p = 0.025）。根據分類，這些參數允許在所有冠心病患者中準確識別出70名（p = 0.009），68名（p = 0.082）和70％（p = 0.013）的ICMP患者。在ICMP中，與沒有ICMP的CHD患者相比，2型糖尿病的發生率更低（6.67％，p = 0.046）左心室舒張末期指數更大（80.93 [72.16；101.2] ml / m2）（ 31.82％和

18.07 ［14.60；27.05］ml / m2）。最後一個參數與血液中許多非經典單核細胞相關（r = -0.79； p〈0.05）。

結論。 ICMP的特徵是IL-10過量和舒張末期指數降低（與血液中許多非經典單核細胞相關）。與非典型單核細胞的缺乏相比，galectin-3的血漿濃度升高，可以在冠心病患者中識別出患有ICMP的患者。

關鍵詞：缺血性心肌病，冠心病，單核細胞，galectin-3，白細胞介素10。

Abstract.

The aim *was to identify distinctive features of blood constitutive (a content of galectin-3, interleukin (IL)-10, non-classical monocytes) and clinical status of patients with ischemic cardiomyopathy (ICMP) in comparison with patients with coronary heart disease (CHD) without cardiomyopathy.*

Material and methods. *Total of 52 patients with heart failure and CHD (II-IV functional classes of angina), with and without ICMP (30 and 22 patients respectively), were enrolled. A control group consisted of 15 healthy people with comparable age and gender distribution. Plasma concentration of galectin-3 and interleukin-10 (IL-10) was determined by ELISA; the content of non-classical monocytes in peripheral blood was assessed by flow cytometry (by expression of CD14 and CD16).*

Results. *It was shown, that, in patients with ICMP, there were a deficiency of non-classical monocytes (5.43 [3.44; 7.86] %, p=0.003), an excess of IL-10 (30.00 [27.00; 36.00] pg/ml, p=0,049), and increased content of galectin-3 in the blood in contrast to CHD patients without ICMP (8.00 [7.20; 9.20] and 6.10 [4.30; 7.48] ng/ml, respectively, p=0.025). These parameters allow to identify patients with ICMP among all CHD patients accurate to 70 (p=0.009), 68 (p=0.082) and 70% (p=0.013), in accordance to classification. In ICMP, an incidence of type 2 diabetes mellitus was less (6.67%, p=0.046) and left ventricle end-diastolic index was greater (80.93 [72.16; 101.2] ml/m^2) than the same parameters in CHD patients without ICMP (31.82% and 18.07 [14.60; 27.05] ml/m^2 respectively). The last parameter was correlated with a number of non-classical monocytes in the blood (r=-0.79; p<0.05).*

Conclusion. *An excess of IL-10 and a decrease of end diastolic index, correlated with a number of non-classical monocytes in the blood, are features of ICMP. A deficiency of non-classical monocytes in contrast to increased plasma concentration of galectin-3 allows to identify patients with ICMP among CHD patients.*

Key words: *ischemic cardiomyopathy, coronary heart disease, monocytes, galectin-3, interleukin-10.*

Introduction. In modern cardiology, there is an acute problem of timely diagnosis of ischemic cardiomyopathy (ICMP) which develops in 25-30% of patients who have had a myocardial infarction [1]. In ICMP, a cardiomegaly and heart

chambers dilatation cause a progression of heart failure (HF) which becomes the leading one in the clinical picture of ICMP. Furthermore, the formation of essential diagnostically criterion for ICMP (a decrease in left ventricular ejection fraction of less than 40% [2]) reflects only significant remodeling of the myocardium, when surgical correction of the heart chambers is required. Thereby, besides morpho-functional criteria of ICMP, it is extremely important to search laboratory criteria that allow to detect the development of the disease. To date, it is known that the concentration of brain natriuretic peptide in the blood increases with the progression of ICMP [3, 4]. However, this blood marker reflects the preload of the heart and the progression of HF itself and not the pathological process in ICMP leading to ICMP. The role of galectin-3 as a marker of not heart failure, but fibrosis [5], which underlies the pathogenesis of ICMP, is also being actively discussed today. This makes galectin-3 attractive from the point of early detection of ICMP. In addition, we previously reported on features of the subpopulation composition of monocytes and cytokine profile of the blood in the ICMP patients, in contrast to patients with ischemic heart disease (IHD) not complicated by cardiomyopathy [6]. Apparently, the above mentioned blood parameters could be applied for identification of patients with ICMP among CHD patients which would help to establish the formation of cardiomyopathy, and not just the fact of its manifestation.

The aim is to establish the distinctive features of the blood composition (content of galectin-3, interleukin (IL)-10, and non-classical monocytes) and the clinical status of patients with ischemic cardiomyopathy in comparison with patients with coronary heart disease without cardiomyopathy.

Material and methods. The case-control study engaged 52 CHD patients with angina of effort of II-IV functional classes and circulatory inefficiency of predominantly II-IV functional classes according to NYHA. Patients with CHD were divided into 2 groups: 30 individuals suffering from ICMP (left ventricular ejection fraction ≤40%, acute myocardial infarction or revascularization, stenosis of the left main or proximal part of the left descending artery ≥75% or stenosis of two or more epicardial vessels ≥75% [2]) and 22 individuals without ICMP (left ventricular ejection fraction >40%, acute myocardial infarction or revascularization, coronary stenosis of any site ≥75%). The control group consisted of apparently healthy 15 people without any cardiovascular diseases. In peripheral blood plasma from the ulnar vein in patients of both study groups and healthy donors, the concentration of galectin-3 and interleukin-10 (IL-10) was determined by ELISA ("IL-10-IFA-BEST" (JSC "Vector-BEST", Novosibirsk) and «Human Galectin-3 ELISA» («Bender MedSystems», Austria)). Non-classical monocytes were determined on the base of expression of $CD14^+CD16^{++}$ (CD14-FITC, CD16 PE («BD Biosciens», USA)) molecules on the surface of cells, taking all cells positive for CD14 as 100%.

According to the analysis of clinical records, the functional classes of angina of effort and heart failure, the nature of comorbidity of patients, left ventricle end-diastolic index were detected according to the findings of echocardiography.

The study conformed to the principles outlined in the Declaration of Helsinki and was carried out with the permission of the local ethics committee of Siberian State Medical University (protocol №5046 (28.11.2016)). All subjects gave written informed consent for the use of their data. The criteria for excluding patients from the study were age over 70 years, autoimmune diseases, an allergic process in the stage of exacerbation, a tumor process, hypoplastic and megaloblastic anemias, virus hepatitis, syphilis, HIV-infection, pre-surgery therapy with iron-containing drugs, erythropoietin or immunosuppressive therapy, and the presence of acute infectious diseases less than 3 weeks before the surgery, as well as the patient's refusal of study.

Statistical data analysis was performed using «Statistica 10.0» program. When statistically describing the quantitative criteria, the median, 25th and 75th percentiles were calculated; when statistically describing the qualitative criteria, sample rate was calculated. For the purpose of comparative analysis of sample data, Mann-Whitney test (for independent samples) was used. To compare the frequencies of occurrence of signs in the group, we used the Chi-square test with Yates correction for continuity. To assess the linear relationships between studied criteria, the Spearman rank correlation coefficient was calculated. For the purpose of search for mathematical model for identification of ICMP patients from the total sample of IHD patients, we calculated the logistic regression for each studied blood parameter. The results of statistical analysis were considered significant at $p < 0,05$.

Results and discussion. Data analysis revealed that ICMP patients showed a decrease in the subpopulation of non-classical monocytes in the blood (Table 1) the number of which correlated with the left ventricle end-diastolic index ($r = -0,79$; $p < 0,05$). This demonstrates an important role of non-classical blood monocytes in the pathogenesis of ICMP, which are recirculating cells of the monocytic-macrophage system and can accumulate in the myocardium [7] mediating its remodeling and deficiency of non-classical monocytes in the blood. Blood concentration of IL-10 was higher in ICMP patients compared to both the group of healthy donors and IHD patients without ICMP, in whom it corresponded to the norm (Table 2). Meantime, the concentration of galectin-3 in the blood was higher in ICMP patients than in IHD patients without ICMP; however, in both groups, it was comparable with this indicator in healthy donors (Table 1).

Table 1.

The blood content of non-classical monocytes, galectin-3, and interleukin-10 in patients with coronary heart disease, with and without ischemic cardiomyopathy (Me [Pe25; Pe75])

Blood parameters	Group of surveyed persons		
	CHD without ICMP	CHD with ICMP	Healthy donors
Non-clsssical monocytes CD14$^+$CD16^{++}, %	8.11 [7.05; 10.83] p_c=0.263	5.43 [3.44; 7.86] **p_c=0.003** p=0.055	10.69 [9.34; 13.84]
IL-10, pg/ml	24.00 [22.00; 28.00] p_c=0.459	30.00 [27.00; 36.00] **p_c=0.049** **p=0.036**	21.00 [20.50; 28.00]
Galectin-3, ng/ml	6.10 [4.30; 7.48] p_c=0.722	8.00 [7.20; 9.20] p_c=0.123 p=0.025	7.07 [5.90; 8.20]

Note. CHD - ischemic heart disease, ICMP - ischemic cardiomyopathy, p_c - the level of statistical significance of differences in indicators in comparison with healthy donors (control), p – level of differences between groups of patients.

Logistic regression analysis made it possible to generate three mathematical models describing dependence of ICMP formation (value of the function is 1) or its absence (value of the function is 0) on the content of non-classical monocytes, galectin-3, and IL-10 in the blood. Among these models, only two were found to be statistically significant: the dependence of the diagnosis of ICMP on the content of non-classical monocytes (formula 1, p=0.009) and the concentration of galectin-3 in the blood (formula 2, p=0.013 in CHD patients. For the third regularity, the level of statistical significance did not reach 0.05 (formula 3, classification accuracy was 68%, p=0.082).

$$P = \exp (2{,}98 – 0{,}43*X_{non\text{-}classic}) / (1+ \exp (2{,}98 – 0{,}43* X_{non\text{-}classic})) \quad (1),$$

$$P = \exp (-3{,}24 + 0{,}44*X_{gal\text{-}3}) / (1+ \exp (-3{,}24 + 0{,}44*X_{gal\text{-}3})) \quad (2),$$

$$P = \exp (-2{,}38 + 0{,}09*X_{IL\text{-}10}) / (1+ \exp (-2{,}38 + 0{,}09*X_{IL\text{-}10})) \quad (3),$$

Note. $X_{non\text{-}classic}$ – the content of non-classical monocytes in the blood (%),

$X_{gal\text{-}3}$ – the content of galectin-3 in the blood (ng/ml),

$X_{IL\text{-}10}$ – the content of IL-10 in the blood (pg/ml),

P – прогнозируемая вероятность (1 – ICMP, 0 – CHD without ICMP).

Both statistically significant mathematical models had a sufficiently high classification accuracy (the predicted probability of diagnosing of ICMP or CHD without according to the model coincident with the observed diagnosis) – 70%. This make it possible to recommend the determination of the content of non-classical monocytes and galectin-3 in the blood of CHD patients in order to identify the pathological process leading to the development of ICMP.

That fact is important since the clinical status of CHD patients, with and without ICMP. Is characterized by minor differences. The severity of angina of effort and circulatory insufficiency (according to their functional classes, Table 2) in ICMP patients corresponded to those in CHD patients without cardiomyopathy. Grade III hypertension and pathology of gastrointestinal tract (gastritis; gastric ulcer duodenal ulcer less often) were the most common concomitant pathologies in both groups of patients, without significant differences between the cohorts of patients (Table 2).

In groups of ICMP patients, the incidence of kidney disease (chronic kidney disease) and lung pathology (chronic obstructive pulmonary disease, chronic bronchitis) was comparable. At the same time, type 2 diabetes mellitus was determined more often in CHD patients without ICMP (Table 2), which can be explained by the increased content of IL-10 and galectin-3 in their blood. Since type 2 diabetes mellitus is associated with obesity, which now is considered a chronic inflammation in adipose tissue that induces insulin resistance [8], a high level of anti-inflammatory IL-10 may inhibit the development of diabetes mellitus. An increased blood content of galectin-3, which is able to bind and facilitate the utilization of glycated molecules [5] may have a similar effect. This explains the lower incidence of type 2 diabetes mellitus in ICMP patients.

In addition, in accordance with predominant diagnosis, there were differences in functional parameters of the myocardium between the groups of CHD patients: in patients with ICMP, lower values of the ejection fraction and higher value of the left ventricle end-diastolic index were noted (Table 2). In ICMP, the relationship of the latter with the number

Table 2.

Clinical characteristics of patients with coronary heart disease, with and without ischemic cardiomyopathy Me [Pe25; Pe75])

Indices	CHD without ICMP	CHD with ICMP	p-value
Number of patients: men, % women, %	22 18 (81.81%) 4 (18.18%)	30 27(90.00%) 3(10.00%)	- 0.658 0.658
Age, years	64.0 [59.5; 68.0]	61.0 [56.0; 64.0]	0.110

Functional class of angina	II	4 (18.18%)	7 (23.33%)	0.916
	III	16 (72.73%)	20 (66.67%)	0.870
	IV	2 (9.09%)	3 (10.00%)	0.714
Functional class of circulatory inefficiency (according to NYHA)	I	2 (9.09%)	2 (6.67%)	0.840
	II	9 (40.91%)	19 (63.33%)	0.187
	III	11 (50.00%)	9 (30.00%)	0.240
LV ejection fraction, %		59.50 [50.25; 67.00]	30.00 [22.00; 36.00]	<0.001
LV end-diastolic index, ml/m^2		18.07 [14.60; 27.05]	80.93 [72.16; 101.2]	**<0.001**
Grade III hypertension		18 (81.81%)	21 (70.00%)	0.517
Type 2 diabetes mellitus		7 (31.82%)	2 (6.67%)	**0.046**
Gastrointestinal pathology		15 (68.2%)	16 (53,3%)	0.428
Chronic kidney disease		5 (22.73%)	10 (33.33%)	0.600
Pulmonary diseases		3 (13.67%)	5 (16.67%)	0.929

Note. CHD - ischemic heart disease, ICMP - ischemic cardiomyopathy, p – level of differences between groups of patients.

of non-classical monocytes in the blood (r=-0.79; p<0.05) and the possibility of using of these cells for identification of ICMP with the use of logistic regression indicates a pathogenetic relationship between clinical and laboratory differential signs of ICMP.

Conclusion. The development of ICMP is characterized by an excess of IL-10 and a deficiency of non-classical monocytes in the blood in contrast to an increased (compared to CHD patients without ICMP) plasma galectin-3 concentration. The determination of the letter (except for IL-10) in the blood makes it possible to revealed patients with ICMP among all CHD patients. With a comparable value of the functional class of angina and heart failure, the nature of comorbid pathology in CHD patients, with and without ICMP; patients with ICMP are characterized by a more rare occurrence of type 2 diabetes mellitus, a greater mass of the left ventricular myocardium, and its lower end-diastolic index interrelated with the number of non-classical monocytes in the blood.

Conflict of interest. The authors declare no conflict of interest.

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甲烷–氫氣混合物為燃料的聯合循環發電廠的熱力學分析
THERMODYNAMIC ANALYSIS OF COMBINED CYCLE POWER PLANTS FUELED BY METHANE-HYDROGEN MIXTURES

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抽象。氫能的開發是減少發電過程中向大氣排放有害物質的一種可能方法。其實施需要開發能夠使用環保燃料的能源設施。同時，從技術角度來看，由於甲烷–氫氣混合物的燃燒，在發電廠中逐步實現向氫的使用更容易。本文介紹了熱力學研究結果，研究甲烷–氫混合物的化學組成對蒸汽–燃氣動力裝置性能的影響。結果表明，燃料混合物中氫的質量分數從0增加到80％導致沃泊數減少15％，而動力裝置的輔助需求增加近3倍。據透露，燃氣輪機發電廠的電力供應增加了1.8％，聯合循環發電廠的電力供應增加了1.3％。
關鍵詞：甲烷–氫氣混合物；聯合循環發電廠；燃氣輪機；數學模型。

Abstract. *The development of hydrogen energy is a possible way to reduce emissions of harmful substances into the atmosphere during power generation. Its implementation requires the development of energy facilities capable of operating on environmentally friendly fuel. At the same time, from a technological point of view, it is easier to implement a gradual transition to the use of hydrogen in power plants due to the combustion of methane-hydrogen mixtures. This paper presents the results of thermodynamic studies of the effect of the chemical composition of the methane-hydrogen mixture on the performance of a steam-gas power unit. It is shown that an increase in the mass fraction of hydrogen in the fuel mixture from 0 to 80% leads to a decrease in the Wobbe number by 15% and an increase in*

the auxiliary needs of the power unit by almost 3 times. It was revealed that the supplied electric power of the gas turbine plant increases by 1.8%, and that of the combined cycle plant - by 1.3%.

Keywords: *methane-hydrogen mixture, combined cycle power plant, gas turbine, mathematical model.*

Today, one of the main global trends in the development of the energy industry is the transition to renewable energy sources (RES). Wind and solar power plants are widespread. At the moment, the total generation of electricity using RES in the world is only 3% [1, 2]. However, in the next few decades, many European countries, Japan, the United States, Canada and China are planning to significantly increase their number in order to reduce emissions of toxic substances and greenhouse gases in the production of electricity [3, 4].

To implement such a large-scale ambitious task, it will be necessary to create storage systems that ensure the alignment of the schedules of energy production and consumption [5, 6]. The structure of the existing energy systems will undergo significant transformation.

One of the possible scenarios for the development of the energy industry is the transition to hydrogen energy [7, 8]. The popular concept involves the production of hydrogen from RES during periods of load sags, followed by the useful utilization of stored energy. Transportation of hydrogen from the place of production to the place of consumption can be carried out through the existing gas pipelines [9, 10]: hydrogen will be mixed with natural gas. Then the fuel mixture will be sent to thermal power plants for subsequent combustion to generate electricity.

Since the cost of hydrogen produced using the above technology will be significant, it is advisable to carry out its subsequent combustion at the most efficient combined cycle plants. In turn, a change in the chemical composition of the fuel entering the combustion chamber (CC) will be accompanied by a deviation of the performance indicators of all elements of the thermal circuit: the combustion chamber, gas turbine (GT), waste heat boiler (WHB) and steam turbine unit (STU).

The aim of this work is to analyze the influence of the ratio of the components of the methane-hydrogen mixture on the main energy characteristics of the combined cycle gas turbine (CCGT) power plant. To solve it, a mathematical model of CCGT operating on a fuel mixture was developed, using which a series of thermodynamic calculations were performed.

Description of the object and methods of research

The object of research was the thermal diagram of a combined cycle gas plant operating on a methane-hydrogen mixture, the diagram of which is shown in figure 1. The Mitsubishi Heavy Industries M701G2 model with an initial temperature

of the working environment equal to 1410°C was taken as a prototype of a gas turbine. It is assumed that the methane-hydrogen mixture is supplied to the TPP via a gas pipeline at a pressure of 0.7 MPa and a temperature of 15 ° C and then increases its pressure by 2.5 MPa in a booster compressor. The combustion products pass through a cooled gas turbine and are then sent to a double-circuit waste heat boiler, which is used to generate steam for a steam turbine plant. The initial data for modeling the thermal circuit are presented in table 1.
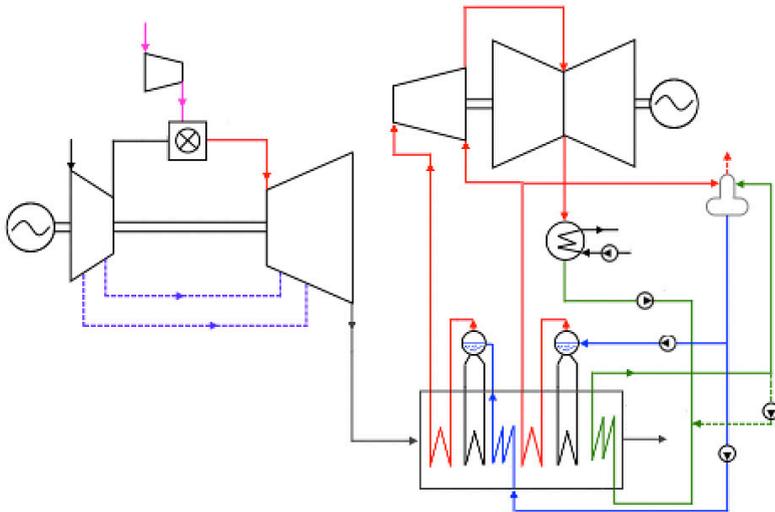
Figure 1 – Basic thermal diagram of CCGT on a methane-hydrogen mixture.

To simulate the CCGT thermal circuit, a corresponding mathematical model was developed using MS Excel. The method for calculating a cooled gas turbine is described in detail in [11-12]. The calculations of the thermophysical properties of the working medium were carried out using the NIST REFPROP thermophysical properties database.

Table 1 – Initial data for modeling.

Parameter	Dimensions	Parameter value
Compressor inlet air flow	kg/s	740
Compressor inlet air temperature/pressure	°C/kPa	15 / 101,3
Working medium temperature at the gas turbine inlet	°C	1400

Compressor ratio	-	21
Internal relative efficiency of the gas turbine / compressor	%	89 / 88
Mechanical efficiency / generator efficiency / heat transport efficiency	%	99 / 99 / 99
Cooling flow rate	%	13,7
Net calorific value of methane / hydrogen	MJ/kg	50,25 / 121
High / low steam pressure at the steam turbine inlet	MPa	7 / 0,7
Deaerator / condenser pressure	MPa	0,58 / 0,004
Temperature at the entrance to the GPC	°C	60

The methodology for calculating the energy performance of CCGT was as follows.

The Wobbe criterion was determined by the formula:

$$W_{OH} = \frac{Q_{H}^{p}}{\sqrt{\rho_{m\varepsilon}/\rho_{\varepsilon\, H.y}}}, \qquad (1)$$

where Q_{H}^{p} – volumetric lower working heat of combustion of fuel, MJ/nm³; $\rho_{m\varepsilon}$ – fuel gas density, kg/m³; $\rho_{\varepsilon\, H.y.}$ – air density under normal conditions, kg/nm³.

Power consumed for own needs:

$$N_{CH} = N_{\Gamma\!ДK} + N_{\Pi\!ЭН\, ВД} + N_{\Pi\!ЭН\, НД} + N_{K\!ЭН} + N_{Ц\!ЭН} + N_{ЭНРК}, \qquad (2)$$

where $N_{\Gamma\!ДK}$ – power consumed to drive gas booster compressors, MW; $N_{\Pi\!ЭН\, ВД}$ and $N_{\Pi\!ЭН\, НД}$ – power consumed to drive high and low pressure feed pumps, MW; $N_{K\!ЭН}$ – power consumed to drive condensate electric pumps, MW; $N_{Ц\!ЭН}$ – power consumed to drive condenser circulating electric pumps, MW; $N_{ЭНРК}$ – power consumed to drive the electric pumps for recirculation of the waste heat boiler condensate, MW.

The delivered power was determined as:

$$N_{\Gamma\!ТУ}^{нm} = \left(N_{\Gamma\!Т} - N_{K}\right)\cdot\eta_{ЭГ} - N_{\Gamma\!ДK};$$

$$N_{\Pi\!СУ}^{нm} = N_{\Pi\!Т}\cdot\eta_{ЭГ} - \left(N_{\Pi\!ЭН\, ВД} + N_{\Pi\!ЭН\, НД} + N_{K\!ЭН} + N_{Ц\!ЭН} + N_{ЭНРК}\right); \qquad (3)$$

$$N_{\Pi\!ГУ}^{нm} = N_{\Gamma\!ТУ}^{нm} + N_{\Pi\!СУ}^{нm},$$

where $N_{\Gamma\!Т}$ – power generated by the gas turbine, MW; N_{K} – power consumed to drive a compressor of a gas turbine unit, MW; $\eta_{ЭГ}$ – efficiency of an electric generator,%; $N_{\Pi\!Т}$ – power generated by a steam turbine, MW.

Thermal power supplied to the combustion chamber of the gas turbine unit:

$$Q_{KC} = V_{m\varepsilon} \cdot Q_{\text{\tiny н}}^p \qquad (4)$$

where $V_{m\varepsilon}$ – volumetric flow rate of bulk gas under normal conditions, nm³.

Heat output of the waste heat boiler:

$$Q_{KV} = G_{\varepsilon} \cdot \left(I_d - I_{yx} \right), \qquad (5)$$

where G_{ε} – exhaust gas consumption, kg/s; I_d – enthalpy of exhaust gases at the inlet to the waste heat boiler, kJ/kg; I_{yx} – enthalpy of exhaust gases at the exit from the waste heat boiler, kJ/kg.

Waste heat boiler efficiency:

$$\eta_{KV} = \frac{I_d - I_{yx}}{I_d - I_{\text{\tiny нв}}}, \qquad (6)$$

where $I_{\text{\tiny нв}}$ – enthalpy of exhaust gases at an outside air temperature of 15°C, kJ/kg.

The net efficiency of installations was determined by the formulas:

$$\eta_{\Gamma T V}^{\text{\tiny нm}} = \frac{N_{\Gamma T V}^{\text{\tiny нm}}}{Q_{KC}} \cdot 100\%;$$

$$\eta_{\Pi C V}^{\text{\tiny нm}} = \frac{N_{\Pi C V}^{\text{\tiny нm}}}{Q_{KV}} \cdot \eta_{KV}; \qquad (7)$$

$$\eta_{\Gamma T V}^{\text{\tiny нm}} = \frac{N_{\Pi\Gamma V}^{\text{\tiny нm}}}{Q_{KC}} \cdot 100\%.$$

Results of thermodynamic studies

Based on the simulation results, it was found that an increase in the hydrogen content in the fuel is accompanied by an increase in the Wobbe number, the auxiliary needs of the power unit, as well as a decrease in the temperature of the working environment at the gas turbine exhaust (figure 2). The increase in the share of own is associated with an increase in the volumetric consumption of the fuel mixture, which leads to an increase in the capacity of gas booster compressors.
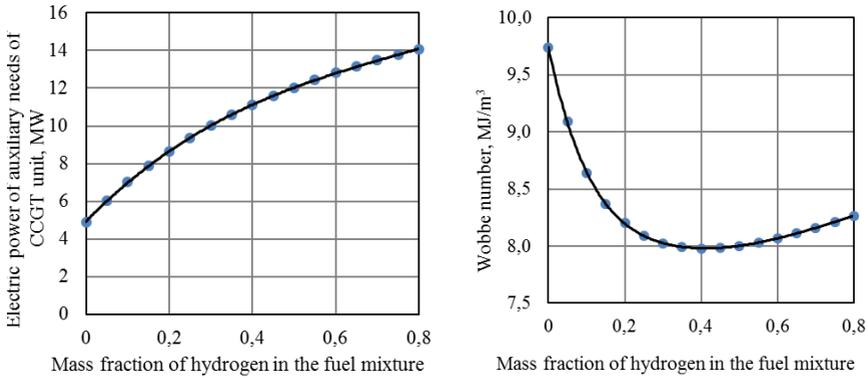
a) Change in electrical capacity of
CCGT auxiliary needs

b) Change in temperature of the gas
turbine exhaust

*Figure 2 – Influence of the mass fraction of hydrogen on the performance
of CCGT*

It was revealed that with an increase in the mass content of hydrogen in the fuel mixture from 0 to 80%, the supplied electric power of the GTU increases from 323.4 to 329.3 MW, the supplied electric power of the PSU decreases from 126.1 to 126.0 MW, and the supplied electric power CCGT increases from 449.5 to 455.3 MW.
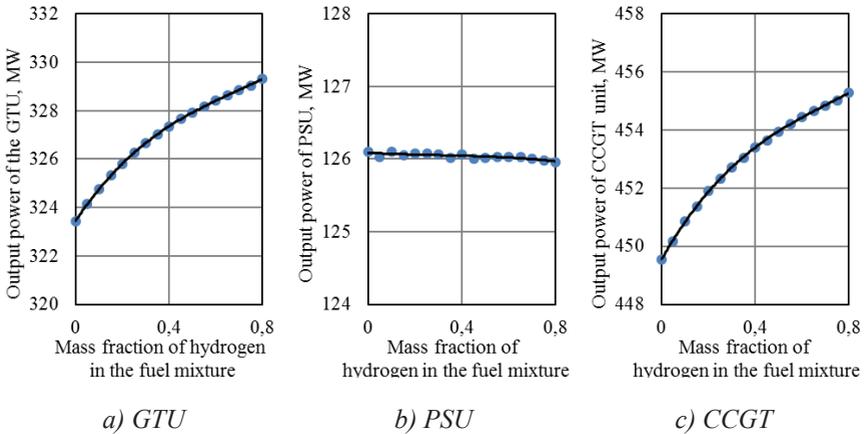
a) GTU

b) PSU

c) CCGT

Figure 3 – Dependence of the supplied power on the mass fraction of hydrogen

In turn, the net GTU efficiency increases from 40.41 to 40.48%, the PSU net efficiency decreases from 27.44 to 27.39%, and the CCGT net efficiency decreases from 56.17 to 55.97%.

a) GTU　　　　　　　*b) PSU*　　　　　　　*c) CCGT*
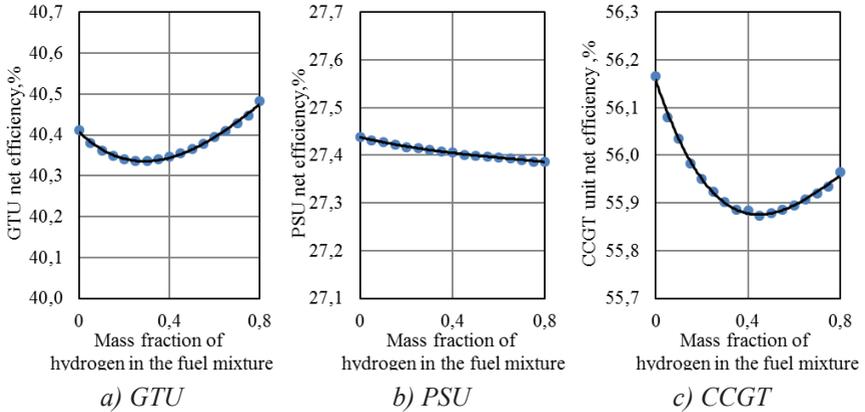
Figure 4 *– Dependence of net efficiency on the mass fraction of hydrogen*

Conclusions

Based on the results of mathematical modeling of the thermal circuit of a combined cycle gas plant operating on a methane-hydrogen mixture, the influence of the chemical composition of the fuel on the energy performance of the power unit is revealed. In particular, it was found that an increase in the mass fraction of hydrogen in the fuel mixture from 0 to 80% leads to a decrease in the Wobbe number by 15% and an increase in the auxiliary needs of the power unit by almost 3 times. It was revealed that the supplied electric power of the gas turbine plant increases by 1.8%, and that of the combined cycle plant - by 1.3%.

In further studies, it is necessary to analyze the effect of an increase in water vapor on the efficiency of thermohydraulic processes in a gas turbine and the need to increase the flow rate of the refrigerant.

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International Conference

對厚度達600μm的PVC電纜的絕緣層進行激光雕刻和剝離的可能性的研究
INVESTIGATION OF THE POSSIBILITY OF LASER ENGRAVING & STRIPPING OF THE INSULATION OF PVC CABLES WITH THICKNESS UP TO 600 MM

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抽象。激光雕刻可以在塑料材料製成的各種消費品上創建各種清晰的徽標，條形碼，數據矩陣代碼，字母數字文本，圖片。由於它的快速性和低廉的成本，它是創建高質量標識雕刻最吸引人的過程之一。

本報告研究了在電信行業中經常使用的激光雕刻和剝離不同顏色PVC產品的能力。該研究的測量是使用CO2激光技術系統進行的。分析了熱影響區深度對主要技術參數的功能依賴性：分析處理速度和平均功率，光柵步距 Δx。該分析有助於確定用於激光雕刻PVC電纜絕緣層以及從電纜芯中去除絕緣層的最佳參數。當選擇激光燒蝕區的幾何形狀以雕刻或去除絕緣層時，該分析有助於確定光柵距離，速度，功率的最佳工作間隔。

關鍵字：CO2激光，激光雕刻，激光剝離，聚氯乙烯，雕刻深度，熱塑性

Abstract. *Laser engraving allows to create a wide variety of legible logos, bar codes, data matrix codes, alphanumeric text, pictures on various consumer goods made of plastic materials. Due to its quickness and low expenses, it is one of the most attractive processes for the creation of high-quality identification engraving.*

This report examines the ability of laser engraving and stripping PVC products of different colours, which are frequently used in the telecommunications industry. The measurements of the study were performed with a CO_2 laser technology system. The functional dependency of the depth of the heat-affected zone on the main technological parameters: processing speed and average power, raster step distance Δx are analysed. The analysis helps to determine optimal parameters for laser engraving of PVC cable insulation and removal of insulation from the core of the cable. The analysis can help to determine the optimal operating intervals

for raster distance, speed, power when choosing a geometry of the laser ablation zone for engraving or removal of the insulation.

Keywords: *CO_2 laser, Laser engraving, Laser striping, Poly-vinyl chloride, Engraving depth, Thermoplastics*

1. Introduction:

Polyvinyl Chloride (PVC) has been, for more than 70 years, one of the most important polymers, and it is the second most-produced thermoplastic resin, placing after polyolefins and before styrene polymers, with a worldwide capacity of more than 44.3 million tons (2018). [1].

Direct laser marking and engraving are a widely used flexible and modern methods to obtain permanent marks containing traceability and identification information: alphanumeric strings of characters, logos, barcodes, and Data Matrix codes [2]. Compared to the traditional marking and engraving processes, like punches, microdot, scribing or electric discharge pencil etcher, laser engraving offers several advantages, such us: non-contact working, high repeatability, high scanning speed, a mark width comparable to the laser spot dimension, high flexibility, and high automation of the process itself [3 – 5].

Extensive studies on the laser marking of plastics with various lasers were carried by Hoffmann et. al. [6]. Blazevska-Gilev et. al. has studied laser engraving process in PVC [7], Bitay has studied markability of automotive cable coatings made of PVC [8].

Lasers used in industry for marking include TEA CO_2 lasers, pulsed or Q-switched Nd: YAG lasers and excimer lasers [9]. High temperatures on plasticized PVC generally results in two main degradation processes. One of these is dehydrochlorination, which is characterized by the formation of polyene sequences and thus discolouration of the polymer [10]. The second process is a mass loss of the plasticizer, which is linear with time when the rate is controlled by an evaporation process [10].

There are mainly three processing parameters used in laser marking: the electric current used for generating a laser beam, the pulse frequency, and the traverse speed of the laser beam. The quality of a mark can be evaluated by mark depth, width, and mark contrast [7, 11]. One of the additional effects, which can influence the amount of absorbed energy is the colour of the material.

The reports [11] and [12] investigate the influence of speed and power density on the processes of laser marking and engraving of plastic products, including PVC. Work intervals of speed are defined for two power densities.

The main purpose of this study is to analyze the most important factors for the laser processing process to determine the quality of engraving and the ability to completely remove the cable insulation, deriving the functional dependences of

the depth of laser ablation on power, speed, and the raster scanning step on PVC insulation with a thickness of up to 600 μm.

2. Technologies of cable marking and engraving

A range of various factors must be considered when deciding the method and equipment for cable engraving operation. The first factor to consider is what kind and amount of information you need to put on the cable and what kind of substrates will be used. Colour of the cable also should be considered.

Ink-jet printing

Ink-jet printing is fast and versatile. It can print on most plastics, and it can print multiple lines of text and simple graphics at up to 2,600 characters per second. Continuous ink-jet systems are relatively cost-effective, however, use of consumables will increase the expenses for operating this marking equipment.

Laser marking and engraving

One of the main benefits of laser engraving and engraving is that mark is permanent, it is etched into the surface of the product. Laser engraving well-suited for operations involving high-speed cable winding because there is no ink needed in the laser engraving process – the risk of smudging of the mark is eliminated. High-quality logos, bar codes, Data Matrix codes, alphanumeric text, graphics, such as international standards symbols, can be easily marked onto the product.

There are several ways, how laser engraving can also be used to strip isolation of a wire or cable. The cross-cut method, in which laser spot is moved perpendicularly to the wire, cutting, and separating parts of insulation. If removal of isolation is needed only for certain parts of insulation, then the laser beam spot is moved back and forth, using raster scanning method, fully vaporizing an area of insulation.

3.   Equipment and materials

Laser engraving of the cables was made with ST-CC9060 laser system, which is designed for engraving various non-metallic materials, like plastic and wood. The laser system has an integrated CO_2 laser combined with the X-Y coordinate table within sealed cavity construction shown in Fig. 1. Parameters of the ST-CC9060 laser system are shown in Table 1.
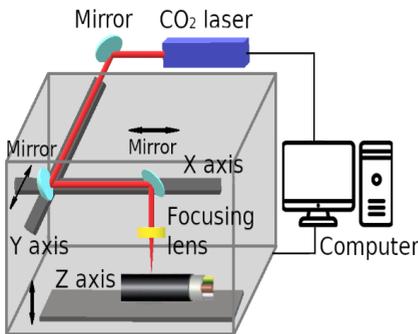
***Fig. 1**. Principal scheme of the experimental setup*

***Fig. 2.** LEXT™ OLS5000 SAF 3D Laser Confocal Scanning Microscope*

Depth of the laser affected area was measured using LEXT™ OLS5000 SAF 3D Laser Confocal Scanning Microscope which is shown in Figure 2. Working principle - Laser beam passing through a light source aperture with an objective lens is focused into a small area on the surface of the cable. An image is created by collecting the emitted photons from the fluorophores from the cable. Magnification used to analyse experimental cables - 10x with repeatability – 0.03μm.

***Table 1.** Parameters of the ST-CC9060 laser system*

Parameter	Values	Parameter	Values
Model	ST-CC9060	Repetition accuracy	±0.02 mm
Max. laser power	100 W	Power supply	220v/50Hz/10A
Laser wavelength	10640 nm	Power Consumption	1.5 kW
Engraving speed	0-1000 mm/s	Cooling system	water cooling
Engraving area	900 mm x 600 mm	Focal length	65 mm

4. Materials / Experimental cables

PVC is an outstanding material because of its robust mechanical strength, low cost, and excellent chemical properties [13]. PVC is a thermoplastic material that can range from soft, flexible materials to hard, rigid plastics. The markability of any thermoplastic material depends only on used additives and material properties. Processes which can occur because of laser light on PVC (foaming, carbonization, colour change etc.) depend on the laser wavelength and the reciprocal effects of material properties. Correct and appropriate selection of laser parameters, homogeneity of the material is the most important parameters for high-quality engraving. There are two major sub-classifications of PVC: rigid and flexible

(plasticized). Also, there are foamed PVC and PVC copolymers [14]. Parameters of various PVC types are shown in Table 2.

Table 2. Parameters of frequently used PVC material types

Property	General-purpose	Rigid	Rigid foam	Plasticized	Co-polymer
Density (g/m³)	1.4	1.34-1.39	0.75	1.29-1.34	1.37
Tensile modulus (GPA)	3.45	2.41-2.45	-	-	3.15
Tensile strenght (MPa)	8.7	37.2-42.4	>13.8	14-26	52-55
Elongation at break (%)	113	-	>40	250-400	-
Notched izod (kJ/m)	0.53	0.74-1.12	>0.06	-	0.02
Hardness	D85 (Shore)	R107-R122 (Rockwell)	D55 (Shore)	A71-A96 (Shore)	-
Linear thermal expansion ($10^{-5} K^{-1}$)	7	5.94	5.58	-	-

5. Methodology

Depth h of the marked 10 x10 mm area was measured as a function of laser processing speed v, power of the laser radiation P and raster step distance Δx. Experiments were divided into three parts of measurements. Coloured PVC cables (white, turquoise, yellow, red, green, blue and black) with a size of 20 x 200 mm and a thickness of 0.6 mm were prepared for the experimental studies. The diameter d of the working spot of the laser beam on the surface area of the cables and the focal length f is constant for the entire period of the study – d = 92.7 μm, f = 65 mm. Based on given parameters, power density W and laser interaction time t for each of the experimental series were calculated. All measurements were repeated 4 times.

10x10 mm area of each individual sample was marked using a raster scanning method as seen in fig. 3. Raster step distance Δx corresponds to the distance between the horizontal lines of the trajectory of the laser beam.
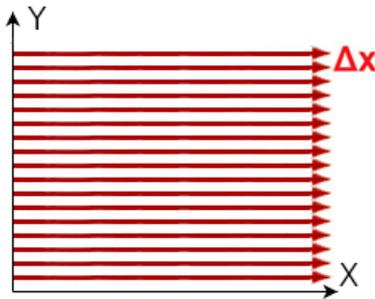
Fig. 3. *Raster scanning method; raster distance Δ x*

In the first part of the experiment, three series of measurements were made. These series of experiments examine the dependence:

➢ *h = h (P)*. Values of the varying power *P* in each series are respectively: - 1, 2.2, 3.5, 4.5, 5.1, 7.3, 9, 10 W. We keep constant the quantities *Δx* and v for each respective series

➢ *Δx = const =* 20 μm, *v =* const = 150, 225 and 300 mm/s.

➢ In the second part of the experiment, four series of measurements were made. These series of experiments examine the dependence:

➢ *h = h (v)* Values of the varying processing speed v in each series varies in the following interval: 100 to 345 mm/s with 35 mm/s intervals. We keep constant the quantities *Δ x* and *P* for each respective series. *Δx =* const = 20 μm, *P =* const = 4.5, 7.3, 10.5, 14 W.

➢ In the third part of the experiment, four of the measurements were made. These series of experiments examine the dependence:

➢ *h = h (Δx)* Values of the raster distance *Δ x* in each series varies in the following interval: 10 to 80 μm with 10 μm interval. We keep constant the quantities *v* and P for each respective series. *v = const =* 240 mm/s, *P = const =* 4.5, 7.3, 10.5, 14 W.

6. Results of experimental studies

The experimental dependence of depth h on power *P* for 7 colours – white, black, red, turquoise, green, blue, yellow is shown in Figure 4. The graphics have the same look and are one below the other in the order of the specified colours.
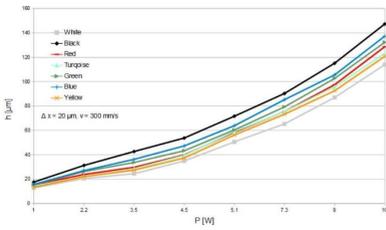
Fig. 4. Depth 'h' as a function of laser power P
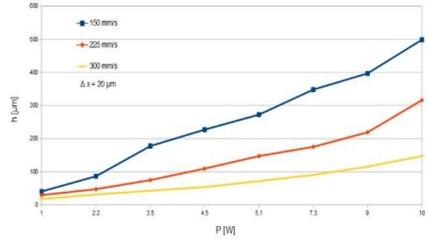
Fig. 5. Depth 'h' as a function of laser power P of red-coloured cable

Generally, white-coloured PVC cables tend to have the smallest engraving depth zone, while black-coloured cables are showing the highest engraving depth. This arrangement is related to the absorbency of PVC plastic for different colours. Besides, for power $P = 1$ W the depth of marking is almost the same for the seven colours of cables (from 18 μm to 20 μm) while for power $P = 10$ W there is a relatively high divergence of the depth of marking (from 115 μm for white cable up to 147 μm for black cable).

In Figure 5, three graphs of the dependence of the depth of marked 10x10 mm area - h on the laser power P for three engraving speeds v for red-coloured cables are given. There is a nonlinear dependence and as the power of the laser radiation increases, the depth of the engraving increases. For a speed of 150 mm/s, the depth of the engraving is about 3 times greater than that for a speed of 300 mm/s. A similar pattern holds for cables of other colours, however, their engraving depth value slightly differs based on the absorbency of PVC plastic for a certain colour.
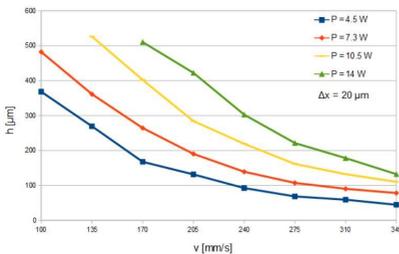
Fig. 6. Depth 'h' as a function of laser processing speed v of blue-coloured cable
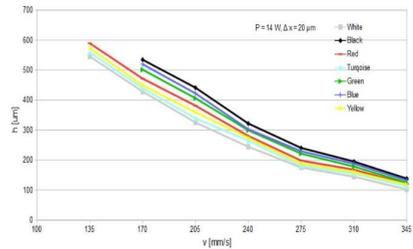
Fig. 7. Depth 'h' as a function of laser processing speed v

Figure 6 shows graphs of the dependence of the depth of marked 10x10 mm area h on the speed v for four different laser power values P for blue-colored

cables. They show a non-linear relationship so with increasing engraving speed, engraving depth decreases. At 14 W power, the engraving depth is about 1.8 times greater than for 7.3 W power. At P= 14 W and v = 100 mm/s to 170 mm/s and at P = 10.5 W and v = 100 mm/s to 135 mm/s, the plastic insulation is penetrated, and it is not suitable for engraving. However, these laser parameters are suitable for cable insulation removal. Penetration of cable insulation was noticed for all colors at P =10.5 W and v =100 mm/s, where power density W = 155.4 kW/mm² and exposure time t = 0.928 ms. Same occurrence happens for cables of all colors at P = 14 W and v = 100 mm/s - W = 207.2 kW/mm² and exposure time t = 0.928 ms. At P = 14 W and v = 135 mm/s laser beam has penetrated insulation of black, green, and blue cables (Fig. 7), where W = 207.2 kW/mm² and t = 0.928 ms.
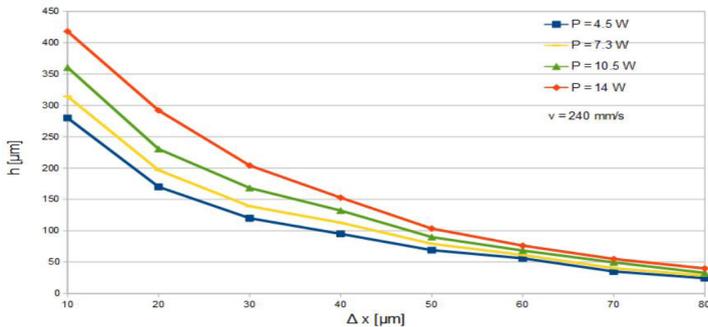
Fig. 8. *Depth 'h' as a function of raster step Δx of green-coloured cable*

Graphs of the dependence of the depth of marked 10 x10 mm area h on the raster step distance Δx for four different laser power values P for green-coloured cables are given in Fig. 8. They show a nonlinear relationship and with increasing raster step distance the depth of the engraving h decreases. For P = 14 W, the h is about 1.55 times greater than for P = 4.5 W. On average, among all experimental series in Figure 8, decreasing Δx by 10 μm increases h by 1.41 times.

7. Discussion:

The following summaries can be made from the analysis of the graphs in Fig. 4-8:

- In the selected modes and methodology in the processing area of the studied cables with very good ablation is observed, as the depth of the removed layer in one raster spread of the beam in area 10 x10 mm is in the range from 50 to 600 μm.

- The obtained results and functional dependencies between the depth of ablation h technological parameters of the processing power P, speed v and raster step Δx, allow optimizing two different technological operations (engraving and stripping of the cable) on the studied material such as:

• laser engraving of a certain percentage of the total thickness of the cable insulation (600 μm) according to the customer's wishes and the requirements of the standard for stability during operation.

• laser stripping of the cable insulation, depending on the diameter of the cable core and the thickness of the insulation layer.

As a concrete example for optimization of red cable processing with a thickness of 300 μm from the functional dependences $h = h (P)$, $h = h (v)$ and $h = h (\Delta x)$ and the obtained database can be indicated as recommended the following modes of processing:

- for laser engraving at a depth of 10% of the total thickness of the insulation: power $P = 1.0$ W, processing speed $v = 225$ mm/s and step $\Delta x = 20$ μm.

- for laser stripping of the cable: power $P = 9.75$ W, processing speed $v = 225$ mm/s and step $\Delta x = 20$ μm.

For each specific technological operation (engraving and stripping PVC insulation of cable) from the database, similar optimal recommended operating parameters for power P, speed v and step Δx can be obtained at a predetermined insulation thickness of the cable to be processed.

8. Conclusion

Laser-material interaction of PVC is an important subject for manufacturers of optical and electrical cables and telecommunications equipment but results of this study can be of interest to companies of other industries which manufacture products made of PVC, such as aerospace and automotive industries. For such products, it is often necessary to mark a considerable amount of data on the surface of PVC. Creating selective crosscut or area insulation removal also can be used by these industries.

Because in the present study we focused only on the study of the depth of ablation, as a function of the speed of laser processing, power, and distance of the raster steps. In future studies, we plan to focus on the study of the possibility of engraving, the contrast of engraving and the removal of surface insulation on rigid PVC, using different types of lasers, such as Nd: YAG and excimer lasers.

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鄂霍次克海南部熱異常的形成機理
MECHANISMS OF THE FORMATION OF THERMAL ANOMALIES IN THE SOUTHERN PART OF THE SEA OF OKHOTSK

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抽象。 基於長期的觀察，根據水域的動態和大氣環流，對研究區域水域的熱態變化進行了研究。 在30年的時間裡，在變暖趨勢的背景下，夏季的表面溫度波動有所增加。 在鄂霍次克海南部的熱狀況，水動力學與鄂霍次克反旋風之間發現了一種關係。 顯示了相互作用機制。 獲得的結果可用於解決漁業和生態問題，以及對該地區的水文狀況進行預測。
關鍵詞：鄂霍次克海，水域熱狀況，鄂霍次克反氣旋。

Abstract. *Based on long-term observations, a study of the variability of the thermal regime of the waters of the study area was carried out, depending on the dynamics of the waters and atmospheric circulation. Over a 30-year period, against the background of a warming trend, an increase in surface temperature fluctuations in summer was revealed. A relationship was found between the thermal regime, water dynamics in the southern part of the Sea of Okhotsk and the Okhotsk anticyclone. The interaction mechanism is shown. The results obtained can be used to solve problems of fisheries and ecology, as well as to develop forecasts of the hydrological conditions of this area.*

Keywords: *Sea of Okhotsk, thermal regime of waters, Okhotsk anticyclone.*

The southern part of the Sea of Okhotsk from the La Perouse Strait to the southern Kuril region in the Sea of Japan - Sea of Okhotsk - Pacific Ocean system is a transitional component and a connecting link. In addition, it is an economically significant water area rich in biological resources. Moreover, this area is characterized by very complex hydrological conditions, which are determined by a set of factors. The monsoon nature of atmospheric processes with a seasonal course of wind direction, tidal phenomena, variability of the system of currents

carrying waters of various origins in conditions of complex topography contribute to the redistribution of oceanological characteristics in the water area. The complex hydrological regime of the region, which determines the local features of the functioning and productivity of aquatic ecosystems, requires careful study in view of the importance of the development of biological resources. In particular, the still open questions require special attention concerning the understanding of the causes of extreme fluctuations in the thermal regime, leading to changes in the conditions of the habitat of aquatic organisms, and the instability of fishing. In this connection, the purpose of this study was to identify the mechanisms of the formation of anomalous hydrological conditions in the area in the summer, taking into account the variability of the dynamics of waters and atmospheric processes.

To solve this problem, the work used: data on interannual variability of water temperature at hydrometeorological stations (HMS) for 1985-2015 of the ESI-MO electronic database (http://portal.esimo.ru/portal/); data on water temperature anomalies at the sea surface (http://www.esrl.noaa.gov); satellite data of IR images of water temperature on the sea surface (http://www.satellite.dvo.ru); data on currents at a depth of 50m (http://data.jma.go.jp/gmd/kayoa/data/db/kaikyo/jun/current_HD/html); atmospheric pressure field maps (JMA archives).

The study of long-term variability of surface water temperature in the zone of the La Perouse Strait with the adjacent southern part of the Sea of Okhotsk and in the southern Kuril region for 1985-2017 in July showed that against the background of the warming trend, significant fluctuations of its values are observed. Analysis of the interannual variation of water temperature anomalies made it possible to identify extremely cold and warm thermal regimes in each of the regions. So, extremely warm (water temperature anomalies were more than 1.5°C) for all studied subareas were revealed in 1990, 1995, 1998, 2000, 2010 and 2013. Extremely cold (negative anomalies exceeded 1.5°C) - 1986, 1997, 2003, 2009, 2015.

The redistribution of heat and cold fluxes in the waters of the region is facilitated by the energy of the heat-carrying Soya current, which flows through the La Perouse Strait from the Sea of Japan along the northeastern shore of Lake Hokkaido, and the energy of the East Sakhalin current, which brings cold waters of the Sea of Okhotsk to the southern Kuril region, and thereby the beginning of the outflow into the ocean of both the warm waters of the Soya Current and the cold waters of the Sea of Okhotsk through the southern Kuril straits. In this area, water temperature variability is a good indicator of currents. That is, the variability of the water characteristics of the southern part of the Sea of Okhotsk in the summer period is largely associated with the active dynamic activity of the region. The joint analysis of the variability of water temperature anomalies in extreme thermal regime years and the development of components of the area currents system at a depth of 50 m showed that extremely warm regimes are formed during periods of

intensification of the Soya current, an abnormally cold thermal regime is formed during periods of strengthening of the East Sakhalin current Soy current intensity.

During the research, it was taken into account that with the typical monsoon circulation of the atmosphere for the region (the prevalence of southeastern winds during the summer monsoon), a local feature is the formation of a high pressure area over the Sea of Okhotsk in the surface layer. This high-pressure area, not associated with the Hawaiian anticyclone - the Okhotsk anticyclone is often observed over the sea at the first stage of the summer monsoon (May - early July). In the presence of such a high-pressure area over the Sea of Okhotsk, in the middle troposphere (on an isobaric surface of 500 hPa), a cold depression is observed, which facilitates the transport of cold air masses to Sakhalin, to the coastal regions of the Primorsky and Khabarovsk Krais, northern Japan, which prevents an increase in the temperature background of the underlying sea surface [1]. With the developed Okhotsk anticyclone, this situation continues throughout July. Then the transition to the establishment of the second stage of the monsoon, characterized by an increase in the influence of the Hawaiian anticyclone, shifts (the so-called "cold summer" - anomalously cold thermal regime). Only in August there is an intensive removal of warm air to the Sea of Okhotsk.

As follows from the joint analysis of interannual variability over a thirty-year period of surface pressure anomalies over the Sea of Okhotsk and surface water temperature anomalies, there is an opposite trend in the dynamics of these parameters (fig. 1). With a warming tendency, the Okhotsk anticyclone tends to weaken.
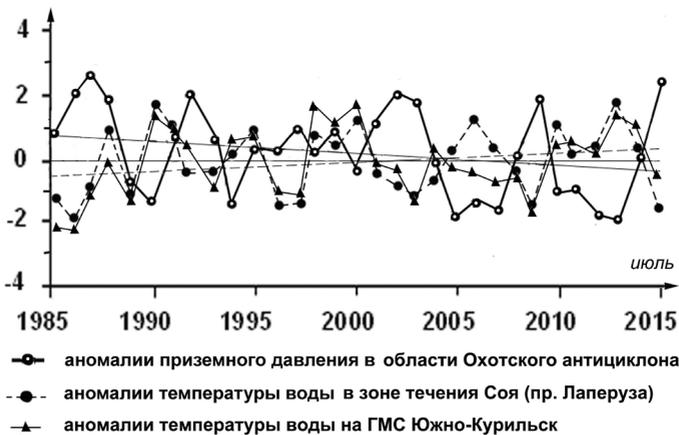
Fig. 1. *Interannual variability of surface pressure anomalies in the area of the Okhotsk anticyclone and water temperature anomalies in the Soya current zone and in the southern Kuril region.*

At the same time, the analysis shows that the years of significant fluctuations in water temperature differed in the anomalies of the surface pressure in the area of the Okhotsk anticyclone.

The study of the characteristic baric structures in July in the years characterized by extreme hydrological conditions made it possible to reveal the mechanism of the formation of anomalous thermal regimes.

During the years of the formation of the cold thermal regime in July, the predominance of this high-pressure area was observed over the Sea of Okhotsk. In this case, a cold tropospheric trough is formed in the geopotential field at AT500, directed towards the sea from northern latitudes. With such a structure of atmospheric fields, contributing to the strengthening of the winds of the northern points, the East Sakhalin Current is developed, transporting the cold North Sea of Okhotsk waters to the southern part of the sea. The developed Okhotsk anticyclone, being a blocking one for passing cyclones, changes their trajectories and directs them to the east. The winds of cyclones passing over the south of the Sea of Okhotsk also contribute to the influx of cold Okhotsk waters from the north to the La Perouse Strait and weaken the Soy current. The water temperature during these periods in the study area becomes much lower than the norm [2].

During the formation of a warm thermal regime in July, a predominance of low pressure was noted over the Sea of Okhotsk. In such years, the cold tropospheric trough affects only the northern part of the Sea of Okhotsk. In the absence of the Okhotsk anticyclone or its destruction in July, the thermal regime is determined by the influence of the Hawaiian anticyclone - an intense removal of warm air occurs on the southern part of the Sea of Okhotsk, which is typical for the summer monsoon. Winds of southern points contribute to the development of the Soya Current and the formation of positive anomalies in the temperature background in the south of the Sea of Okhotsk. According to observations [3], the flow rates of the Soybean in a warm thermal regime of 2000 were 1.5 Sv in July, which is more than 2 times higher than the minimum values - up to 0.5 Sv.

A fairly close causal relationship was revealed between the peculiarities of the atmospheric circulation, the variability of the intensity of the development of one or another link in the system of currents in the region and the formation of the temperature regime in the southwestern part of the Sea of Okhotsk. The mechanism of this connection is determined. One of the important factors in the formation of abnormally cold thermal regimes is the structure of the atmospheric fields - the active development of the Okhotsk anticyclone and the formation of a tropospheric trough in the altitude field, which contributes to the transport of cold Arctic air masses to the Sea of Okhotsk and a decrease in the temperature background of the southern Okhotsk sea area. Not only water cooling occurs, but also dynamic interaction, the inflow of warm waters of the Soya Current into the strait is weakened,

and cold waters of the East Sakhalin Current flow to the southwestern part of the Sea of Okhotsk and the southern Kuril region. The formation of warm thermal regimes is associated with the early destruction of the Okhotsk anticyclone (or its absence) and the intensification of the influence of the Hawaiian anticyclone, the intensification of the Soya current. The results obtained can be used to develop forecasts of the hydrological conditions of the region, to solve the problems of fishing and ecology.

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1976–2012年和1976–2019年北高加索地區地表氣溫變化率的比較評估
COMPARATIVE ASSESSMENT OF THE RATE OF CHANGE IN THE SURFACE AIR TEMPERATURE IN THE NORTH CAUCASUS REGION FOR 1976-2012 AND 1976-2019

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　　註解。　國際科學界幾乎一致認為地球上正在發生重大的氣候變化。　持續的氣候變化可能對自然和經濟系統以及整個人類造成嚴重影響。

　　本文的目的是評估北高加索地區1976-2012年和1976-2019年期間溫度狀況的變化，包括對不同氣候區的季節性溫度異常的比較分析。

　　結果發現，在北高加索地區的所有氣候帶中，這兩個研究時期一直保持著統計學上顯著變暖趨勢的主導地位。

　　關鍵字。　氣候變化，北高加索地區，氣候帶，溫度，趨勢。

***Annotation.** The world scientific community has come to almost a unanimous opinion that significant climatic changes are taking place on Earth. The ongoing climate changes can have a serious impact on natural and economic systems and on humanity as a whole.*

The purpose of this article is to assess changes in the temperature regime in the North Caucasus region for the periods 1976-2012 and 1976-2019 including a comparative analysis of seasonal temperature anomalies for different climatic zones.

It was found that in all climatic zones of the North Caucasian region for the two studied sub-periods the dominance of a statistically significant warming trend persists.

Keywords. *Climate change, North Caucasus region, climatic zone, temperature, trend.*

Climate change is rapidly gaining strength and has a significant impact on all spheres of human activity and the environment [1-4]. It is a reliable fact that warming is uneven over time in addition, it manifests itself in different ways in different regions.

The geographical position, relief and orography of the area have a great influence on the climate of the North Caucasus region.

For a differentiated study of the peculiarities of climatic changes, the North Caucasian region was divided into 4 zones depending on the height above sea level: plain, foothill, mountain and high-mountain zones. Each of these territories is characterized by its own temperature regime. Figure 1 shows the course of average annual temperatures according to 16 meteorological station data for the North Caucasus region, divided by climatic zones. Figure 1 shows that in all climatic zones of the region, changes in mean annual temperatures occur synchronously, while temperature changes within each climatic zone fit into their own ranges. The average annual temperature is maximum in the lowland zone (t_{av}=11.8°C) and minimum in the high-mountain zone (t_{av}=2.6°C). A wide range of variation in average temperatures in different climatic zones is also determined by the location of m/stations [5].
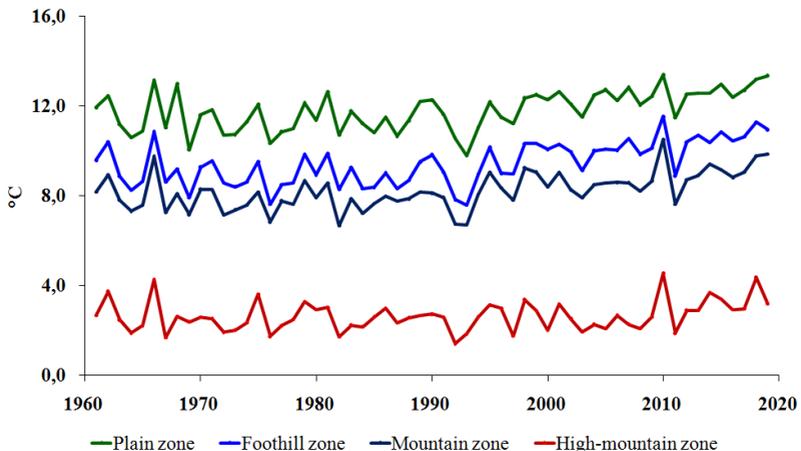
Figure 1 – The course of average annual temperatures according to 16 m / stations of the North Caucasus region.

Characteristics of changes in the temperature regime in different climatic zones of the North Caucasus region were obtained by the method of regression analysis.

The trends coefficient *b* characterizes the rate of change of the meteorological parameter, and the strength of the trend, its significance, describes the value of the contribution to the total variance (D,%). The summary characteristics of the linear trend (trends coefficient *b* (°C/10 years) and contribution to the total variance D (%)) are presented in Table 1.

There was a further significant increase in average annual temperatures in the plain zone of the North Caucasus region at a rate of 0.46°C/10 years (D=47.2%) for the period 1976-2019. Off-season differences in trends have become less noticeable. In all seasons, except for autumn, the rate of warming increased slightly, and decreased in autumn (from 0.58 ° C / 10 years for the period 1976-2012 to 0.42°C/10 years for the period 1976-2019). All annual and seasonal trends are positive (Table 1). In the foothill zone in the period 1976-2019 the increase in average annual temperatures occurred at a rate of 0.57°C/10 years (D=55.1%), which is higher than the rate of growth of average annual temperatures in the period 1976-2012.

Table 1 – *Comparative estimates of the rate of change in the average surface air temperature of the North Caucasus region for 1976-2012 and 1976-2019.*

Season	1976-2012 yy.		1976-2019 yy.		1976-2012 yy.		1976-2019 yy.	
	b	*D(%)*	*b*	*D(%)*	*b*	*D(%)*	*b*	*D(%)*
Plain zone					**Mountain zone**			
Year	0,43	**32,8**	0,46	**47,2**	0,37	**26,8**	0,43	**44,2**
Winter	0,27	4,6	0,38	**12,2**	0,32	5,1	0,47	**13,9**
Spring	0,30	**13,2**	0,41	**29,1**	0,16	0,31	0,34	**17,3**
Summer	0,59	**38,4**	0,59	**50,2**	0,55	**40,5**	0,53	**48,7**
Autumn	0,58	**23,1**	0,42	**18,9**	0,47	**17,5**	0,37	**17,0**
Foothill zone					**High-mountain zone**			
Year	0,53	**39,2**	0,57	**55,1**	0,06	1,2	0,19	**13,6**
Winter	0,36	7,5	0,49	**17,3**	-0,16	1,6	0,11	0,9
Spring	0,35	**12,6**	0,50	**29,8**	-0,07	0,7	0,16	4,3
Summer	0,76	**45,4**	0,76	**57,5**	0,45	**33,8**	0,44	**42,1**
Autumn	0,65	**27,8**	0,52	**26,4**	0,04	0,2	0,05	0,4
1976-2012 yy.					**1976-2019 yy.**			
	b		*D(%)*		*b*		*D(%)*	

Average values for the North Caucasus region			
Year	0,35	**27,1**	0,41	**45,1**
Winter	0,20	2,8	0,36	**12,0**
Spring	0,18	5,1	0,35	**21,4**
Summer	0,59	**41,9**	0,58	**52,6**
Autumn	0,43	**17,2**	0,34	**16,0**

* b - trends coefficient of the linear trend (°C/10 years)

** D (%) - the contribution of the trend to the total variance

*** Bold indicates trends that are statistically significant at the 5% level.

The highest growth rate was observed in the summer period and amounted to 0.76°C/ 10 years, the trend is statistically significant (D=57.5%). In the autumn season, there was a decrease in the growth rate of the average temperature (0.52°C/10 years) compared to the period 1976-2012. (0.65°C/10 years) (table 1). In the mountainous zone, the increase in average annual temperatures in the period 1976-2019 occurred at a rate of 0.43°C/10 years (D=44.2%). In the spring season, the growth rate increased significantly during the period 1976-2019 compared with the previous period and amounted to 0.34°C/10 years. In the summer season, the growth rate was the highest and amounted to 0.53°C/10 years, the trend is statistically significant (D=48.7%). In the autumn season, as well as in the foothill zone, there was a decrease in the growth rate of the average temperature (0.37°C/10 years) compared to the period 1976-2012. (0.47°C/10 years) (table 1).

The high-mountain zone was characterized by an almost constant average annual temperature in the period 1976-2012, but in the period 1976-2019 there was a significant increase in the average annual temperature at a rate of 0.19°C/10 years (D=13.6%). In the winter season of the period 1976-2012, there was a statistically insignificant decrease in the average temperature at a rate of -0.16°C/10 years. In the period 1976-2019 there was an increase in average winter temperatures at a rate of 0.11°C/10 years (D=13.9%). In the spring season of the period 1976-2012 there was also a decrease in temperature (-0.07°C/10 years), and in the period 1976-2019, there was a statistically insignificant increase in average temperatures at a rate of 0.16°C/10 years with D=4.3%. In contrast to the winter and spring seasons, in the summer season the average temperatures tended to increase significantly over all periods. The growth rate of summer temperatures for the period 1976-2012 was 0.45°C/10 years and was statistically significant (D=33.8%), decreasing to 0.44°C/10 years (D=42.1%) in the period 1976-2019. (Table 1).

Let us analyze the change in the temperature regime based on the averaged values for the North Caucasus region. The parameters of linear temperature trends given in Table 1 indicate that in the period 1976-2012 significant was the increase

in summer (0.59°C/10 years, D=41.9%) and autumn temperatures (0.43°C/10 years, D=17.2%), which contributed to the increase in average annual temperatures (0.35°C/10 years, D=27.1%), during this period. In the period 1976-2019 an increase in temperature was observed in all seasons and the year as a whole and was statistically significant. In the autumn season, there is a decrease in the growth rate of the average temperature (0.58°C/10 years) compared to the period 1976-2012. (0.43°C/10 years). It follows from Table 1 that the characteristics of the growth of the average annual temperature in the region coincide with the growth trends in the annual temperature in the plain zone. At all meteorological stations, in seasons and years, the magnitude and direction of the trends are generally preserved.

Table 2 presents comparative estimates of the rate of change in the maximum surface air temperature of the North Caucasus region for 1976-2012 and 1976-2019.

Table 2 – Comparative estimates of the rate of change in the maximum temperature in different climatic zones of the North Caucasus region for 1976-2012 and 1976-2019.

Season	1976-2012 yy.		1976-2019 yy.			1976-2012 yy.	1976-2019 yy.	
	b	D(%)	b	D(%)		b	D(%)	b
Plain zone					**Mountain zone**			
Year	0,74	**28,8**	0,78	**38,6**	0,51	7,81	0,51	**10,65**
Winter	-0,32	2,6	-0,08	0,21	0,72	**13,54**	0,52	**10,46**
Spring	0,42	6,48	0,56	**15,02**	0,14	0,82	0,28	4,76
Summer	0,72	**26,8**	0,77	**37,2**	0,3	2,91	0,42	7,29
Autumn	0,75	**25,2**	0,61	**20,5**	0,53	5,74	0,15	0,68
Foothill zone					**Average values for the North Caucasus region**			
Year	0,81	**22,6**	0,76	**27,2**	0,69	**20,56**	0,68	**26,66**
Winter	0,26	0,14	0,35	3,75	0,22	1,7	0,27	3,48
Spring	0,29	2,35	0,44	8,1	0,28	3,47	0,43	**10,9**
Summer	0,76	**18,7**	0,75	**25,2**	0,60	**15,82**	0,65	24,05
Autumn	1,09	**25,1**	0,7	**14,3**	0,79	**19,15**	0,49	9,96

During these periods, all seasonal and annual values of absolute maximum temperatures are positive, with the exception of winter maximums in the plain zone. The highest growth rate of annual maximum temperatures was observed

in the plain (0.78°C/10 years) and foothill (0.76°C/10 years) zones in the period 1976-2019. A significant contribution to this increase is made by the summer season, where the rate of increase in the maximum temperature is 0.77°C/10 years (D=37.2%) in the flat zone and 0.75°C/10 years (D=25.2%) in the foothill zone. In the mountainous zone, a statistically significant increase in maximum temperature took place only in the winter season of the period 1976-2012 by 0.72°C/10 years (D=13.54%) and the winter season (0.52°C/10 years (D=10.46%)) and the year as a whole (0.51°C/10 years (D=10.65%)) for the period 1976-2019.

Table 2 shows that in the period 1976-2019 the increase in annual temperature maximums remained significant (0.68°C/10years (D=26.66%), while the growth of autumn maximums (0.49°C/10years (D=9.96%)) slowed down and the growth of spring (0.43°C/10 years (D=10.9%)) and summer (0.65°C/10 years (D=24.05%)) maximum temperatures.

Table 3 presents comparative estimates of the rate of change in the minimum surface air temperature in different climatic zones of the North Caucasus region for 1976-2012 and 1976-2019. Basically, all trends are positive, except for the annual and winter absolute minimum temperatures in the flat zone in the period 1976-2012.

***Table 3** – Comparative estimates of the rate of change in the minimum surface air temperature in different climatic zones of the North Caucasus region for 1976-2012 and 1976-2019.*

Season	1976-2012 yy.		1976-2019 yy.		1976-2012 yy.		1976-2019 yy.	
	b	*D(%)*	*b*	*D(%)*	*b*	*D(%)*	*b*	*D(%)*
Plain zone					**Mountain zone**			
Year	-0,23	0,49	0,37	1,43	0,37	3,55	0,57	**9,83**
Winter	-0,11	0,11	0,22	0,48	0,21	1,06	0,42	4,93
Spring	0,7	5,29	0,76	**9,88**	1,27	**14,05**	1,17	**17,59**
Summer	0,26	3,87	0,33	**8,92**	0,50	**11,67**	0,54	**19,66**
Autumn	0,35	1,03	0,33	1,55	0,22	0,51	0,41	2,82
Foothill zone					**Average values for the North Caucasus region**			
Year	0,24	0,58	0,26	0,87	0,13	0,23	0,48	3,95
Winter	0,25	0,64	0,61	4,46	0,04	0,02	0,42	2,72
Spring	1,19	**12,04**	1,23	**19,24**	1,05	**11,24**	1,05	**16,97**
Summer	5,28	**15,06**	0,64	**28,51**	0,43	**11,50**	0,51	**22,40**
Autumn	0,6	2,99	0,62	5,20	0,45	2,05	0,45	3,34

The absolute temperature minimums in the North Caucasus region had a significant trend in the spring and summer seasons of 1976-2012 and 1976-2019 (Table 3). In the spring season, their growth was 1.05°C/10 years, in the summer – 0.43°C/10 years in the period 1976-2012 and 0.51°C/10 years in the period 1976-2019 which contributes to the increase in annual temperature minimums.

The analysis of temperature showed that in all climatic zones of the North Caucasus region in 1976-2019 there was a statistically significant increase in average annual temperatures by 0.46°C/10 years (D=47.2%).

For average seasonal temperatures for the period 1976-2019. in all climatic zones of the North Caucasus region, a general pattern was observed - the highest rate of temperature rise took place in the summer season.

Seasonal absolute maximum temperatures grow with the greatest speed in the summer season in the plain and foothill zones, in the mountainous zone the highest growth rate of maximum temperatures is observed in the winter season.

The absolute temperature minima increased statistically significantly in the spring and summer seasons in all climatic zones and the region as a whole.

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1961-2019年北高加索聯邦區的氣候變化分析
ANALYSIS OF CLIMATIC CHANGES IN THE NORTH CAUCASIAN FEDERAL DISTRICT IN THE PERIOD 1961-2019

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　　註解。當前，人們對氣候變化的研究給予了極大關注。當然，氣候，季節變化，天氣現像是生態系統生命最重要的條件。天氣是某一時刻氣候的一種表現，"氣候"一詞是指相當長一段時間內許多參數的狀態：平均，最高和最低溫度，空氣濕度，風速，降水，水文現像等...當前氣候的特征世界氣象組織（WMO）建議使用三十年時間段-從1961年到1990年，與這些年平均值的偏差被視為異常。

　　本文基於1961-2019年北高加索聯邦區不同氣候帶的16 m /站的數據，對氣候變化進行了分析。

　　關鍵詞：氣候，溫度，年平均溫度，絕對最高溫度，絕對最低溫度，平均降水量，最大降水，氣象站。

　　Annotation. *Currently, much attention is paid to the study of climate change. Climate, change of seasons, weather phenomena, of course, are the most important conditions for the life of ecosystems. While weather is a manifestation of climate at a certain moment, the term "climate" means the state of many parameters over a fairly long period of time: average, maximum and minimum temperatures, air humidity, wind speed, precipitation, hydrological phenomena, etc. characteristics of the current climate The World Meteorological Organization (WMO) recommends using a thirty-year period - from 1961 to 1990, deviations from the mean values of these years are considered anomalies.*

This article presents an analysis of climatic changes based on data from 16 m/stations in various climatic zones of the North Caucasus Federal District for 1961-2019.

Keywords: *climate, temperature, average annual temperatures, absolute maximum temperature, absolute minimum temperature, average amount of precipitation, maximum precipitation, meteorological station.*

To assess the possible consequences of climate change in various areas of activity in the North Caucasian Federal District, a study of climate change in this area over the past 60 years was carried out. The territory of the subject of the Russian Federation (NCFD) with various climatic zones (subtropical, coastal, continental) is of particular scientific interest [1, 2]. The climatic features of the territory of the constituent entity of the Russian Federation (NCFD) are determined by a number of factors, the main of which are the Caucasus Mountains, which serve as a climatic divide between the temperate and subtropical zones. For a differentiated study of the peculiarities of climatic changes, the territory of the Russian Federation (NCFD) was divided into 4 zones depending on the height above sea level: plain (<500 m above sea level), foothill (500-1000 m above sea level) , mountain (> 1000 m above sea level) and high-mountain (> 2000 m above sea level). Each of these territories is characterized by its own temperature regime and amount of precipitation [3, 4].

Table 1 shows the physical and geographical characteristics of 16 meteorological stations, divided into 4 climatic zones.

Table 1 - *Physical and geographical characteristics of the NCFD weather stations*

№ n/n	Weather stations	Longitude (°N), Latitude (°E)	Height above the sea level, m (m a. s. l.)
Plain stations (< 500 m a. s. l.)			
1	Prokhladnaya (Kabardino-Balkaria)	43.46° N; 44.05° E	198
2	Izobil'nyi (Stavropol region)	45.22° N; 32.42° E	194
3	Makhachkala (Dagestan)	42.59° N; 47.31° E	173
4	Mozdok (Republic of North Ossetia - Alania)	43.44° N; 44.39° E	126
5	Derbent (Dagestan)	42.04° N; 48.17° E	30
6	Izberg (Dagestan)	42.34° N; 47.45° E	21
7	Kizlyar (Dagestan)	43.51° N; 46.43° E	-17

Foothill stations (500–1000 m a. s. l.)			
8	Kislovodsk (Stavropol region)	43.54° N; 42.43° E	819
9	Vladikavkaz (Republic of North Ossetia - Alania)	43.21° N; 44.40° E	680
10	Buinaksk (Dagestan)	42.49° N; 47.07° E	560
11	Stavropol (Stavropol region)	45.03° N; 41.58° E	540
12	Cherkessk (Karachay-Cherkessia)	44.17° N; 42.04° E	526
13	Nalchik (Kabardino-Balkaria)	43.22° N; 43.24° E	500
Mountain stations (1000–2000 m a. s. l.)			
14	Teberda (Karachay-Cherkessia)	43.45° N; 41.73° E	1280
15	Akhty (Dagestan)	41.28° N; 47.44° E	1054
High-mountain station (> 2000 m a. s. l.)			
16	Terskol (Kabardino-Balkaria)	43.15° N; 42.30° E	2144

To identify current trends for the periods 1961-1990. (climate norm) (table. 2) and 1961-2019 years. (entire period) for all climatic zones, the following climatic parameters of the time series for January, July and the year as a whole were studied:
- average values of surface air temperature;
- absolute maximum temperatures;
- absolute minimum temperatures;
- average maximum temperature;
- average minimum temperature;
- the amount of precipitation;
- daily maximum precipitation;
- the number of days with precipitation of at least 20 mm.

Table 2 - Average climatic parameters of the region in 1961-1990 (norms)

Weather station	Geographic coordinates	months	Air temperature, °C					Precipitation, mm		
			average	absolute maximum	absolute minimum	average maximum	average minimum	average precipitation	maximum precipitation	number of days with precipitation not less than 20 mm
Plain stations (< 500 m a. s. l.)										
Izobil'nyi (Stavropol region)	45.22°N; 32.42°E	I VII год	-2,3 22,9 10,7	17,9 38,2 38,2	-25,1 10,4 -25,6	11,4 34,8 38,5	-17,1 12,8 -19,4	39,5 55,7 601,8	11,4 18,4 39,7	0,1 0,6 5,1
Mozdok (Republic of North Ossetia - Alania)	43.44°N; 44.39°E	I VII год	-3,6 23,8 10,4	15,2 39,8 39,8	-31,9 11,2 -31,9	7,9 36,3 37,0	-17,6 13,4 -22,1	25,3 54,7 481,3	6,7 21,8 42,3	0,0 0,7 3,7
Prokhlad-naya (Kabardino-Balkaria)	43.46°N; 44.05°E	I VII год	-3,6 23,1 10,1	14,7 38,9 38,9	-28,1 10,7 -28,5	8,6 35,5 36,2	-17,0 13,4 -20,4	19,4 61,2 475,3	5,3 23,4 37,8	0,0 1,0 4,2
Derbent (Dagestan)	42.04°N; 48.17°E	I VII год	2,0 24,7 12,7	26,7 35,2 35,3	-18,9 13,3 -19,0	11,5 32,4 33,0	-7,0 17,1 -9,1	29,7 19,4 375,6	8,9 10,8 38,6	0,0 0,2 2,6
Kizlyar (Dagestan)	43.51°N; 46.43°E	I VII год	-0,6 24,0 11,8	16,6 38,4 38,4	-29,9 11,0 -29,9	9,4 35,2 35,9	-15,7 14,2 -19,4	19,9 26,3 309,4	7,0 13,9 33,2	0,0 0,2 2,0
Makhach-kala (Dagestan)	42.59°N; 47.31°E	I VII год	0,3 24,8 12,2	19,0 37,6 37,6	-22,6 14,9 -22,6	10,3 33,3 34,0	-10,7 17,2 -13,2	23,3 25,9 327,9	8,5 12,6 33,2	0,1 0,2 2,0
Izberg (Dagestan)	42.34°N; 47.45°E	I VII год	1,1 24,2 12,1	19,9 34,6 35,0	-19,8 14,5 -19,8	9,0 31,0 31,8	-8,6 17,4 -11,3	13,3 20,4 263,4	4,5 11,7 30,5	0,0 0,1 0,1
Averaged over the *plain* sta-tions		I VII год	-1,0 23,9 11,4	26,7 39,8 39,8	-31,9 10,4 -31,9	9,7 34,1 35,2	-13,4 15,1 -16,4	24,3 37,7 405,0	7,5 16,1 36,5	**0,0 0,4 2,8**

Weather station	Geographic coordinates	months	Air temperature, °C					Precipitation, mm		
			average	absolute maximum	absolute minimum	average maximum	average minimum	average precipitation	maximum precipitation	number of days with precipitation not less than 20 mm
Foothill stations (500–1000 m a. s. l.)										
Stavropol (Stavropol region)	45.03°N; 41.58°E	I	-3,5	16,7	-25,8	9,6	-17,4	30,2	10,1	0,1
		VII	21,7	37,2	8,8	33,5	12,1	60,0	23,5	0,5
		год	9,2	37,2	-27,7	34,2	-19,9	566,3	40,3	4,7
Cherkessk (Karachay-Cherkessia)	44.17°N; 42.04°E	I	-3,5	19,7	-26,9	10,8	-18,6	22,1	7,4	0,0
		VII	20,6	37,1	7,1	32,5	10,5	82,8	25,3	1,0
		год	9,0	37,1	-26,9	33,6	-21,1	569,1	38,0	4,2
Kislovodsk (Stavropol region)	43.54°N; 42.43°E	I	-2,9	18,5	-24,4	12,0	-15,9	15,1	6,0	0,0
		VII	18,4	34,4	6,0	29,8	9,1	98,8	30,4	1,1
		год	7,8	35,2	-26,2	31,2	-17,8	646,4	41,3	5,3
Nalchik (Kabardino-Balkaria)	43.22°N; 43.24°E	I	-3,6	18,5	-26,7	10,2	-16,9	22,6	6,7	0,0
		VII	21,5	35,5	10,5	32,5	12,7	72,3	25,0	0,8
		год	9,3	36,1	-29,8	33,4	-19,7	636,4	43,0	5,8
Vladi-kavkaz (Republic of North Ossetia - Alania)	43.21°N; 44.40°E	I	-3,7	20,9	-26,5	13,5	-17,7	24,5	9,0	0,1
		VII	19,8	36,3	8,5	31,4	11,5	121,9	36,5	1,7
		год	8,5	38,0	-28,2	32,9	-20,8	909,2	59,6	10,4
Buinaksk (Dagestan)	42.49°N; 47.07°E	I	-2,1	22,7	-26,3	13,6	-14,9	17,4	6,1	0,0
		VII	22,0	39,4	10,8	34,1	12,7	52,4	23,7	0,6
		год	9,9	39,5	-28,1	35,2	-18,2	463,7	43,7	3,6
Averaged over foot-hill stations		**I**	**-3,2**	**22,7**	**-26,9**	**11,6**	**-16,9**	**22,0**	**7,6**	**0,0**
		VII	**20,7**	**39,4**	**6,0**	**32,3**	**11,4**	**81,4**	**27,4**	**1,0**
		год	**9,0**	**39,5**	**-29,8**	**33,4**	**-19,6**	**631,9**	**44,3**	**5,7**

Weather station	Geographic coordinates	months	Air temperature, °C					Precipitation, mm		
			average	absolute maximum	absolute minimum	average maximum	average minimum	average precipitation	maximum precipitation	number of days with precipitation not less than 20 mm
Mountain stations (1000–2000 m a. s. l.)										
Teberda (Karachay-Cherkessia)	43.45°N; 41.73°E	I	-3,2	14,9	-27,4	10,9	-18,0	51,7	18,5	0,7
		VII	15,7	34,6	1,0	29,1	4,5	77,8	23,0	0,9
		год	6,5	34,6	-27,4	30,5	-15,9	62,5	44,5	0,8
Akhty (Dagestan)	41.28°N; 47.44°E	I	-1,5	23,4	-21,4	15,0	-14,1	10,9	6,1	0,0
		VII	19,8	40,1	7,6	33,2	11,2	38,5	15,1	0,2
		год	9,2	40,1	-21,7	34,5	-16,8	15,0	29,2	0,0
Averaged over mountain station		**I**	**-2,4**	**23,4**	**-27,4**	**13,0**	**-16,1**	**31,3**	**12,3**	**0,4**
		VII	**17,8**	**40,1**	**1,0**	**31,2**	**7,9**	**58,2**	**19,1**	**0,6**
		год	**7,9**	**40,6**	**-27,4**	**32,5**	**-16,4**	**38,8**	**36,9**	**0,4**
High-mountain station (> 2000 m a .s. l.)										
Terskol (Kabardino-Balkaria)	43.15°N; 42.30°E	I	-7,6	-	-	-	-	60,0	-	-
		VII	12,0	-	-	-	-	106,1	-	-
		год	2,5	-	-	-	-	935,9	-	-
Averaged over high-mountain station		**I**	**-7,6**	**-**	**-**	**-**	**-**	**60,0**	**-**	**-**
		VII	**12,0**	**-**	**-**	**-**	**-**	**106,1**	**-**	**-**
		год	**2,5**	**-**	**-**	**-**	**-**	**935,9**	**-**	**-**
North Caucasus Federal District		**I**	**-3,5**	**26,7**	**-31,9**	**11,4**	**-15,4**	**34,4**	**9,1**	**0,1**
		VII	**18,6**	**40,1**	**1,0**	**32,5**	**11,5**	**70,8**	**20,8**	**0,6**
		год	**7,7**	**40,6**	**-31,9**	**33,7**	**-17,4**	**502,9**	**39,2**	**3,0**

To identify the average climatic parameters of the North Caucasus Federal District, 2 months were chosen: January is the coldest month of the cold period, July is the hottest month of the warm period, as well as annual indicators. The data obtained for climatic zones and for the North Caucasus Federal District as a whole are shown in Table 3.

Table 3 - Average climatic parameters of the region in 1961-2019

Weather station	Geographic coordinates	months	Air temperature, °C					Precipitation, mm		
			average	absolute maximum	absolute minimum	average maximum	average minimum	average precipitation	maximum precipitation	number of days with precipitation not less than 20 mm
Plain stations (< 500 m a. s. l.)										
Izobil'nyi (Stavropol region)	45.22°N; 32.42°E	I	-1,5	18,4	-26,1	11,7	-15,9	38,0	10,6	0,1
		VII	23,4	41,3	9,2	35,4	13,2	58,9	21,2	0,6
		год	11,0	41,3	-26,1	36,2	-18,7	616,9	43,1	5,4
Mozdok (Republic of North Ossetia - Alania)	43.44°N; 44.39°E	I	-2,8	15,2	-31,9	8,9	-16,9	26,0	7,2	0,0
		VII	24,3	41,0	8,4	36,5	13,6	49,7	20,7	0,6
		год	10,8	43,1	-31,9	37,7	-20,9	471,6	41,6	3,5
Prokhladnaya (Kabardino-Balkaria)	43.46°N; 44.05°E	I	-2,8	14,7	-29,1	9,6	-15,9	21,0	5,9	0,0
		VII	23,7	40,7	8,2	36,1	13,6	54,5	23,3	0,7
		год	10,6	40,9	-29,5	37,0	-19,4	485,3	41,8	4,0
Derbent (Dagestan)	42.04°N; 48.17°E	I	2,5	26,7	-18,9	11,2	-6,2	30,6	8,9	0,0
		VII	25,2	37,4	12,9	33,0	17,3	21,2	13,2	0,2
		год	13,2	38,8	-19,0	33,8	-8,4	389,8	40,0	3,0
Kizlyar (Dagestan)	43.51°N; 46.43°E	I	-0,3	17,5	-29,9	10,2	-14,9	21,8	7,3	0,0
		VII	24,6	41,6	11,0	35,7	14,6	25,1	12,934,5	0,2
		год	12,1	41,6	-29,9	36,4	-18,5	312,2		2,1
Makhachkala (Dagestan)	42.59°N; 47.31°E	I	0,6	19,0	-22,6	10,5	-11,3	29,5	9,5	0,1
		VII	24,8	39,5	10,4	34,1	16,0	23,5	11,9	0,2
		год	12,4	40,2	-26,8	35,0	-14,3	353,5	34,7	2,6
Izberg (Dagestan)	42.34°N; 47.45°E	I	1,6	19,9	-19,8	9,3	-8,0	18,0	6,4	0,0
		VII	24,6	34,9	13,6	31,6	17,4	18,3	10,7	0,1
		год	12,5	36,9	-21,2	32,6	-10,9	291,5	32,7	0,1
Averaged over the plain stations		**I**	**-0,4**	**26,7**	**-31,9**	**10,2**	**-12,7**	**26,4**	**8,0**	**0,0**
		VII	**24,4**	**41,6**	**8,2**	**34,6**	**15,1**	**35,9**	**16,3**	**0,4**
		год	**11,8**	**43,1**	**-31,9**	**35,5**	**-15,9**	**417,3**	**38,3**	**3,0**

Weather station	Geographic coordinates	months	Air temperature, °C					Precipitation, mm		
			average	absolute maximum	absolute minimum	average maximum	average minimum	average precipitation	maximum precipitation	number of days with precipitation not less than 20 mm
Foothill stations (500–1000 m a. s. l.)										
Stavropol (Stavropol region)	45.03°N; 41.58°E	I	-3,0	16,7	-27,7	9,9	-16,6	29,3	9,4	0,0
		VII	22,3	38,6	8,5	34,1	12,5	59,2	23,8	0,7
		год	9,6	39,7	-28,3	35,0	-28,3	564,2	41,5	0,0
Cherkessk (Karachay-Cherkessia)	44.17°N; 42.04°E	I	-2,9	19,7	-27,3	11,2	-17,5	21,5	7,4	0,0
		VII	21,1	37,9	6,8	33,0	10,8	73,2	23,9	0,8
		год	9,4	38,0	-27,9	34,1	-27,9	584,4	40,3	0,0
Kislovodsk (Stavropol region)	43.54°N; 42.43°E	I	-2,5	18,5	-25,4	12,2	-16,1	17,8	6,7	0,0
		VII	19,0	36,8	4,2	30,5	9,3	94,4	29,1	1,1
		год	8,3	36,8	-27,9	32,0	-27,9	649,4	41,1	0,0
Nalchik (Kabardino-Balkaria)	43.22°N; 43.24°E	I	-2,8	18,6	-26,7	10,8	-15,8	22,1	6,6	0,0
		VII	22,2	38,3	8,3	33,2	13,1	70,8	24,6	0,8
		год	9,9	38,3	-29,8	34,1	-29,8	638,3	43,3	0,0
Vladikavkaz (Republic of North Ossetia - Alania)	43.21°N; 44.40°E	I	-2,7	20,9	-26,5	13,9	-15,9	27,4	9,5	0,1
		VII	20,4	37,5	7,5	32,0	11,9	118,1	35,1	1,6
		год	9,1	39,2	-28,2	33,5	-28,2	932,2	60,2	0,1
Buinaksk (Dagestan)	42.49°N; 47.07°E	I	-1,4	13,9	-26,3	13,9	-13,6	18,9	6,7	0,0
		VII	22,6	40,4	9,8	34,8	13,0	54,7	23,7	0,6
		год	10,5	40,4	-28,1	35,9	-28,1	468,8	41,7	0,0
Averaged over foothill stations		**I**	**-2,6**	**20,9**	**-27,7**	**12,0**	**-15,9**	**22,8**	**7,7**	**0,0**
		VII	**21,3**	**40,4**	**4,2**	**32,9**	**11,8**	**78,4**	**26,7**	**0,9**
		год	**9,5**	**40,4**	**-29,8**	**34,1**	**-28,4**	**639,6**	**44,7**	**0,0**
Mountain stations (1000–2000 m a. s. l.)										
Teberda (Karachay-Cherkessia)	43.45°N; 41.73°E	I	-2,7	15,3	-27,4	11,3	-17,2	50,2	18,4	0,6
		VII	16,2	37,4	1,0	29,9	5,1	75,4	21,1	0,7
		год	6,9	37,4	-27,4	31,2	-15,1	60,9	46,8	0,7
Akhty (Dagestan)	41.28°N; 47.44°E	I	-1,1	23,4	-21,4	15,6	-13,4	11,7	6,3	0,0
		VII	20,2	40,1	3,9	32,9	11,1	38,9	16,1	0,3
		год	9,6	40,6	-21,7	34,6	-15,9	14,4	31,2	0,0
Averaged over mountain station		**I**	**-1,9**	**23,4**	**-27,4**	**13,5**	**-15,3**	**31,0**	**12,4**	**0,3**
		VII	**18,2**	**40,1**	**1,0**	**31,4**	**8,1**	**57,2**	**18,6**	**0,5**
		год	**8,3**	**40,6**	**-27,4**	**32,9**	**-15,5**	**37,7**	**39,0**	**0,4**

Weather station	Geographic coordinates	months	Air temperature, °C					Precipitation, mm		
			average	absolute maximum	absolute minimum	average maximum	average minimum	average precipitation	maximum precipitation	number of days with precipitation not less than 20 mm
High-mountain station (> 2000 m a. s. l.)										
Terskol (Kabardino-Balkaria)	43.15°N; 42.30°E	I	-7,6	-	-	-	-	57,7	-	-
		VII	12,4	-	-	-	-	105,4	-	-
		год	2,6	-	-	-	-	968,6	-	-
Averaged over high-mountain station		**I**	**-7,6**	**-**	**-**	**-**	**-**	**57,7**	**-**	**-**
		VII	**12,4**	**-**	**-**	**-**	**-**	**105,4**	**-**	**-**
		год	**2,6**	**-**	**-**	**-**	**-**	**968,6**	**-**	**-**
North Caucasus Federal District		**I**	**-3,1**	**26,7**	**-31,9**	**11,9**	**-14,7**	**34,5**	**9,3**	**0,1**
		VII	**19,1**	**41,6**	**1,0**	**33,0**	**11,7**	**69,2**	**20,5**	**0,6**
		год	**8,0**	**43,1**	**-31,9**	**34,1**	**-16,7**	**515,4**	**40,7**	**1,1**

Table 3 shows that the highest average temperature for the entire study period from 1961 to 2019 for the hottest month, July, were observed at two lowland (Caspian) m/stations Derbent and Makhachkala (Dagestan) and, respectively, were equal to 25.2 °C and 24.8 °C. The lowest average temperature for the coldest month of January (-7.6 °C) was observed at the high-mountain m/station Terskol (Kabardino-Balkaria).

The highest values of the absolute maximums in January over a 58-year period were observed in Dagestan, at the plain m/station Derbent and at the mountain m/station Akhty, and amounted to 26.7 °C and 23.4 °C, respectively. In July, the absolute maximum temperature of 41.3 °C was observed at the Izobil'nyi station (Stavropol Territory) and at the Kizlyar station (Dagestan) -41.6 °C.

The lowest values of the absolute minima in January were observed at the lowland m/stations Mozdok (-31.9 °C) and Kizlyar (-29.9 °C). During the hottest month (July), the lowest temperature values were observed at mountain m/stations Teberda and Akhty with values of 1.0°C and 3.9 °C, respectively, and at the foothill station Kislovodsk (4.2 °C).

The maximum of the average temperatures for the year was noted at the plain stations Izobil'nyi (36.2 °C) and Mozdok (37.7 °C). The lowest of the average temperatures for the year (-29.8 °C) was noted at the foothill station Nalchik and was recorded in February 1969.

For the entire study period, the highest averaged values of precipitation in January were observed at two meteorological stations: mountain - Teberda (Karachay-Cherkessia) and high-mountain - Terskol (KBR) with values of 50.2 mm and 57.7 mm. And in the hottest month at the foothill m/station Vladikavkaz (Republic of North Ossetia - Alania) - 118.1 mm and at the high mountain m/ station Terskol (KBR) - 105.4 mm. The maximum amount of precipitation for the year was also observed at m/station Vladikavkaz (932.2 mm).

It can be seen from the results of the study that the highest average temperature, as well as maximum temperatures, took place at the flat m/stations.

Consider tables 2 and 3 and compare the climatic parameters for the entire observation period (1961-2019) with the climatic norm (1961-1990) for each climatic zone separately and in the North Caucasus Federal District as a whole.

It was found that for the flat zone:

- the average temperature in January for the period from 1961 to 2019 was equal to -0.4 °C with a climatic norm of -1.0 °C ($\Delta T = + 0.6$ °C). The temperature in July for the same period was 24.4 °C, which is 0.5 °C more than the climatic norm (N = 23.9 °C);

- the absolute maximum temperature in January in both periods under consideration was 26.7 ° C. At the same time, summer and annual maximum temperatures in the period 1961-2019 was higher than in the period 1961-1990;

- the absolute minimum temperature in the winter period (January) and in the year in both periods had the same values and amounted to -31.9 °C. The minimum value of July temperature in the period 1961-2019 was lower than in the base period;

- the average maximum temperature in January exceeded the norm by 0.5 °C (10.2 °C). In July, the average maximum temperature was 34.6 °C, while the norm was 34.1 °C. The annual average maximum temperature also exceeded the climatic norm by 0.3 °C;

- the average minimum temperature in July was equal to the norm, in January there was a deviation from the norm by $\Delta T = + 0.7$ °C. Annual values were above the norm by 0.5 °C and amounted to -15.9 °C, while the norm was -16.4 °C;

- the average annual precipitation in the plain zone for the period 1961-2019 amounted to 417.3 mm at a rate of 405 mm, and at the same time the values of the maximum daily precipitation increased to 38.3 mm at a rate of 36.5 mm;

- the change in the number of days with precipitation of at least 20 mm is statistically insignificant in comparison with climatic norms.

It was found that for the foothill zone:

- the average temperature in January for the period from 1961 to 2019 was -2.6 °C with a climatic norm of -3.2 °C. The temperature in July for the same period was 21.3 °C, which is 0.6°C higher than the climatic norm;

- the absolute maximum temperature in January for the period 1961-2019 was lower than in the base period. At the same time, summer and annual maximum temperatures in the period 1961-2019 were higher than in the period 1961-1990 by 0.9 °C and 1.0 °C, respectively;

- absolute minimum temperature in January and July 1961-2019 was lower than for the period 1961-1990. The minimum values of the annual temperature coincided in both periods;

- all average maximum temperatures exceeded climatic norms by 0.4 °C - 0.7 °C;

- the annual values of the average minimum temperature were 0.8 °C higher than the norm, and the January and July temperatures were 1.0 °C and 0.4 °C, respectively;

- average annual precipitation and daily maximum precipitation in the foothill zone for the period 1961-2019 remains within normal limits;

- the change in the number of days with precipitation of at least 20 mm is statistically insignificant in comparison with climatic norms.

It was found that for the mountainous zone:

- average temperatures in the year, January and July in the period from 1961 to 2019 exceeded climatic norms by 0.4 °C, 0.5 °C, 0.4 °C;

- the absolute maximum temperature and the absolute minimum temperature in January and July coincide in both periods under consideration. At the same time, the annual maximum temperatures differ insignificantly, and the minimum ones coincide;

- all average maximum temperatures in the year, January and July in the period from 1961 to 2019 exceeded climatic norms by 0.4 °C, 0.5 °C, 0.2 °C;

- the annual values of the average minimum temperature were above the norm by 0.9 °C, and the temperatures in January and July by 0.8 °C and 0.2 °C, respectively;

- average annual precipitation and daily maximum precipitation in the mountainous zone for the period 1961-2019 remained within normal limits;

- the change in the number of days with precipitation of at least 20 mm is statistically insignificant in comparison with climatic norms.

For the high-mountain zone (Terskol), it was obtained that:

- the average temperature for January coincided with the climatic norm and was equal to -7.6 °C. In July, the average temperature was 12.4 °C, which is 0.4 °C higher than the climatic norm. At the same time, the annual value for the entire period (2.6 °C) differed only by 0.1 °C from the climatic norm (2.5 °C).

The amount of precipitation for the two periods does not differ statistically significantly.

In the North Caucasus Federal District, there was an increase in average temperatures in January and July, as well as in the year as a whole. Annual and sea-

sonal (January, July) temperatures, both maximum and minimum, exceeded the climatic norm.

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邊境地區經濟地理研究中的經濟安全與經濟複雜性
ECONOMIC SECURITY VS ECONOMIC COMPLEXITY IN ECONOMIC AND GEOGRAPHICAL STUDIES OF BORDER REGIONS

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抽象。本文在邊境地區的經濟和地理研究框架中研究了一個新的科學問題，與在經濟複雜性邊界內確保經濟安全的問題有關。經濟的複雜性歸因於不利於經濟安全的外部發展動力，這與該區域的內部潛力和資源有關。一方面，經濟安全可被視為增加領土系統經濟複雜性的邊界。另一方面，經濟複雜性的增加不僅是對現代技術挑戰的回應，而且是對領土系統的穩定性和競爭力的支持，即對與該地區有關的外部威脅的回應。因此，本文考慮到經濟安全性與經濟複雜性的聯繫，從而證實了經濟安全研究的方法論規定，從而確定了該地區增長和發展的現代創新和技術邊界。

關鍵詞：經濟安全，經濟複雜性，區域研究，社會經濟地理，邊境地區。

Abstract. *The article examines a new scientific problem in the framework of the economic and geographical study of border regions, associated with the issues of ensuring economic security within the boundaries of economic complexity. Economic complexity is due to the external vector of development against economic security, which is associated with the internal potential and resources of the region. On the one hand, economic security can be viewed as the boundaries of increasing the economic complexity of the territorial system. On the other hand, an increase in economic complexity is not only a response to modern technological challenges, but also support for the stability and competitiveness of the territorial system, that is, a response to external threats that arise in relation to the region. As a result, the paper substantiates the methodological provisions of the study of economic security, taking into account its connectivity with economic complexity, which determines the modern innovative and technological boundaries of the growth and development of the region.*

Keywords: *economic security, economic complexity, regional studies, socio-economic geography, border regions.*

Introduction

The development of regions today is influenced by two oppositely directed processes. First, it is the need to follow global and national technological trends, openly supporting various forms of international cooperation, which is due to economic complexity. Secondly, it is required to provide protection from the effect of external influences and threats, through more intensive use of the available internal potential, which is associated with economic security. That is, there is a clash of interests of the region at the level of certain centrifugal and centripetal forces, depending on the balance of which the prospects for future growth and development are determined. Moreover, this balance is changing under the influence of new challenges and threats, which include the COVID-19 pandemic, geopolitical turbulence [2], expected changes in the global and domestic markets in connection with ensuring the carbon neutrality of countries [1], etc. In regional studies, this situation gives rise to the scientific problem of the coherence and interdependence of economic complexity and economic security. Changes in territorial systems in response to increased economic complexity can have various consequences for sectors, branches and industries that support economic security and preservation of regional stability. The solution to this problem is proposed in the article on the basis of establishing permissible boundaries for changing economic complexity in the context of ensuring the economic security of the region. The methodology and materials of this study are the results of the author's developments carried out within the framework of projects: RFBR №19-410-390002 "Economics of complexity and the choice of sectoral strategies by the regions of Russia in the new paradigm of value creation on the example of Kaliningrad Oblast" (head – Cand. Econ. Sci., Voloshenko K.Yu.) and RSF №18-17-00112 "Ensuring the economic security of the regions of the Western borderlands of Russia in the conditions of geopolitical turbulence" (supervisor – Dr. Geol. Sci., Prof. G.M. Fedorov).

Economic security vs economic complexity

The current level of economic security in the region is a very dynamic category, and the concept itself is ambiguous. It is studied in modern domestic and foreign works at the level of well-being and satisfaction of individual needs [7], through the influence of regional inequality and differentiation [8], competitiveness and economic sovereignty [6], includes issues of social identity, ecology, natural and random threats [5] and etc. Studying its content and specifics on the example of the border regions of Russia, especially the Western borderlands [9, 13], we have established the following:

The economic security of the border region is a stable state of the territorial system, achieved by keeping it in dynamic equilibrium with the multidirectional action of factors caused by the border position, which ensures its development, protection of the interests of the economy and society.

The key role here belongs to the maintenance of the territorial system in a state of dynamic equilibrium. To characterize the economic security of the border region, we introduce the concept of the central forces of the border area, which include: 1) geopolitical factors and conditions; 2) globalization, integration, internationalization, etc.; 3) administrative and economic barriers; 4) participation of the region in the territorial division of labor; 5) sustainability (balance and reproductive process); 6) barrier and contact functions of the border; 7) internal properties and characteristics of the territorial system (the degree of openness or closeness of the system). Their manifestation and impact determine the socio-economic, geopolitical and institutional contexts in the development of a specific type of border region. On this basis, general and specific hazards and challenges, potential and real threats associated with the border position of the territory are identified. The effect of the borderline factor itself in ensuring economic security is accordingly reduced to the establishment and maintenance of balances of external and internal sources of functioning and development. Economic security - the internal potential and resources of the region, as an external vector and source of development of the region can be considered economic complexity, proposed by researchers at Harvard University - Hausmann R. and Hidalgo C. [3] (fig. 1).
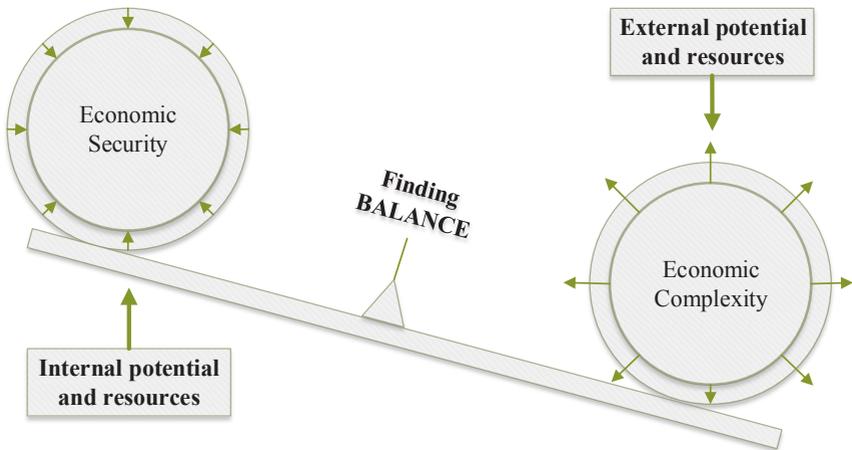
Fig. 1. Economic security and economic complexity of the region

Economic complexity refers to the ability of a territory, by accumulating capabilities, to produce more diverse and complex products. At the same time, within the framework of the theory of economic complexity, productive knowledge and competencies are understood as non-tradable productive inputs [4], which include technologies, methods or techniques of work, know-how, laws and legislation, in-

stitutions and infrastructure, organizational abilities, relational capital, etc. Technological shifts and subsequent changes in the way of creating prices (value) have the following consequences. At the level of organizations and companies (micro level), there is a transformation of their tasks and structure, methods of work and technologies; at the level of individual regions - new and old industries, industries and sectors appear and old ones disappear, that is, the economy is restructuring and their production structure changes [10]. Maintaining a balance of interests at the regional level, the key role of economic complexity is to ensure competitiveness at the international level; the external vector of growth and development of the region is of priority importance. Economic security, on the contrary, is associated with the internal vector of growth and development, acting as a limitation. To a greater extent, it affects internal competitiveness in order to preserve the socio-economic potential for achieving development goals and fulfilling the tasks of the functioning of the region. As a result, in the study of economic security, economic complexity determines the modern innovative and technological boundaries of the growth and development of the region. To establish a balance between economic security and economic complexity, we have worked out certain methodological provisions in the development of the territorial system.

Ensuring economic security within the boundaries of economic complexity

The methodological connection between economic complexity and economic security is manifested in the substantiation of sectoral strategies and the choice of directions of the region's industrial policy in the process of calculations and obtaining the corresponding estimates (fig. 2). It should be noted here that the theory of economic complexity as applied to Russian regions has practically not been developed. In all the few studies of domestic scientists, the originally developed methodology at the country level is used [3]. Therefore, a group of researchers from Immanuel Kant Baltic Federal University in 2019-2020 under the leadership of the author of this article within the RFBR project proposed an approach to the analysis of economic complexity at the subnational level based on [11]. In particular, the prevalence of the region's products in the national and global food spaces is taken into account, the diversification of the region's export basket is estimated, which potentially includes goods involved in both international and interregional trade. For these purposes, the authors have implemented an algorithm for adjusting the database of world trade statistics and developed the corresponding software [12]: 1) basic software preparation and processing of the initial export and import databases for measuring economic complexity; 2) auxiliary software processing of data in the formation of the initial export and import databases. The codes are open source and are freely available at: https://github.com/hydrophis-spiralis/regional_economics_complexity.

1 Database for Economic Complexity analysis

World trade statistics (export and import)

Interregional data (export and import)

Ensuring data compliance (codes and classifiers)

Cleaning the data from transit

Data sensitivity and reliability analysis

Preparing initial data for software processing

2 Indicators of economic complexity and derived metrics

Revealed comparative advantage **(RCA)**

Economic Complexity Index **(ECI)**

Product Complexity Index **(PCI)**

Opportunity outlook **(OV и COI)**

Relative opportunity gain **(OG и COG)**

Export potential

Economic complexity level

Ubiquity and diversification

Proximity to more complex products

Benefits from more complex products

3 Analysis of the region's product space and prioritization of industries

Industries of the past paradigm

Emerging (developing) industries

Emerging high complexity industries

Industries for filling structural holes

Industries that show a decline in RCA

Industry priorities and structure

Economic security level for the region

Compliance with industry prioritization of the target security model

Modeling of economic security

Indicators of economic security

Assessment of shifts and changes in threshold levels

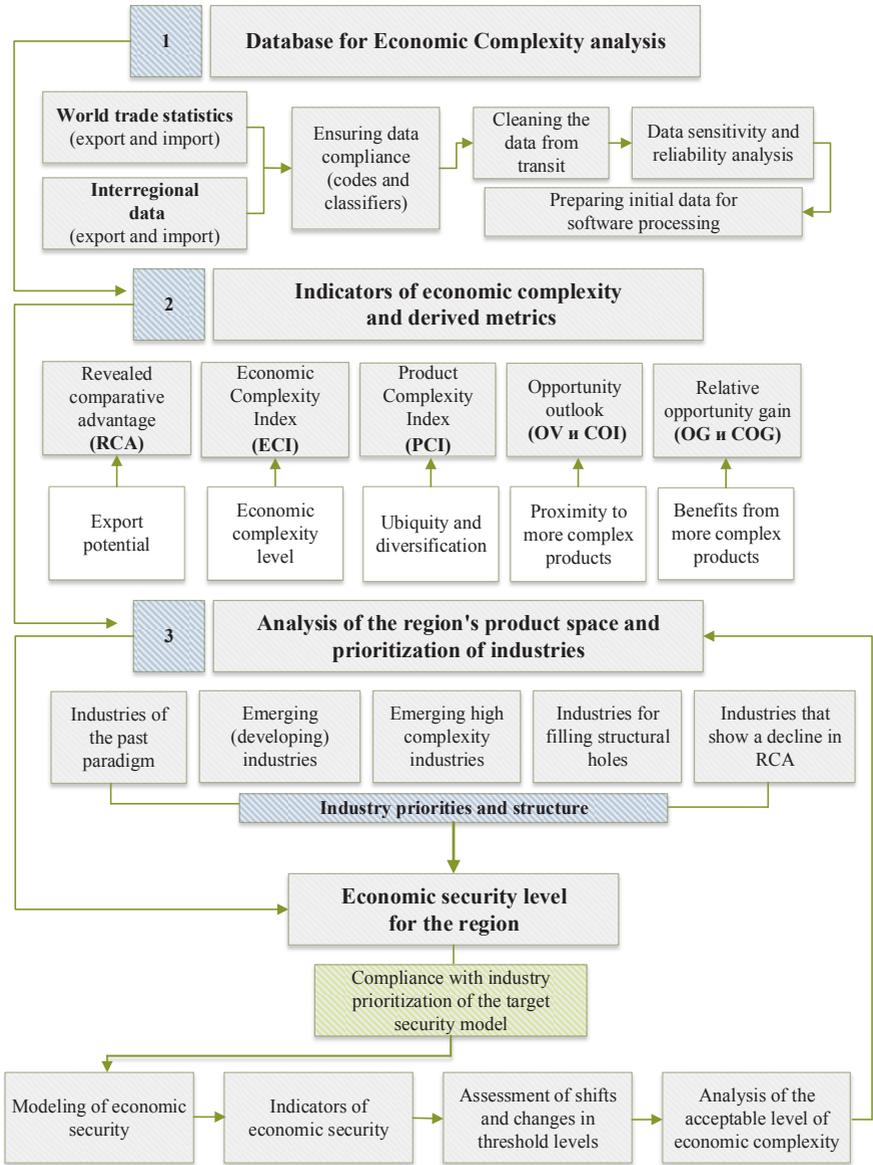Analysis of the acceptable level of economic complexity

Fig. 2. Assessment of economic complexity within the boundaries of economic security

At the **first stage**, an initial database is prepared for assessing economic complexity and subsequent sectoral prioritization. The peculiarity of the author's methodological approach is 1) the inclusion of the region as a separate statistical unit in the general data sets and databases on the international trade of countries. This makes it possible to take into account not only international, but also internal (interregional) trade flows; 2) "clearing" the trade statistics of the region from transit (export and import transit) at the level of 6 characters of the Commodity nomenclature of foreign economic activity; 3) assessing the sensitivity and reliability of the data; 4) software processing and data preparation.

At the **second stage**, the indicators of economic complexity and derived metrics are calculated. The following indicators are found mainly: 1) revealed comparative advantage (RCA), which gives an assessment of the export presence of the region's economy; 2) economic complexity index (ECI), which characterizes the level of complexity of the export basket; 3) product complexity (PCI) - an assessment of the diversity of production competencies in the region for the release of economically complex products; 4) potential for economic complication (OV and COI), which characterizes how close a region is to more complex products versus those already present in its export basket; 5) the relative potential benefit (OG and COG) that the region receives from the production of more complex products.

At the **third stage**, the obtained indicators are analyzed, the product space of the region is assessed and sectoral strategies are analyzed. Manufactures and industries are grouped in terms of their contribution to increasing the output of complex products:

1) the most significant sectors of the economy that were formed in the previous paradigm of value creation with a low level of resource consumption;

2) emerging (developing) complex industries in which the region already has identified comparative advantages or has the potential for their emergence;

3) industries that currently do not exist in the region, but there is sufficient potential for their successful development;

4) industries that do not currently exist in the region, but which could fill structural holes in the economy and provide the necessary conditions for breakthrough innovations in the industries that they will link together;

5) industries associated with the previous value creation paradigm showing declining comparative advantage.

Based on the results of the prioritization of industries, an assessment is made of their compliance with the boundaries of the economic security of the region under study. The main criterion is the promotion of the identified priorities to maintain or increase the level of economic security, as well as to prevent the deterioration of the region's position. Clarifying the sectoral priorities, a conclusion is made about

the possible directions of growth in the economic complexity of the region, which does not contradict, but contributes to the implementation of the model and the strengthening of the region's position in terms of economic security.

Conclusions

The border position of the region (often its remoteness or isolation) makes special demands on balanced development. This is manifested both from the position of ensuring internal growth and socio-economic development, ensuring the economic security of the country as a whole, and economic complexity for increasing the position of international competition, which is a consequence of their proximity to the world market and the predominant role of the foreign economic dominant in development. Following the established logic and the relationship between economic complexity and security, the following main points should be considered.

Firstly, the analysis of economic complexity allows only preliminary identification of the prospects for increasing the international competitiveness of the region and the transition to the production of new, more complex types of products. To select sectoral strategies, an additional analysis of regional specifics and an assessment of the existing limitations is required.

Secondly, the assessment of the current level of economic security, including its functional types, makes it possible to adjust the identified industry priorities based on the analysis of economic complexity. This is both the prioritization of industry tasks and the identification of a list of manufactures and industries, the presence of which and preservation in the production structure is mandatory from the point of view of safety.

Thirdly, from a methodological point of view, the problem arises of forming a model for the development of a region with the target function of ensuring the growth of economic complexity under restrictions, which are accumulated knowledge and competencies, as well as the requirement to maintain the required level of economic security.

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