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SCIENCE EDUCATION PRACTICE



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

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FINANCIAL SUSTAINABILITY OF ORGANIZATIONS OF THE KYRGYZ REPUBLIC IN THE CONTEXT OF A PANDEMIC

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The impact of the coronavirus pandemic on the financial stability of organizations is investigated, an analysis of the decline in business activity of organizations, a decrease in activity in local markets and a downturn in the financial markets of Kyrgyzstan is presented.

Keywords: financial stability, profit, capital, innovation, increased demand, interest rates, loans, external and internal factors, digitalization.

In 2020, issues of financial stability, image and reputation took a hit from all sides. First, companies had to make efforts to save face against the backdrop of a pandemic, the crisis market would radically restructure. Secondly, it has become difficult for brands to use an electronic platform to maintain their image in the face of an incessant series of negative consequences. But in a changing environment, accompanied by a crisis, these are, first of all, small opportunities and even negative conditions with insignificant potential. The changes in people's lives are unprecedented and impact on many industries. Many businesses work with reduced headcounts, as well as distance rules to function and make decisions, implement ideas for a more flexible organization. The coronavirus epidemic in the Kyrgyz Republic has also negatively impacted the service sector, as lower consumer spending has negatively impacted retail, restaurants and aviation. The analysis shows that the virus epidemic can affect markets in three ways: a decrease in business activity of organizations, a decrease in activity in local markets, and a downturn in financial markets [1,2].

Operating economic entities by type and territories for 2019 (thousand units) [3].

Regions of the Kyrgyz Republic	total	Including					
		small	average	large	peasant (farming) households	individual entrepreneurs	other separate divisions
Republic of Kyrgyzstan	707.2	24.5	4.3	1.9	333.0	335.1	8.3
Batken region	64.5	1.0	0.4	0.1	31.0	31.6	0.4
Jalal-Abad region	128.0	1.9	0.7	0.3	77.0	46.5	1.6
Issyk-Kul region	62.7	1.4	0.4	0.1	19.8	40.0	0.9
Naryn region	56.1	0.7	0.3	0.1	31.5	22.7	0.8
Osh region	172.2	2.5	0.6	0.2	98.1	69.1	1.7
Talas region	36.9	0.9	0.2	0.1	21.6	13.5	0.6
Chui region	120.6	2.8	0.6	0.2	51.2	64.4	1.3
Bishkek	38.7	12.1	0.8	0.6	0.5	23.9	0.9
Osh	27.5	1.2	0.2	0.1	2.4	23.3	0.3

In the context of the pandemic, mainly small enterprises were affected, in which their financial instability is of great importance, on the one hand, since they depend on the state of financial resources, their distribution and use, the prospects for the development of the organization based on the growth or decrease in profits and capital, and on the other - because the timely identification of problems in this area will allow timely development of measures to reduce the risks of insolvency of enterprises. To ensure effective functioning in a pandemic, small businesses must not only ensure their financial stability and solvency, but also invest in innovative development directions, produce or use advanced technological and other developments and innovations.

Currently, small businesses operate in a rapidly changing macroeconomic environment amid a pandemic, and this factor should be taken into account when forecasting the financial statements of the company as a

whole or some of its individual aspects. Assessing the financial stability of companies taking into account macroeconomic factors is difficult because the problems of some factors with the frequency of origin of financial indicators: such as exchange rates can change daily, weekly or monthly. Changes in the key interest rate can be characterized as systematic, since the National Bank may vary the key interest rate depending on market external conditions. Meanwhile, the company's financial indicators are falling based on semi-annual and annual reports. The pandemic has created an increased demand for high technology development and has allowed redefining for growth and technological renewal, rethinking approaches to working in the shortest possible time and requiring organizations to innovate.

The institutions of the stock and foreign exchange markets, the global trade in goods produced by manufacturers from different countries, and the trade in oil define the macroeconomic environment. This is not a complete list of parameters that characterize the macroeconomic situation in the Kyrgyz Republic. They can also include the consumer price index, unemployment and interest rates on loans and deposits, which are largely determined by the size of the key interest rate, and other indicators. For example, changes in exchange rates have a direct impact on international enterprises and directly affect domestic-oriented enterprises through structural changes in the economy. However, the above parameters of the nature and degree of impact on the financial condition of the company are uncertain. Moreover, the impact of changes in these parameters can affect the performance of organizations in different ways, depending on the nature of their interaction with the environment. For example, whether they purchase raw materials in foreign currency, where are the main market channels, etc. The financial condition of an organization largely depends on its ability to quickly adapt to macroeconomic conditions. Research by organizations shows that the pandemic has reshaped the role and meaning of digital shoppers' experiences and the rise in e-commerce across the globe.

More flexible customer engagement strategies are needed. If the organization can provide customers with digital experience management, it will also provide a quick way to get information about wants and needs. The problem of financial stability of modern enterprises predetermines the long-term development of the state. The economic instability that exists at the present time during the crisis, inevitably affects the business systems of all levels; therefore, any management team must be ready for quick actions like planning and monitoring processes in the enterprise. The area

of finance is usually singled out as one of the main types in the enterprise, since the result will depend on the quality, timing and amount of funding that is needed.

The new methodology for stabilizing the financial system of organizations implies a partial disclaimer of responsibility about generally accepted elements and methods of anti-crisis financial management; it is based on a separate analysis of the activities and processes operating in the enterprise [4].

Ensuring the financial stability of an enterprise is becoming one of the determining factors for its functioning in modern conditions. In this regard, the role and importance of analysis and search for factors to increase financial stability for many enterprises and its counterparties are significantly increasing. Only small businesses can be flexible and subject to change. The consequences of the pandemic leading to economic instability of enterprises has a negative impact on the state of the economy, entails non-payments and a slowdown in business activity in general. Therefore, it is necessary to prevent the instability of enterprises as early as possible. This is possible due to the timely identification of factors affecting the level of financial stability, as well as timely analysis and the adoption of specific measures to restore the financial stability of enterprises. Financial stability serves as the basis for a stable position of organizations and a guarantee of its survival, due to the fact that they need prompt measures, to carry out flexible measures in a changing environment that allow maintaining a stable state of the enterprise for a short time and makes fundamental changes to the situation. On the one hand, it is difficult to adapt the accompanying poor vision of the prospects for the development of the enterprise, and on the other, with the narrowness of the approach used to diagnose the existing situation and predict changes in external factors [5].

- общеэкономические факторы, в частности, снижение национального дохода, рост инфляции, замедление платежей, нестабильность налоговой системы, нестабильность нормативного законодательства, снижение реальных доходов населения, рост безработицы;

- рыночные факторы, такие как уменьшение емкости внутреннего рынка, усиление монополии на рынке, значительное снижение спроса, увеличение предложения товаров-заменителей, снижение активности на фондовом рынке, нестабильность рынка. валютный рынок;

- Финансовые факторы: финансовая стратегия, структура активов (ликвидность), доля заемного капитала, доля краткосрочных источников заемного капитала, дебиторская задолженность, стоимость капитала, уровень финансовых рисков, управление финансами.

- Операционные факторы: маркетинг, структура текущих затрат (доля постоянных и переменных затрат), уровень использования основных средств, размер страховых и сезонных запасов, ассортимент продукции, управление производством;

- инвестиционные факторы: портфель акций, потребление инвестиционных ресурсов, планируемая сумма прибыли проекта, управление инвестициями;

- Операционные факторы: маркетинг, структура текущих затрат (доля постоянных и переменных затрат), уровень использования основных средств, размер страховых и сезонных запасов, ассортимент продукции, управление производством;

Fig. 1. Internal and external factors affecting the financial stability of the organization

In the context of a pandemic, it is necessary to focus on the formation of the economic policy of the state aimed at weakening fluctuations in the national currency exchange rate, stabilizing the bank lending rate, reducing prices for industrial and consumer goods, creating conditions conducive to enhancing entrepreneurial activity. There are a number of industries that will be hardest hit by the effects of the epidemic. Among them are tourism, energy, the technology sector, fiscal, monetary policy will not be effective during the coronavirus crisis. Monetary policy and stimulation of demand will lead to inflation due to disruption in the supply chain, reduced production and trade turnover. The greatest attention should be paid to the group of internal factors, the choice of the type of activity and the structure of the product, effective management of current assets, provision of rational capital. However, it is important to remember that the bankruptcy of an enterprise is the result of a negative effect on financial stability, which requires the enterprise not only to monitor the actions of suppliers, competitors, management and accounting structures, but also to constantly analyze the external environment, study and predict great opportunities or potential threats, the impact of new trends. and technological change.

The Kyrgyz Republic must begin to create a new economy, since the old one will no longer be the same due to the COVID-19 coronavirus pandemic. There will be no return to the "old normality" of the economy. The massive reallocations of financial resources by governments in these weeks and months are a glimpse of the future. The COVID-19 crisis plunges the global economy into a recession with historical levels of unemployment and poverty, contributes to the acceleration of the digitalization of the world economy by 10 times [6].

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INDICATORS OF CASH FLOWS IN THE ECONOMIC ASSESSMENT OF THE SECURITY OF THE COMPANY

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The article reveals the place and role of the financial component in assessing the economic security of a company. Financial indicators are compared in assessing economic security. The necessity of using indicators of monetization and cash flows in assessing economic security is substantiated.

Keywords: Economic security, financial stability, financial independence, profitability, liquidity, cash flows, monetization.

The economic security of an organization (enterprise, company) is a state of functional elements and their connections, which ensures the most effective use of both corporate and external resources, aimed at preventing threats and creating conditions for its stable functioning.

The following functional elements of economic security are distinguished:

- financial condition;
- staffing;
- organizational and legal support;
- information security,
- technical and technological equipment;
- ecological state and others.

Let us dwell on the financial condition of an organization as one of the main functional elements of economic security. Financial condition includes financial stability and independence, solvency and liquidity, necessary for the development of cash flows and stable profitability. Financial stability, independence, liquidity can be assessed using the recommended indicators, which are calculated by many government organizations and analytical companies both for Russian companies as a whole, and in the context of industries and groups of organizations. So, it is customary

to assess liquidity using the current liquidity ratio (the recommended value is 1.5 - 2), stability - the ratio of the provision of own circulating assets (the recommended value is 0.2), independence - the autonomy ratio (the recommended value is 0.5 - 0.6). Data on these indicators in recent years are presented in table 1.

Table 1. Dynamics of the solvency ratios of organizations (excluding small businesses) in the Russian Federation (according to financial statements, in%)¹

	Current liquidity ratio	Coefficient of provision with own circulating assets	Autonomy ratio
2018	126.1	-44.4	40.6
2019*	157.3	-13.7	50.2

* according to statistical reporting

To assess economic security, one can compare corporate indicators with the recommended ones, as well as with indicators for the aggregate of Russian companies and/or in the industry.

Table 2. Dynamics of profitability of organizations (excluding small businesses) in the Russian Federation (according to financial statements, in%)²

	Return on assets	Profitability of sold goods, products, works, services
2018	4.7	10.7
2019	6.8	11.4

Profitability can be assessed in a similar way (tab. 2), only instead of the recommended values, the emphasis is on comparison with industry values (tab. 3) and competitors.

¹According to the Federal State Statistics Service,
<https://rosstat.gov.ru/folder/11192>

²According to the Federal State Statistics Service,
<https://rosstat.gov.ru/folder/11192>

Table 3. Industry values of return on assets³

Type of activity	2018	2019
All industries in the RF	5.4%	5.1%
Coal mining	4.2%	2.8%
Extraction of crude oil and natural gas	4.9%	3%
Food production	3.6%	3.5%
Manufacture of wearing apparel	6.5%	5.7%
Manufacture of computers, electronic and optical products	7.2%	7%
Retail trade	6.7%	6.8%
Food and beverage provision activities	12.8%	12.6%
Development of computer software, consulting services in this area	14.5%	13.1%
Information technology activities	12%	11.3%
Research and development	6.1%	5.6%
Education	7.7%	9.1%
Healthcare activities	14.9%	14.9%

The main problem in assessing economic security is the analysis of cash flows. But it is cash flows, their structure, distribution by spheres of activity, their intensity and frequency that determine economic security. Many companies with good indicators shown above and profit do not have the money to carry out their activities. One of the most common business questions: "Is there profit, but no money?"

Consider the main indicators of monetization, saturation of revenue and profit with money:

1. Return on cash flow = $NCFm/RS \cdot 100\%$,
Where NCFm – net cash flow from main operating activities,
RS – revenues from sales;
2. Net profit monetization indicator = $NCF/NP \cdot 100\%$,
Where NCF – net cash flow from the company's activities as a whole,
NP – net profit;
3. Self-financing ratio = $NCFm/LC$,
Where LC – short-term loan capital;
4. Cash flow liquidity ratio =
= $(CF_{in} - C. b. at e.p.) / CF_{out}$,

³According to <https://www.testfirm.ru/finfactor/roa/>

Where CF_{in} – incoming cash flow

CF_{out} – outgoing cash flow

C. b. at e.p. – cash balance at the end of the period.

Without assessing these indicators, comparing them with indicators of profitability in terms of profit, it is impossible to determine the economic security of the organization. For example, if a company's profitability (profit-to-revenue ratio) rises and its cash flow profitability declines, this indicates a weakened economic security.

The financial component of economic security is the most important condition for the stable functioning of Russian organizations. For its comprehensive assessment, it is necessary to supplement the standard classical financial indicators with an analysis of the monetization of the company's performance.

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**«GUILLOTINE RÉGLEMENTAIRE» ET L'ENSEIGNEMENT
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L'article est consacré à l'évaluation du rôle de la «guillotine réglementaire» dans l'optimisation du fonctionnement du système d'enseignement supérieur, y compris dans le but d'améliorer la qualité de la formation des employés pour l'agriculture et le complexe agro-industriel. Les modèles russes et étrangers de la «guillotine réglementaire» sont examinés. Il est à noter que la «guillotine» crée une base à la réforme de l'enseignement supérieur à l'avenir. Il est proposé de passer à la «guillotine réglementaire sectorielle» pour enlever les restrictions départementales existantes du développement de l'enseignement supérieur agricole.

Mots-clés: «guillotine réglementaire» sectorielle, enseignement supérieur, universités agricoles de la Russie et de la CEI, expérience internationale

Introduction

Pour éliminer les exigences entravantes le développement de l'économie, de la société et de l'état, le soi-disant «principe de la guillotine» est utilisé, qui dans de nombreux pays étrangers proche et lointain et dans le monde entier a déjà devenu un outil reconnu pour optimiser le règlement

actuel. L'essentiel de la stratégie de la "guillotine" est ce que dans le délai assez limité, un grand nombre d'actes juridiques normatifs sont rapidement révisés.

Il est certain que la guillotine, en tant que le processus assez rapide, ne peut pas effectuer le remplacement et la révision détaillés de tout l'ensemble du règlement, car il faudra un peu plus de temps pour modifier de nombreux actes nécessaires qu'il était initialement prévu. Pour l'enseignement professionnel supérieur, comme pour de nombreux secteurs de réglementation, il faudra une réorganisation dès les principes initiaux, ce qui ne peut pas être réalisé uniquement par la «guillotine». Par conséquent, le processus de la «guillotine» doit être considéré comme le début des réformes, la mise en place des procédures et des institutions qui peuvent servir de base à la construction d'une stratégie des réforme aux étapes ultérieures.

Un nombre des objectifs de la stratégie de la «guillotine» peuvent être soulignés: la réduction des coûts politiques et administratifs pour éliminer rapidement un grand nombre de règles inutiles; le changement des incitations au sein des ministères de la résistance passive à la "pro-réforme" au système d'exécution fiable (crédible); la création d'un processus consultatif actif pour la communauté professionnelle et les autres parties impliqués; la mise en place d'un processus durable pour l'avenir du contrôle qualitatif et de la garantie légale, tout d'abord par la mise en place d'une liste de contrôle de bonne qualité et d'une étude, ainsi que par la création d'un registre central complet et sécurisé; le développement d'une infrastructure institutionnelle composante d'un mécanisme de la coordination et de la coopération intersectorielle et intersectorielle notamment pour la mise en œuvre effective de la réforme réglementaire [1].

À cette heure dans la Fédération de la Russie la mise en œuvre active d'un nouveau modèle de l'activité du contrôle et de la surveillance a lieu, attribuée non seulement à la sphère de l'éducation et de la science en général, mais aussi à l'enseignement supérieur agricole de l'éducation. Il est prévu que le nouveau mécanisme entrera en vigueur le 1er janvier 2021, dès que de nombreux anciens actes réglementaires seront supprimés. Il est convient de souligner qu'à la fin de 2020, dans le cadre des activités du contrôle et de la surveillance dans la Fédération de la Russie, 3013 actes ont été annulés, 477 actes sont en train d'être validés, et 247 ont été déjà adoptés. Les travaux sur la «guillotine réglementaire» intègrent 21 autorités chargées de la réglementation, 33 autorités chargées des fonctions du contrôle et de la surveillance, 43 groupes de travail sectoriels [2,3].

De nombreux experts russes et étrangers soulignent l'importance de ces aspects du nouveau modèle d'activité du contrôle et de la surveillance: 1) la participation des employeurs, des consommateurs des services éducatifs et de la communauté étudiante à la surveillance; 2) la transmission à l'évaluation réelle des connaissances au contraire des procédures de contrôle formalisées; 3) la réorientation à l'élaboration des recommandations pour le développement des organisations d'enseignement (bien que précédemment les inspections étaient plus importantes, et dans le cas de la détection des violations – des sanctions dures); 4) la différenciation hiérarchique des approches de la réglementation. Ainsi, les objectifs prioritaires dans le modèle de la «guillotine réglementaire» sont les surveillances et les recommandations pour le développement des organisations éducatives et, ce qui est évident à cette approche, la minimisation du nombre des contrôles et des sanctions.

Certains pays de l'étranger proche considèrent qu'il est acceptable pour eux-mêmes d'utiliser l'expérience de la Russie dans le choix des mesures du contrôle et de la surveillance sur la base d'une approche axée aux risques [4]. Les activités dans le cadre de cette approche sont basées sur la base d'une surveillance constante, lorsque les établissements d'enseignement, d'après du groupe de risque, ont des délais de surveillance différents: aucun contrôle n'est pas prévu pour un risque bas, pour celui modéré un contrôle tous les 2 à 6 ans, un haut risque un contrôle tous les 1 à 4 ans et un contrôle extrêmement élevé une à deux fois par an. En outre, de nombreux dirigeants des universités de la CEI notent justement que la «guillotine réglementaire» permet d'analyser en détail les exigences actuelles pour les organisations éducatives et de les classer en plusieurs groupes: 1) les exigences dont l'exécution doit certainement être vérifiée; 2) les exigences dont les textes doivent être modifiés; 3) les exigences dont l'exécution est sous la vérification, mais qui n'ont aucun rapport à la qualité de l'enseignement et dont l'exécution est inutile.

Dans le modèle russe de la «guillotine réglementaire», de nombreux changements sont prévus, y compris la clarification des exigences de qualification pour les experts et les organisations d'experts afin d'utiliser les résultats d'une évaluation indépendante de la qualité de l'éducation pour l'accréditation de l'état, la réduction de la liste des documents pour l'application de cette procédure, du placement des documents, utilisés pour une accréditation, publiés sur le site de l'organisation sans leur délivrance en papier et beaucoup d'autre.

Résultats et débats

L'enseignement supérieur professionnel est un domaine important des relations publiques, nécessitant un inventaire détaillé des exigences actuelles et obligatoires du fonctionnement des organisations éducatives, en tenant compte que certains documents ont été adoptés sous l'URSS et la RSFSR. En moyenne, au cours des deux dernières années, 10 documents du Ministère de l'éducation de la Russie relatifs à la «guillotine réglementaire» dans le domaine de l'enseignement supérieur professionnel et complémentaire ont été officiellement publiés.

Dans la Fédération de la Russie l'année 2020 se caractérise par l'adoption d'un ensemble fondamental des documents dans la partie de la «guillotine réglementaire»: la loi Fédérale du 31.07.2020 N 247-FZ «Sur les exigences obligatoires dans la Fédération de la Russie», la loi Fédérale du 31.07.2020 N 248-FZ "Sur le contrôle d'état (supervision) et le contrôle de la municipalité de de la Fédération de la Russie", la Décision du Gouvernement de la Fédération de la Russie du 20 juin 2020 N ° 897 «Sur la reconnaissance des certains actes du Gouvernement de la Fédération de la Russie et des certaines dispositions de certains actes du Gouvernement de la Fédération de la Russie supprimés et l'abolition de certains règlements du Service fédéral de surveillance dans le domaine de l'éducation et des sciences, contenant les exigences obligatoires, dont le respect est évalué lors de la réalisation des événements du contrôle lors de la mise en œuvre de la surveillance d'état fédéral (supervision) dans le domaine de l'éducation», etc. Le dernier document indique l'abolition des plusieurs dispositions incluses dans la Résolution du Gouvernement de la Fédération de la Russie du 28 octobre 2013 n ° 966 "Sur l'attribution d'une licence aux activités éducatives". Certains actes juridiques normatifs du Service fédéral de surveillance dans le domaine de l'éducation et de la science ont également été abolis en ce qui concerne les exigences relatives à la structure du site officiel de l'organisation éducative dans le réseau d'information et de télécommunications "Internet".

Le système d'enseignement agricole supérieur de la Russie joue un rôle particulier dans la résolution des problèmes stratégiques du développement du complexe agro-industriel du pays, pour cette raison l'importance de son changement qualitatif à la base des principes de la «guillotine réglementaire» est évidente. Les données du groupement statistique montrent que les universités agricoles russes sont caractérisées par des fluctuations considérables des indicateurs des activités principales (tableau 1). Ainsi, par exemple, la plupart des étudiants admis à l'éducation sont des diplômés des écoles rurales qui ont obtenu des scores faibles sur les

résultats de l'examen national unifié et ont consciemment choisi la profession agricole pour eux - cependant, pour cette catégorie d'étudiants il est difficile de faire concurrence à leurs pairs urbains lors de l'admission dans les universités agricoles. En raison du financement public insuffisant des travaux de la recherche scientifique la plupart des universités agricoles de la Russie a une activité de publication internationale moyenne et faible. En outre, des moyens importants sont consacrés à l'entretien de nombreux sites, souvent obsolètes, au lieu de développer une base logistique moderne. Les outils efficaces de motivation des jeunes enseignants et scientifiques sont peu utilisés pour améliorer quantitativement et qualitativement la personnel de cadre des universités agraires de la Russie. Cependant, les universités agraires des pays de l'étranger proche, qui sont à peu près dans des conditions d'activité pareilles aux universités russes, utilisent plus efficacement le potentiel interne de leur développement et interagissent plus activement avec les autorités de la gestion d'état, y compris dans le processus de la «guillotine réglementaire».

Tableau - Regroupement des universités agricoles de la Fédération de Russie par les indicateurs d'activité essentiels en 2019

1. L'Éducation			
La note moyenne de l'ENU des étudiants , admis selon les résultats de l'ENU à l'éducation en présentiel du baccalauréat et du spécialité à charge du budget du système budgétaire de la Russie	до 60	60-70	plus que 70
	41	9	3
2. La recherche scientifique			
Le nombre des publications des organisations référencées dans le système informatique-analytique de la citation scientifique Web of Science CoreCollection, en solde de 100 du pers.	moins 20	20-50	plus que 50
	25	20	8
3. L'activité financière et économique			
Revenus de l'organisation d'enseignement de toutes les sources en solde du nombre des étudiants (le contingent amené), milles roub.	moins 200	200-300	plus que 300
	12	37	5
4. L'infrastructure			
Superficie combiné des auditoires des études et de laboratoire en solde du nombre des étudiants (le contingent amené), m.c	moins 20	20-30	plus que 30
	11	34	9

Nombre des ordinateurs personnels en solde d'un étudiant (le contingent amené)	moins 0,25	0,25-0,5	plus que 0,5
	7	42	5
5. Le personnel			
Nombre du personnel , qui a un degré scientifique du doctorat et du docteur ès sciences en solde de 100 étudiants.	moins 3,0	3,0-5,0	plus que 5,0
	8	41	5

En général, la «guillotine réglementaire» dans les pays de l'étranger proche se développe dans plusieurs directions: tout d'abord, en cours de la modernisation nationale de la réglementation des activités éducatives par des accords de licence, de l'agrément national, du contrôle d'état de la qualité de l'éducation et de la supervision et d'autres procédures, deuxièmement, les exigences des activités d'enseignement sont réactualisées en compte de la modification de nombreux facteurs internes et externes du développement, y compris ceux politiques, économiques, sociaux, scientifiques et technologiques et autres; troisièmement, les normes nationales et internationales d'organisation des activités des organisations éducatives sont intégrées suite des exigences des classements internationaux, de l'accréditation internationale des programmes éducatifs, du développement des processus d'internationalisation, etc.

Les données du tableau 2 montrent que l'attribution d'une licence aux activités éducatives dans les universités agraires de la CEI est effectué par les ministères comme les organes de l'administration publique dans le domaine de l'éducation (Azerbaïdjan, Biélorussie, Turkménistan, Ouzbékistan), de l'éducation et de la science (Kazakhstan, Kirghizistan, Tadjikistan), de l'éducation, de la science et de la culture (Arménie, Moldavie). En tant que donneur de licence une structure spéciale agit souvent pour ces objectifs, comme par exemple l'Institution de l'état "le Comité de contrôle dans le domaine de l'éducation et de la science du Ministère de l'éducation et de la science de la République du Kazakhstan" ou le Service fédéral de surveillance dans le domaine de l'éducation et de la science (Rosobrnadzor) dans la Fédération de la Russie.

Tableau-Données sur les licences d'activités éducatives dans certaines des universités agraires principales de la CEI

Pays	Dénomination de l'université	Année de la fondation	Nombre des programmes licenciés éducatifs	Donneur de licence
Azerbaïdjan	L'Université agricole d'État d'Azerbaïdjan	1920	137	Le ministère de l'Éducation de la République d'Azerbaïdjan
Arménie	L'Université agricole d'État d'Arménie	1930	29	Le ministère de l'éducation, de la science, de la culture et du sport de la République d'Arménie
Biélorussie	L'Académie d'état agricole de Biélorussie	1840	49	Le ministère de l'éducation de la République de Biélorussie
Kazakhstan	L'Université des recherches agricoles d'État de Kazakhstan	1929	96	Le ministère de l'éducation et de la science de la République de Kazakhstan
Kirghizistan	L'Université agricole d'État de Kirghizistan K.I. Skryabine	1933	55	Le ministère de l'éducation et de la science de la République de Kirghizistan
Moldavie	L'Université agricole d'État de Moldavie	1933	52	Le ministère de l'éducation, de la culture et des recherches de la République de Moldavie

Tadjikistan	L'Université agricole d'État de Tadjikistan Chirincho Chotemour	1931	46	Le ministère de l'éducation et de la science de la République de Tadjikistan
Turkménistan	L'Université agricole d'État de Turkménistan S.A. Nyязov	1930	~16	Le ministère de l'éducation de Turkménistan
Ouzbékistan	L'Institut de l'irrigation et de la machinisation agricole de Tachkent	1923	86	Le ministère de l'enseignement supérieur et secondaire de la République d'Ouzbékistan

Une des universités agraires principales de la CEI est l'Établissement de l'éducation «l'Académie agricole d'état Biélorussie de la révolution d'octobre et de de la bannière rouge du travail». Selon les résultats pertinents des procédures établies par le Ministère de l'éducation de la République de Biélorussie BARH a publié la licence illimitée n ° 02100/280 suite à la décision n ° 475 du 29.04.2004, qui offre une permission de la mise en œuvre des travaux et des services à noter, composants de l'activité d'enseignement: la formation de diplômés de l'enseignement supérieur; la formation de perfectionnement des cadres et des professionnels ayant un enseignement supérieur; la formation de perfectionnement des cadres et des professionnels ayant un enseignement secondaire spécialisé; l'autorisation pour certains types d'activités éducatives pour les deux branches de l'académie. Une expérience intéressante de la réglementation des activités sur la base du «principe de la guillotine» a lieu dans les universités principales d'autres pays de la CEI [5].

Conclusion

En généralisant les résultats de l'analyse de l'expérience internationale, la mise en œuvre d'un mécanisme de la «guillotine réglementaire» il est particulièrement important de noter les perspectives de l'utilisation de ce mécanisme dans la pratique nationale du point de vue de réduire les risques de corruption lors de la mise en œuvre du contrôle de l'activité de la surveillance, du développement de la dotation de l'agriculture et de l'ensemble de la sphère agro-alimentaire de la Fédération de la Russie.

La "guillotine réglementaire" peut également devenir un mécanisme efficace pour réglementer l'activité éducative des établissements d'enseignement supérieur agraires, car elle permet de réviser rapidement les actes juridiques normatifs. L'expérience réglementaire étrangère accumulée permet de prendre en compte et de prendre comme base tout le meilleur pour l'utiliser en avenir pour améliorer le système d'enseignement agricole supérieur de la Russie.

Pour enlever plusieurs restrictions juridiques il est possible de passer à la «guillotine réglementaire sectorielle», quand il y a une révision des règlements sectoriels, y compris ceux résultant de l'activité éducative dans le secteur agricole de l'économie, ce qui permettra d'annuler un certain nombre des actes juridiques normatifs, et, en général, de fournir un cadre législatif de la stabilité et de la transparence de la réglementation en vigueur, d'engager activement la communauté professionnelle à l'optimisation de la base législative, de réduire les coûts administratifs et juridiques de la procédure.

En général, le compte tenu de l'analyse de l'expérience internationale, il est recommandé d'effectuer la transition de niveau national la "guillotine réglementaire" de la réalisation du mécanisme identifiée comme la mise en œuvre de la "guillotine réglementaire sectorielle" et appliquer ses principes pour la révision d'un cadre réglementaire régissant l'activité d'enseignement supérieur agricole et les établissements d'enseignement et de la mettre en conformité avec les conditions modernes.

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MATHEMATICAL MODELING OF GROSS PRODUCT

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The aim of the work is to obtain analytical dependence of gross domestic product on changes in the main factors of production: labor resources, physical capital and natural resources. Based on the apparatus of vector analysis, an integro-differential equation for the change in the gross product was obtained. Particular cases of the equation describing the stable growth of the gross product are considered. The equation obtained in this case is a generalization of Lagrange's theorem on finite increments.

A finite-difference model of an integro-differential equation is presented. To obtain the forecast value of the gross product, the values of the gross product and the main factors of production of the two previous years are used.

Numerical modeling of changes in gross domestic product and gross value added in the period from 2001 to 2018 was carried out. The results obtained provide a very good model in the period of stable economic growth, but in the crisis and post-crisis period it is possible only to capture the general dynamics of development. This phenomenon is due to the fact that the time step was taken for one year, and according to the theory of difference schemes, a good result should be expected only on monthly data.

The econometric analogue of the equation can be one of the tools for forecasting the gross product in the short term.

Keywords: gross domestic product, main factors of production, gross value added, mathematical modeling, marginal labor productivity, marginal capital productivity, GDP growth, econometric model, dynamic divergence.

Let's describe the main variables that we will use when presenting the material. The dimensions of the gross product Y indicate opportunities, but do not indicate the efficiency of the country's economy. A more indicative economic characteristic of the efficiency of the economy is the ratio of the gross product produced to the spent or applied main factors of production, i.e., some average productivity of the economy. In our assumptions, the gross product can be viewed as a function continuously distributed in space with four degrees of freedom: time t , labor resources L , physical capital K , natural resources N .

The space characterized by a set of coordinates L , K and H (phase coordinates) is called the phase space or the space of the main factors of production. It should be noted that the phase space is the set of all states of the economic system at a fixed point in time. Each possible state of the system corresponds to a point in the phase space, and the evolution of an economic system corresponds to the movement of a point. The extended phase space is the space to which the coordinates L , K , H and t belong.

Let's choose in the space of production factors some point D with coordinates $\bar{r} = (L, K, H)$. The quantity

$$\frac{d\bar{r}}{dt} = \bar{v}(\bar{r}, t)$$

is called the phase velocity or the rate of development of the main factors of production.

Product of the factors of production used represents the phase volume of the factors used. Let's designate the product of factors of production $w = L \cdot K \cdot H$ and call this value the phase volume or simply the volume.

For each point of the space of production factors, it is possible to determine at each moment of time the vector of the rates of renewal of the main factors of production:

$$\bar{v} = v_L \bar{i} + v_K \bar{j} + v_H \bar{k},$$

where \bar{i} , \bar{j} , \bar{k} — basis in space (L, K, H) .

The magnitude of the change in the factors of production for a certain time interval is determined from the equality $|\bar{v}| = \sqrt{(v_L)^2 + (v_K)^2 + (v_H)^2}$. In order to set the vector field of changes in the factors of production (the space of states of the economy), you can require setting the speed at a certain time interval or indicate the direction of the speed vector without taking into account its value. That is, it is necessary to build a family of lines, the tangents to which at each point in the space of factors of production will coincide at a given time with the direction of change in factors

of production at this point. Such lines for the field of rates of renewal of factors of production are called the lines of development of these factors, and in the case of an arbitrary vector field of the economic indicator $\vec{F}(\vec{r}, t)$ - the line of development of this indicator.

Let us choose a closed contour C in the space of the main factors of production, which forms a certain section S_1 . In this section, we will take the initial conditions for economic objects and build a line of development of factors of production for these economic objects (fig. 1).

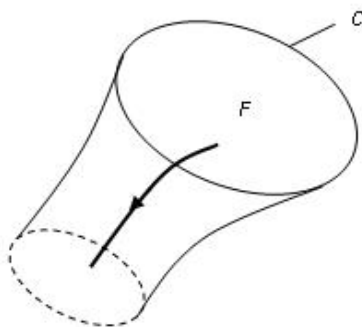


Fig. 1. Economic indicator development corridor $\vec{F}(\vec{r}, t)$

We will get a certain corridor, which we will call the economic development corridor. The last section of the corridor is designated S_2 . Obviously, the development corridor has the property that development lines do not pass through its lateral border. It should be noted that such development corridors can be built for any vector economic indicator $\vec{F}(\vec{r}, t)$. But in order not to introduce new concepts and not to clutter up the reasoning, we will call all of them the corridors of the development of the economic indicator $\vec{F}(\vec{r}, t)$.

We take in the space of production factors some surface S . Let us find the integral of the vector of the economic indicator $\vec{F}(\vec{r}, t)$ over this surface, or, in other words, the flux of the vector $\vec{F}(\vec{r}, t)$ through the surface S . To do this, at all points of the surface, we define the unit normal vectors \vec{n} .

Suppose that at some point on the surface D the vector economic indicator $\vec{F}(\vec{r}, t)$ and its normal component are determined:

$$F_n(\vec{r}, t) = \vec{F}(\vec{r}, t) \cdot \vec{n} = F_L \cos(n, L) + F_K \cos(n, K) + F_H \cos(n, H).$$

Let us represent the surface S in the form of a large number of small elements ΔS , which can be represented by a vector that is directed along

the normal to the element and equal to the area of this element. Indeed, let ΔS have a contour C that does not lie in the same plane of production factors. Let's design contour C on three planes HK , HL , KL and get, respectively, three areas with contours C_L , C_K and C_H , which can be represented by vectors $\Delta S_L \vec{i}$, $\Delta S_K \vec{j}$, $\Delta S_H \vec{k}$. Then:

$$\Delta \vec{S} = \Delta S_L \vec{i} + \Delta S_K \vec{j} + \Delta S_H \vec{k}.$$

In the general case, consider a surface consisting of production factors S , which can be represented by a vector $\vec{S} = S\vec{n}$, where \vec{n} — the normal vector to the surface S .

For each element, we find the scalar products $\vec{F}(\vec{r}, t) \cdot \Delta \vec{S}$, which we sum up over all elements. The resulting amount will tend to the final limit, as all elements of the surface of production factors tend to zero. The resulting limit is called the flow of the vector economic indicator $\vec{F}(\vec{r}, t)$ through a given surface S and is denoted:

$$\int \vec{F}(\vec{r}, t) \cdot d\vec{S} = \lim_{\Delta S \rightarrow 0} \sum \vec{F}(\vec{r}, t) \cdot \Delta \vec{S}.$$

The flow of an economic indicator through the surface S is represented as:

$$\begin{aligned} \int_S \vec{F}(\vec{r}, t) \cdot d\vec{S} &= \int_S F_n(\vec{r}, t) d\vec{S} = \int_S \vec{F}(\vec{r}, t) \cdot \vec{n} dS = \\ &= \int_S (F_L \cos(n, L) + F_K \cos(n, K) + F_H \cos(n, H)) dS \end{aligned}$$

Similarly, the concept of volume integration can be introduced. The last equality can be written:

$$\int_S \vec{F}(\vec{r}, t) \cdot d\vec{S} = \int_S (F_L dKdH + F_K dLdH + F_H dKdL),$$

understanding, for example, by $dKdH$ the projection of the element $d\vec{S}$ onto the plane KH , taken with the proper sign.

In (Kuznetsov, 2011), the following statement was proved.

Let the components of the rate of renewal of factors of production depend on the influence of all factors of production. Then, for any continuous and having first continuous derivatives within the development corridor, as well as at the initial and final moments of time of a vector economic indicator that depends on factors of production, the following formula is true:

$$\int_{\Gamma} \bar{F} \cdot d\bar{S} = \int_w \left(\frac{\partial F_L}{\partial L} + \frac{\partial F_K}{\partial K} + \frac{\partial F_H}{\partial H} + \frac{v_L}{|\bar{v}|^2} \frac{\partial F_L}{\partial t} + \frac{v_K}{|\bar{v}|^2} \frac{\partial F_K}{\partial t} + \frac{v_H}{|\bar{v}|^2} \frac{\partial F_H}{\partial t} \right) dV = \int_w \nabla_t \cdot \bar{F} dV, \quad (1)$$

where Γ – the entire surface w , and by the sign ∇_t we mean the dynamic Hamilton operator:

$$\nabla_t = \left(\frac{v_L}{|\bar{v}|^2} \frac{\partial}{\partial t} + \frac{\partial}{\partial L}, \frac{v_K}{|\bar{v}|^2} \frac{\partial}{\partial t} + \frac{\partial}{\partial K}, \frac{v_H}{|\bar{v}|^2} \frac{\partial}{\partial t} + \frac{\partial}{\partial H} \right) = DIV; \text{ the dot between}$$

the vectors $\nabla_t \cdot \bar{F}$ means dot product.

A special case of this equation can be obtaining an equation for the vector of productivity of the economy:

$$\bar{F}(\bar{r}, t) = \left(\frac{\partial Y}{\partial L}, \frac{\partial Y}{\partial K}, \frac{\partial Y}{\partial H} \right) = grad Y.$$

Its direction coincides with the direction of the fastest growth of the gross product. The gradient is perpendicular to the level surface $Y=const$ at each point.

Then, for the productivity vector of the flow of the main factors of production of the economy, taking into account the absence of intersection of lateral surfaces and from equality (1), we have:

$$\begin{aligned} \int_w DIV(grad Y(\bar{r}, t)) dV &= \int_{\Gamma} grad Y(\bar{r}, t) \cdot d\bar{S} = \\ &= \int_{s^1} \left(\frac{\partial Y}{\partial L} dK dH + \frac{\partial Y}{\partial K} dL dH + \frac{\partial Y}{\partial H} dL dK \right) - \int_{s^2} \left(\frac{\partial Y}{\partial L} dK dH + \frac{\partial Y}{\partial K} dL dH + \frac{\partial Y}{\partial H} dL dK \right), \end{aligned}$$

(2)

where $\bar{r}_i = (L_i, K_i, H_i)$ – lying in sections S_1 and S_2 , $i=1,2$.

Let us prove the following equality:

$$DIV(grad(Y(\bar{r}, t))) = \Delta Y + \frac{1}{|\bar{v}|^2} \left(\bar{v} \cdot \frac{\partial(grad Y)}{\partial t} \right),$$

where $\Delta Y = \frac{\partial^2 Y}{\partial L^2} + \frac{\partial^2 Y}{\partial K^2} + \frac{\partial^2 Y}{\partial H^2}$ – Laplace operator.

Indeed, let us describe in detail all the components of the static gradient and dynamic divergence:

$$DIV(grad(Y(\bar{r}, t))) =$$

$$\begin{aligned}
&= \frac{v_L}{|\bar{v}|^2} \frac{\partial^2 Y}{\partial t \partial L} + \frac{\partial^2 Y}{\partial L^2} + \frac{v_K}{|\bar{v}|^2} \frac{\partial^2 Y}{\partial t \partial K} + \frac{\partial^2 Y}{\partial K^2} + \frac{v_H}{|\bar{v}|^2} \frac{\partial^2 Y}{\partial t \partial H} + \frac{\partial^2 Y}{\partial H^2} = \\
&= \Delta Y + \frac{1}{|\bar{v}|^2} \left(\bar{v} \cdot \frac{\partial(\text{grad} Y)}{\partial t} \right) = \Delta Y + \frac{1}{|\bar{v}|^2} \left(\bar{v} \cdot \text{grad} \left(\frac{\partial Y}{\partial t} \right) \right).
\end{aligned}$$

Based on the last formula and formula (2), we conclude that

$$DIV(\text{grad}(Y(\bar{r}, t))) = \Delta Y + \frac{1}{|\bar{v}|^2} \left(\bar{v} \cdot \text{grad} \left(\frac{\partial Y}{\partial t} \right) \right) = \Delta Y + \frac{1}{|\bar{v}|^2} \frac{d^2 Y}{dt^2} \quad (3)$$

From formulas (2) - (3) we have the equation

$$\begin{aligned}
&\int_w \left(\Delta Y + \frac{1}{|\bar{v}|^2} \frac{d^2 Y}{dt^2} \right) dL dK dH = \\
&= \int_{S^1} \left(\frac{\partial Y}{\partial L} dK dH + \frac{\partial Y}{\partial K} dL dH + \frac{\partial Y}{\partial H} dL dK \right) - \int_{S^2} \left(\frac{\partial Y}{\partial L} dK dH + \frac{\partial Y}{\partial K} dL dH + \frac{\partial Y}{\partial H} dL dK \right).
\end{aligned}$$

The last equation is considered in the development corridor (see fig. 1). As the boundary and initial conditions, we take the known gross product $Y(\bar{r}_1)$ at a certain moment of time t_1 for known values of the factors of production, \bar{r}_1 , i.e., at a known section of the development corridor. At the moment t_2 we do not know \bar{r}_2 and $Y(\bar{r}_2)$, and we finally get the integro-differential equations for calculating the gross product through changes in production factors

$$\begin{aligned}
&\int_w \left(\Delta Y + \frac{1}{|\bar{v}|^2} \frac{d^2 Y}{dt^2} \right) dL dK dH + \int_{S^1} \left(\frac{\partial Y}{\partial L} dK dH + \frac{\partial Y}{\partial K} dL dH + \frac{\partial Y}{\partial H} dL dK \right) = \\
&= \int_{S^2} \left(\frac{\partial Y}{\partial L} dK dH + \frac{\partial Y}{\partial K} dL dH + \frac{\partial Y}{\partial H} dL dK \right). \quad (4)
\end{aligned}$$

In the particular case, when the growth of the gross product remains constant in time $\left(\frac{dY}{dt} = \text{const} \right)$ with the factors of production used, the last equation takes the form:

$$\begin{aligned}
&\int_w \Delta Y dL dK dH + \int_{S^1} \left(\frac{\partial Y}{\partial L} dK dH + \frac{\partial Y}{\partial K} dL dH + \frac{\partial Y}{\partial H} dL dK \right) = \\
&= \int_{S^2} \left(\frac{\partial Y}{\partial L} dK dH + \frac{\partial Y}{\partial K} dL dH + \frac{\partial Y}{\partial H} dL dK \right).
\end{aligned}$$

The modeling of the gross value added of the Russian Federation in basic prices, measured in trillions of rubles (Regions..., 2018) was carried out.

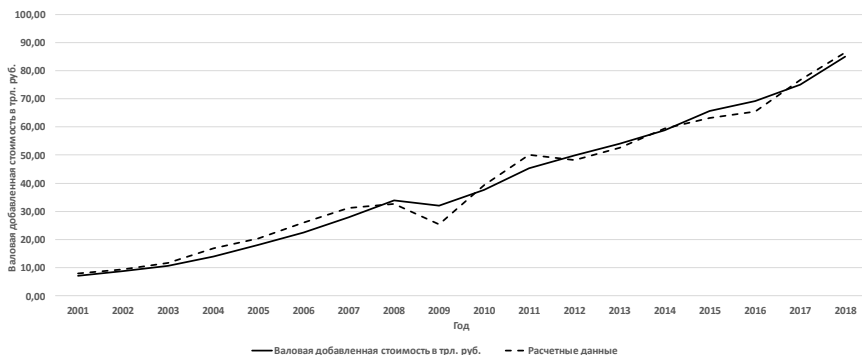


Fig. 2 Modeling the gross value added of the Russian Federation

The calculation (fig. 2) showed that knowing the behavior of factors of production and gross value added over the previous two years, it is possible to fairly well predict the behavior of gross value added for the next year. Analysis of the graph shows that the greatest error occurred during the crisis and post-crisis periods of the economy.

We use the same algorithm to model gross domestic product (fig. 3).

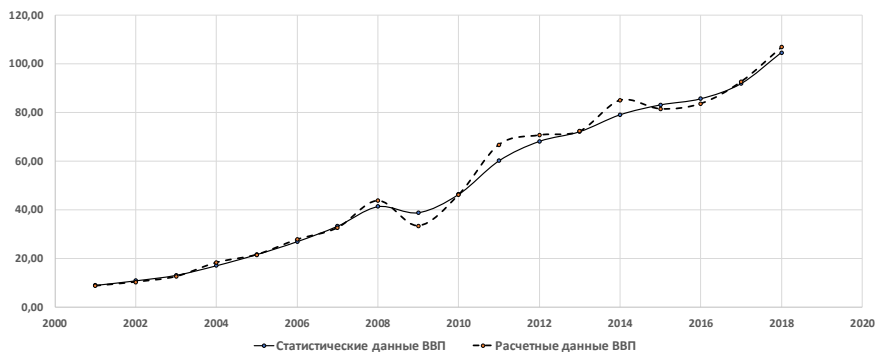


Fig. 3 Modeling the gross domestic product of the Russian Federation

In both cases, there is some discrepancy with statistical data, this is explained by a large time step (1 year). When simulated on monthly data, the discrepancy becomes quite acceptable.

Thus, an integro-differential equation was obtained that describes the relationship between the gross domestic product and the main factors of production: physical capital, labor resources and used natural resources. On the basis of this equation, an econometric model has been built, which shows the applicability of the work results for short-term forecasting of gross domestic product and gross value added both at the regional and national levels.

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CHARACTERISTICS OF METHODS AND MEANS OF ALTERNATIVE MEDICINE AT VARIOUS STAGES OF THE REHABILITATION AND RECOVERY PERIOD

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The article deals with the application of methods and means of alternative medicine at the stage of recovery. In favor of practical means of alternative medicine, there is currently a lot of evidence, however, the evidence base highlights only positive changes, without specifying how, when and at what stage, in which pathology, this method of alternative medicine is most effective and relevant. The lack of data on the appropriateness of the application, in combination with the generally accepted methods of traditional medicine, makes it difficult to develop a recovery technology, taking into account the disorders and individual characteristics of the body, the work is aimed at solving this problem.

Keywords. Alternative medicine, recovery, rehabilitation, apitherapy, aromatherapy, Ayurveda, hirudotherapy, homeopathy, yoga therapy, manual therapy, massage, reflexology.

Introduction

How to restore health after an illness? The goal of rehabilitation is to restore body function, restore physical activity, resistance to stress, and overcome stress. In conditions of instability, psychological tension, a person is looking for any means of recovery [1]. We expect quick relief from our suffering without understanding the dangers of individual drugs. We

must remind ourselves that there is no one-size-fits-all cure for all ailments. Are our hopes for health and the expectations placed on medicine are really legitimate, endowing it with omnipotence in matters of health and belittling, and often ignoring the opportunities provided at our disposal by other areas dealing with health issues, the so-called alternative medicine, such as apitherapy, aromatherapy, Ayurveda, hirudotherapy, homeopathy, yoga therapy, manual therapy, massage, reflexology, etc. [2].

Purpose of the study

To determine the effectiveness of the use of methods and means of hirudotherapy, homeopathy, at the stages of rehabilitation and recovery period.

Research methods and organization

Analysis of scientific and methodological literature, conversations with specialists in the field of rehabilitation and health programs, questionnaires, personal observations, experiment, statistical data processing.

The study involved 12 people (men), who were divided into three groups (4 people each) with diseases of the cardiovascular system (CVS). The first group (1TM) underwent recovery, according to the traditional scheme recommended by the attending physician, "in passive mode." Groups (2NTM and 3NTM) classes were conducted according to the author's methodology by E.A. Spiridonov [3], which provides for the use of methods and means of alternative medicine (2NTM - hirudotherapy, 3NTM - homeopathy). Measurements of the functional state, in groups, were carried out once a week, at the same time, during 5 stages of recovery, as well as before and after each recovery period.

Dynamic observation included the study of heart rate variability and recording the integral indicator of the functional state (Health), which includes: the level of adaptation of the cardiovascular system (A), the indicator of autonomic regulation (B), the indicator of central regulation (C), - psycho-emotional state (D), (Health scale: 80-100% - good functional state of the body (eustress); 50-79% - satisfactory; 20-49% - low (distress); 19 and below - lack of reserves, overstrain, etc.

To assess the state of autonomic regulation, we used the system of a comprehensive computer study of the functional state of the human body "Omega Medicine" [4].

Statistical processing of the data consisted in determining the standard deviation, the coefficient of variation and conducting one-way analysis of variance (ANOVA) - the reliability of differences within the group is more than 95% ($P > 0.05$), followed by the application of the method of multiple comparisons, which is an indicator of the reliability of differences

between the obtained values, studied groups, with a confidence level of more than 95% ($P < 0.05$) [5].

Research results and discussion

Hirudotherapy is a type of alternative medicine that involves the use of physiotherapeutic methods of influencing the human body with the help of medicinal leeches (*Hirudo medicinalis*), refers to alternative medicine (one of the areas of naturopathy) [6].

Homeopathy is a type of alternative medicine that involves the use of herbs or natural substances in minimal doses or preparations with a low content of the active substance [7].

Below are the results of the study, the use of traditional medicine (TM) and alternative medicine (AM) methods - hirudotherapy and homeopathy, at various stages of recovery and rehabilitation (table 1,2,3,4,5)

Table 1. Indicators of functional state, in persons with CVS disorders, using the TM and AM methods (stage 1)

Groups	A%		B%		C%		D%		Health %		ANOVA	P
	before	after	before	after	before	after	before	after	before	after		
1TM	13.6	19.1	22.1	24.5	20.4	23.3	23.1	22.4	19.8	22.3	<0.05	>0.05
2AM	17.4	24.8	21.4	22.4	18.8	20.7	23.3	22.5	20.2	22.6	<0.05	
3AM	19.4	21.8	18.4	23.4	18.6	22.1	23.3	28.8	19.9	24.0	>0.05	

Table 1 shows that in the groups the indicators of the 1st stage of recovery have a positive dynamics of changes. Statistical processing of the data made it possible to determine that in groups 1TM and 2AM the intragroup index has a value of $P < 0.05$, which indicates the unreliability of changes. In the 3AM group, the intragroup indicator has a $P \text{ value} > 0.05$, which reflects the reliability of changes in the group at the end of the 1st stage of recovery.

The method of multiple comparisons has a $P \text{ value} > 0.05$, which indicates the insignificance of differences between groups.

Table 2. Indicators of functional state, in persons with CVS disorders, using the TM and AM methods (stage 2)

Groups	A%		B%		C%		D%		Health %		ANOVA	P
	before	after	before	after	before	after	before	after	before	after		
1TM	19.1	21.3	24.5	22.8	23.3	23.5	22.4	24.4	22.3	23.0	<0.05	>0.05
2AM	24.8	21.6	22.4	23.5	20.7	21.8	22.5	25.5	22.6	23.1	<0.05	
3AM	21.8	22.4	23.4	22.5	22.1	21.9	28.8	27.7	24.0	23.6	<0.05	

Table 2 shows that in the groups the indicators at the 2nd stage of recovery have a positive dynamics of changes. Statistical processing of the data made it possible to determine that in groups 1TM, 2AM and 3AM, the intragroup indicator has a value of $P < 0.05$, which indicates the unreliability of changes.

The method of multiple comparisons has a $P \text{ value} > 0.05$, which indicates the insignificance of differences between groups.

Table 3. Indicators of functional state, in persons with CVS disorders, using the TM and AM methods (stage 3)

Groups	A%		B%		C%		D%		Health %		ANOVA	P
	before	after	before	after	before	after	before	after	before	after		
1TM	21.3	22.9	22.8	24.8	23.5	23.9	24.4	26.7	23.0	24.5	<0.05	<0.05
2AM	21.6	39.4	23.5	32.8	21.8	33.8	25.5	37.1	23.1	35.7	>0.05	
3AM	22.4	26.6	22.5	28.1	21.9	27.7	27.7	28.4	23.6	27.7	>0.05	

Table 3 shows that in the groups the indicators at the 3rd stage of recovery have a positive dynamics of changes. Statistical processing of the data made it possible to determine that in groups 2AM and 3AM, the intragroup indicator has a $P \text{ value} > 0.05$, which indicates the reliability of changes. In group 1TM, the changes were insignificant ($P < 0.05$).

The method of multiple comparisons, has a $P \text{ value} < 0.05$, which indicates the reliability of differences between the groups, the indicators in the 2AM and 3AM groups are significantly higher than in the 1TM group.

The difference between the 2AM and 3AM groups is also significant.

Table 4. Indicators of functional state, in persons with CVS disorders, using the TM and AM methods (stage 4)

Groups	A%		B%		C%		D%		Health %		ANOVA	P
	before	after	before	after	before	after	before	after	before	after		
1TM	22.9	25.5	24.8	27.4	23.9	26.3	26.7	27.8	24.5	26.5	<0.05	<0.05
2AM	39.4	41.1	32.8	39.4	33.8	36.2	37.1	38.5	35.7	38.9	>0.05	
3AM	26.6	35.1	28.1	39.9	27.7	34.8	28.4	36.1	27.7	36.4	>0.05	

Table 4 shows that in the groups the indicators at the 4th stage of recovery have a positive dynamics of changes. Statistical processing of the data made it possible to determine that in the 2AM and 3AM groups, the intragroup indicator has a P value > 0.05, which indicates the reliability of changes. In group 1TM, the indicator has a P value <0.05, which indicates the unreliability of changes.

The method of multiple comparisons, has a P value <0.05, which indicates the reliability of differences between the groups, the indicators in the 1TM group are significantly lower than in the 2AM and 3AM groups, the difference between the 2AM and 3AM groups is insignificant (P > 0.05).

Table 5. Indicators of functional state, in persons with CVS disorders, using the TM and AM methods (stage 5)

Groups	A%		B%		C%		D%		Health %		ANOVA	P
	before	after	before	after	before	after	before	after	before	after		
1TM	25.5	30.2	27.4	32.4	26.3	29.6	27.8	31.8	26.5	31.0	>0.05	<0.05
2AM	41.1	40.5	39.4	41.1	36.2	39.6	38.5	40.4	38.9	40.4	>0.05	
3AM	35.1	37.2	39.9	42.2	34.8	36.8	36.1	39.1	36.4	38.8	>0.05	

Table 5 shows that in the groups the indicators at the 5th stage of recovery have a positive dynamics of changes. Statistical processing of the

data made it possible to determine that in groups 1TM, 2AM and 3AM the intragroup indicator has a P value > 0.05 , which indicates the reliability of changes.

The method of multiple comparisons, has a P value < 0.05 , which indicates the reliability of differences between the groups, the indicators in the 1TM group are significantly lower than in the 2AM and 3AM groups, the difference between the 2AM and 3AM groups is insignificant ($P > 0.05$).

Conclusion. The obtained research results, the use of AM methods and means (hirudotherapy, homeopathy), in the recovery period (in men), made it possible to identify the specifics and features of these AM methods. The methods of hirudotherapy had their maximum effect at the third stage, which was expressed in a significant improvement in the functional state, which remained at all stages of recovery. The most dynamic and highest indicator was the "level of adaptation of the cardiovascular system" (A).

Improvement of indicators in the group, using the methods and means of homeopathy, manifested itself at the 4th stage, which was expressed in a significant improvement in the functional parameters of the body, at the 5th stage the changes were preserved. The most dynamic and highest was the "index of autonomic regulation" (B).

Conclusions

1. Methods and means of hirudotherapy (for men), with CVS disorders, it is advisable to use at the third stage of the recovery period.

2. The methods and means of homeopathy (for men), in case of CVS disorders, are advisable to use at the 4th stage of the recovery period.

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ANALYSE COMPARATIVE DE L'INTONATION TCHÉTCHÈNE ET FRANÇAISE SUR L'EXEMPLE DES NARRATIVES, INTERROGATIVES, MOTIVATIONNELS ET DES PHRASES D'EXCLAMATION

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Abstract. Le présent recherche est une continuation des études phonétiques typologique de la langue tchétchène. Le but de l'article était de déterminer les similitudes et les différences des groupes d'intonation (syntagmes) de la tchétchène et du français en utilisant le programme informatique Praat. Une analyse comparative des syntagmes des langues littéraires modernes tchétchène et française sont réalisées pour la première fois sur l'exemple des spectrogrammes narratives, interrogatives, motivationnels et des phrases d'exclamation. Les similitudes et les différences des groupes d'intonation rythmiques des langues tchétchène (source) et française (cible) sont établies. Les données obtenues contribueront à l'assimilation correcte de l'intonation française par les locuteurs natifs tchétchènes, peuvent devenir la base de développement des recherches supplémentaires de la linguistique tchétchène.

Mots-clés: intonation tchétchène, intonation française, aspect comparatif, Praat, spectrogramme, mélodie, le ton.

Le présent recherche est une continuation des études phonétiques typologique de la langue tchétchène. Le but de l'article était de déterminer les similitudes et les différences des groupes d'intonation (syntagmes) de la tchétchène et du français en utilisant le programme informatique Praat.

Les tâches sont d'analyser les spectrogrammes et d'analyser la hauteur dans des phrases narratives, interrogatives, motivationnels et des phrases d'exclamation.

Pour résoudre ces problèmes, on a utilisé principalement une méthode de l'analyse comparative des langues non apparentées et électroacoustique (informatique).

La nouveauté scientifique de cette recherche est déterminée par le fait que on a effectué pour la première fois une analyse comparative et typologique des groupes d'intonation (narratives, interrogatives, motivationnels et des phrases d'exclamation) des langues multi-structurels: tchéchène et française.

Les données obtenues contribueront à l'assimilation correcte de l'intonation française par les locuteurs natifs tchéchènes, peuvent devenir la base de développement des recherches supplémentaires de la linguistique tchéchène. Ça a déterminé le choix du sujet et sa pertinence.

Dans la linguistique nationale, les bases de l'étude de l'intonation sont posées par V.A. Bogoroditsky, L.V. Shcherba et d'autres scientifiques.

Yu D. Desheriev, D. C. Imnaishvili, K. Tchrelashvili, K. Z. Tchokaev, A. D. Timaev, R. A-H. Salamova, M. R. Ovkhadov, A. I. Khalidov et d'autres scientifiques caucasiens ont apporté une contribution importante dans le développement du système phonétique des langues Nach. Malgré le fait que plusieurs de recherches sont faites en phonétique et phonology tchéchène, l'intonation est encore peu étudiée.

De nombreux linguists ont traité de problèmes de l'intonation: Leon and Martin (1970), Di Cristo (1975), Gibbon (1976), Bertinetto (1979), Rossi, Di Cristo, Hirst, Martin and Nishunurna (1981), Selkirk (1984), Cruttenden (1986), Ladd (1996), Cutler, Dahan and van Danselaar (1997), Hirst and Di Cristo (1998), Lacheret and Beaugendre (1999).

L'intonation est «un outil puissant dans le message de tout échange linguistique» (Ramirez Verdugo, 2006).

L'intonation est comprise comme un certain nombre de moyens d'organiser le discours sonore: ton (mélodie du discours), effectué en élevant ou en abaissant la voix; rythme de la parole (observé dans l'alternance de syllabes stressées et non stressées); tempo (vitesse ou lenteur de l'énoncé); timbre de voix; phrasal et le stress logique. La mélodie de la parole a son propre modèle dans chaque langue. (Reformatski, p.191)

La transmission de la teinte sémantique de la phrase est la fonction principale de l'intonation, car c'est l'intonation correcte qui contribue à la perception par l'interlocuteur de l'humeur, des sentiments, des émotions du locuteur.

L'intonation est un changement dans le ton principal, l'intensité et la durée d'une phrase parlée qui contribue à diviser le flux de la parole en segments séparés – syntagmas; en plus de la signification syntaxique, ils ont aussi une signification émotionnelle.

L'intonation joue un rôle important dans l'apprentissage des langues. Le programme informatique Praat a été utilisé pour mesurer l'intonation

en tchéchène et en français, car il génère des informations claires et complètes.

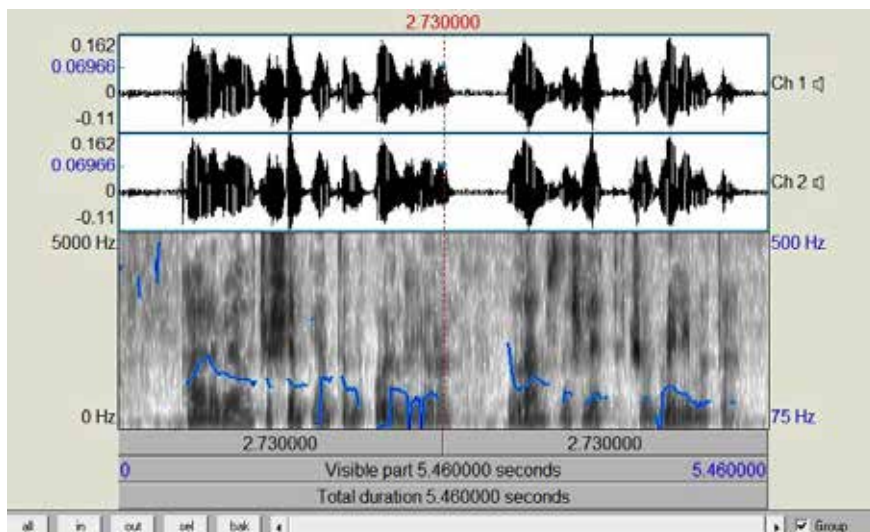
Le programme informatique Praat, développé en 2008 par le département de phonétique de l'Université d'Amsterdam sous la direction de Boersma et Weenink, comme outil de mesure de l'intonation. L'une des fonctions de Praat est l'analyse des spectrogrammes, l'analyse de la hauteur et de l'intensité. Après l'enregistrement des phrases en tchéchène et en français, qui a été produit par l'auteur de l'article, le programme Praat affiche un écran avec le contour de la hauteur de la phrase prononcée, en plus d'indiquer la hauteur, l'intensité et sa durée (les textes lus des phrases ont été tirés d'œuvres de classiques littéraires tchéchènes et françaises).

Lors de l'analyse comparative des syntagmes rythmico-intonation des langues tchéchène et française, le programme informatique Praat est utilisé pour mesurer l'intonation. Pour la première fois les études spectrales des groupes d'intonation dans la langue littéraire tchéchène moderne sur l'exemple des phrases narratives, interrogatives, incitatives et exclamatives sont faites par l'auteur de cet article. (Alkhastova, 2020).

Considérons les spectrogrammes obtenus à la suite de l'enregistrement de phrases narratives, interrogatives, motivationnels et des phrases d'exclamation des langues tchéchène et française.

Phrases narratives:

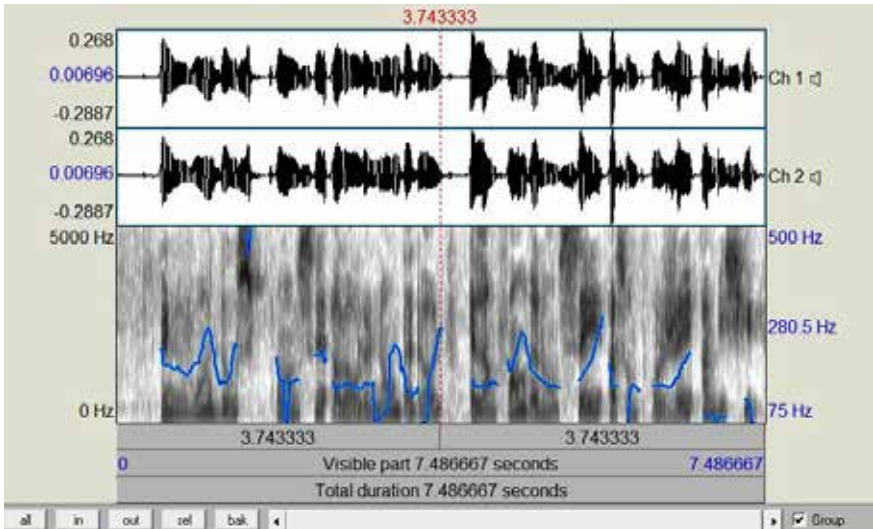
- en langue tchéchène :



- Араваьллачу шен к1ентан ойна йора, ламаз деш лаьттаху Мелимата. – Melimat a prié et a pensé à son fils, qui venait de sortir dans la rue. (6, p.16.)

Le spectrogramme montre une augmentation du ton au début et au milieu d'une phrase narrative, avec une diminution progressive du ton à la fin d'une phrase.

- en français:



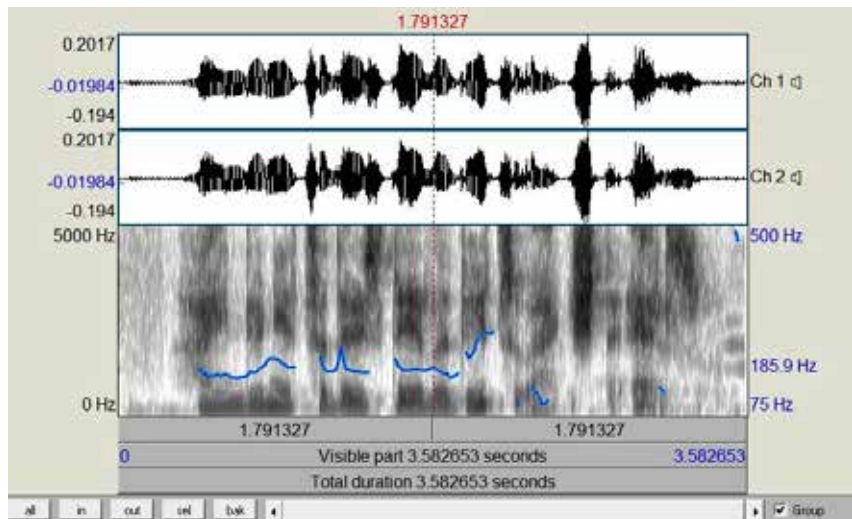
- Une voix douce prononçait alors le nom d'Adolphe, et l'enfant renonçait à son projet ambitieux. (9, p.13)

Le spectrogramme montre une augmentation du ton au début et au milieu d'une phrase narrative, avec une diminution progressive du ton à la fin d'une phrase.

Phrases intonation-interrogative:

- en tchéchène:

Une question dans une phrase tchéchène est exprimée soit par intonation, soit par des mots et une intonation interrogatifs spéciaux. Si la question est exprimée en intonation, alors le mot qui exprime la pensée qui nous intéresse est prononcé plus énergiquement, dans le ton de la question.

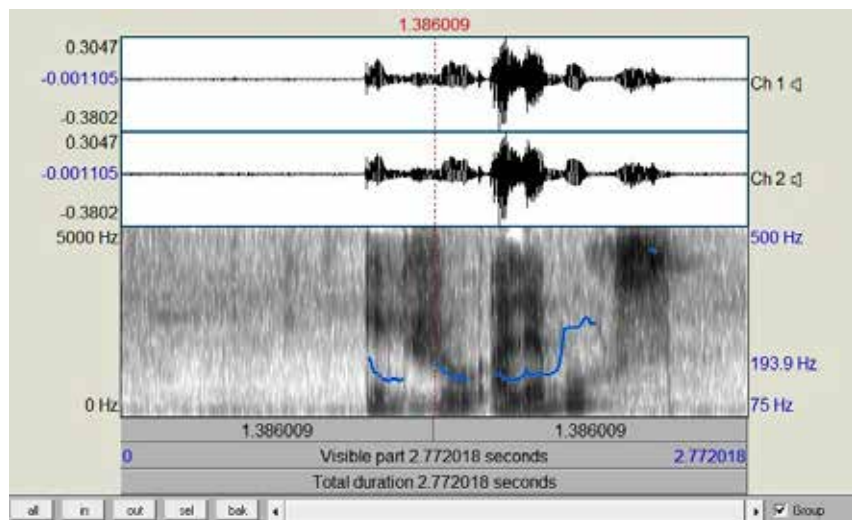


- Хъайна дуьне ца девза дела дуьйцу ахъа ишта, Аьрзу?

- Vous dites cela, Arzu, parce que vous ne connaissiez pas le monde?
(1, p.257).

Le spectrogramme au début des phrases montre une augmentation ascendante-descendante et une forte augmentation du ton sur l'avant-dernier mot avec un ton descendant graduel à la fin d'une phrase.

- en francais:



- *Il joue a la Bourse?* (3, p. 8).

Le spectrogramme montre une intonation ascendante à la fin d'une phrase.

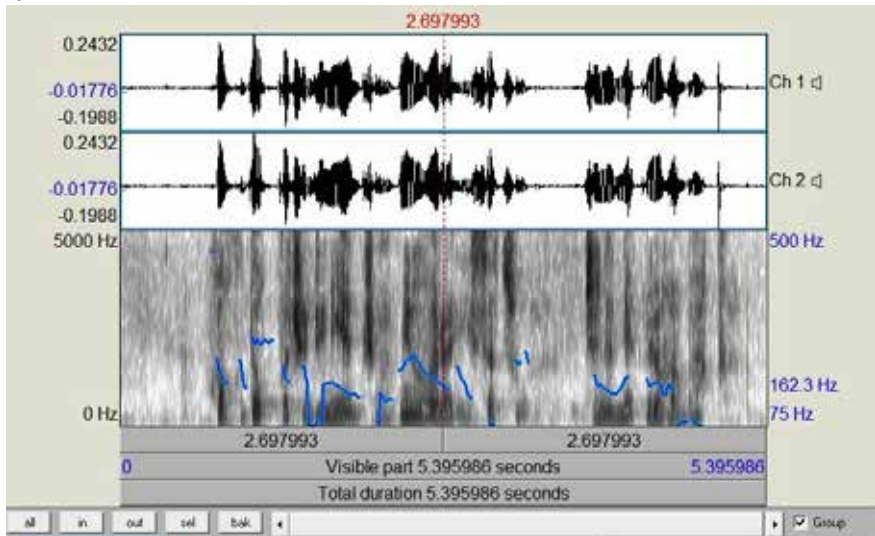
Phrases interrogatives:

- en tchéchéne:

Dans la langue tchéchéne, l'intonation des phrases interrogatives peut être un peu plus faible si la question est exprimée par un mot interrogatif.

La langue tchéchéne contient les pronoms interrogatifs suivants:

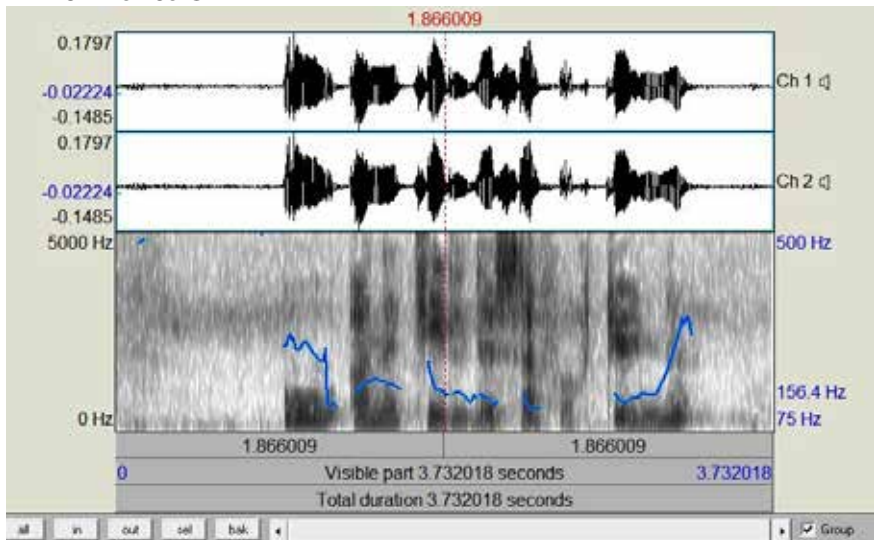
Quoi? - qui?; Pourquoi? Comment? Comment? Lequel? Quoi? Lequel?



- *Х1окху доккхачу дуьненахь мила вара и сацо а, цуьнан некъ юхахьабаккха а?* - *Qui pourrait l'arreter et tourner son chemin sur cette grande terre?* (6, p.66.)

Le spectrogramme de debut de phrase montre une forte augmentation de ton avec baisse progressive de ton à la fin d'une phrase.

- en francais:

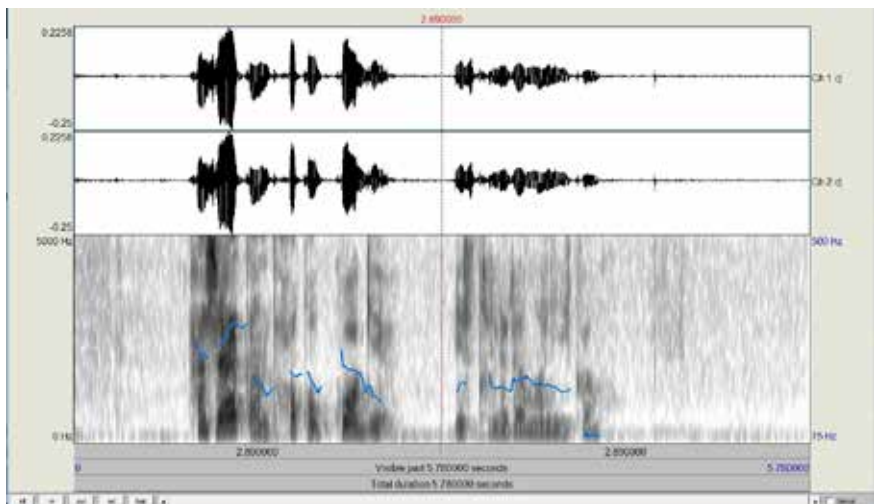


- Où en est-il de sa fortune?- (3, p.8)

Le spectrogramme montre une forte augmentation de ton à la fin d'une phrase

Phrases motivationnels:

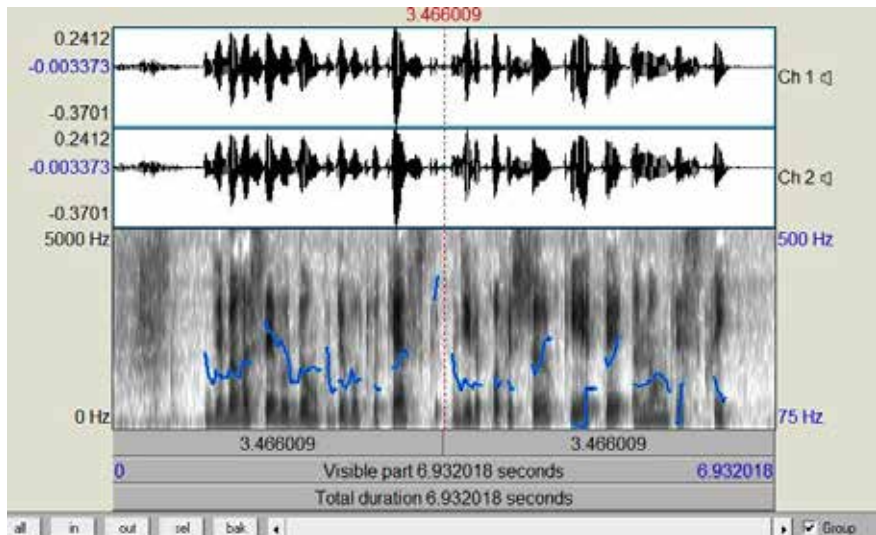
- en tchéchène:



- *Хъажа, к1ант, х1окху коге,- йистхилира Малика.* – Regardez cette jambe, mon fils, - Malika a commencé à parler. (6, p.252).

Le spectrogramme au début d'une phrase montre une intonation descendante-ascendante avec un ton descendant graduel à la fin d'une phrase. Dans la langue tchéchène, l'intonation est utilisée à la place du mot «s'il vous plait». Selon l'intonation la même phrase peut être prononcée sur un ton ordonné ou sur un ton mendiant.

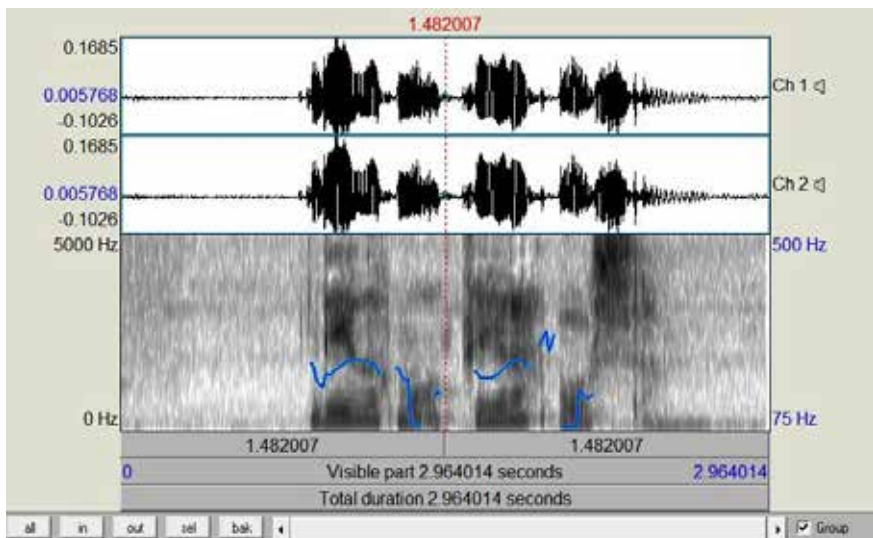
en français:



- *Débarrassez-vous donc de votre casque dit le professeur qui était un homme d'esprit.*- (10, p.6).

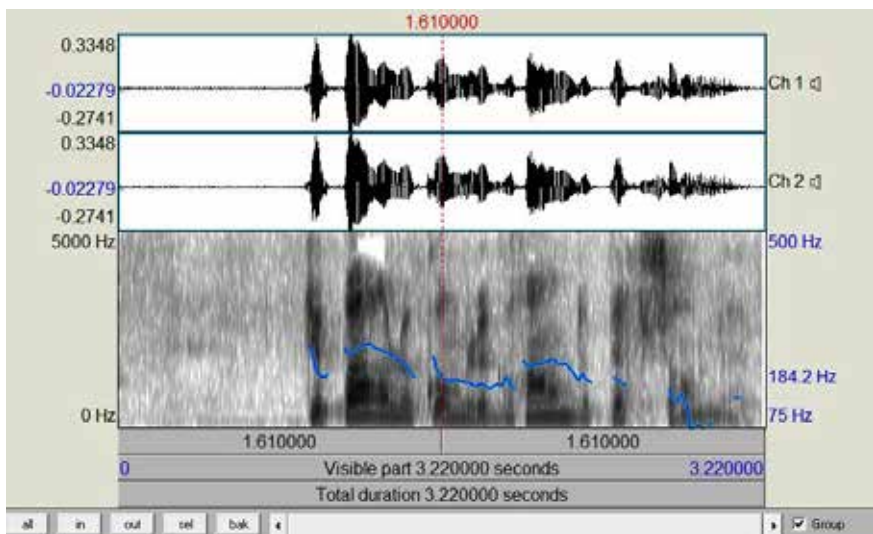
Le spectrogramme au début d'une phrase montre une intonation descendante avec une tonalité ascendante au milieu d'une phrase et une tonalité descendante graduelle à la fin d'une phrase.

Phrases d'exclamation:

- en tchéchène:

- Делах мукъа кхерахъа, loca! - Craignez- vous d'Allah, Osa! (1, p.48)

Les spectrogrammes montrent une intonation ascendante- descendante au debut des phrases et une légère augmentation du ton à l'avant - dernier mot avec une descente progressive en fin de phrases.

- en francais:

-Tu parles comme les grandes personnes! – (8, p.26).

Le spectrogramme montre une intonation descendante – ascendante au début et au milieu d'une phrase avec un ton descendant graduel à la fin d'une phrase.

En résumé nous pouvons conclure que en tchéchène et français l'intonation descendante est utilisée dans les phrases narratives, interrogatives, motivantes et d'exclamation. Dans les phrases à intonation interrogative, l'intonation ascendante-descendante est utilisée au début des phrases et la tonalité aiguë sur l'avant-dernier mot avec une descente graduelle du ton à la fin de la phrase. Dans la phrase à intonation interrogative en langue tchéchène, un ton descendant est utilisé à la fin de la phrase, contrairement à le français, où une intonation ascendante est utilisée dans la question correspondante (type général de question).

Une analyse comparative des syntagmes des langues littéraires tchéchènes et françaises modernes a été réalisée pour la première fois sur l'exemple des spectrogrammes de phrases narratives, interrogatives, incitatives et exclamatives. Des similitudes typologiques et des différences entre les groupes rythmico-intonation des langues tchéchène (source) et française (cible) ont été établies.

La valeur pratique est que les résultats de la présente recherche peuvent être utilisés dans l'enseignement de la phonétique théorique et pratique de la langue française pour les étudiants tchéchènes dans les universités de la République tchéchène.

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CIRCADIAN RHYTHM OF RESPIRATION RATE AND OXYGEN SATURATION IN BURN TOXEMIA IN ADULTS

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Keywords: circadian index, respiratory rate, oxygen saturation, toxemia, burn

A more pronounced tendency towards an increase in respiration on day 1 may have a prognostic significance in the development of ARF in the later stages of severe toxemia in persons over 61 years of age. A pronounced tendency to faster breathing at 17-21 hours was found in group 3. The least pronounced increase in RR corresponded to the minimum of all groups of the burn area of 3B degree of $11.9 \pm 8.9\%$ in group 2. The average hourly rate of breathing in the circadian rhythm for the period of toxemia revealed the most favorable state of the respiratory system in group 2, a tendency to increase breathing regardless of the time of day in group 1, and a more pronounced tendency to increase respiration at 17-21 hours in group 3. A more frequent inversion of the RR circadian rhythm was revealed in persons aged 71.3 ± 7.0 years. In old age (group 3) during the period of toxemia, the respiratory system spends more effort, increasing the need for oxygen, than in patients of groups 1 and 2. The most pronounced shifts in the average parameters of acrophase and bathiphase were found in patients of group 3, confirming the relatively more pronounced ARF in older burned patients. An increase in the total area and depth of skin damage more than $54.3 \pm 16.5\%$, grade 3B more than $11.9 \pm 8.9\%$, IF more than $92.5 \pm 20.8\%$, accompanied by ineffectiveness of compensatory mechanisms of the response of the respiratory rate and mean BP, possibly due to the failure of the corresponding organs and systems of the body.

Relevance. One of the most important components of homeostasis, which plays an important role in maintaining the vital activity of the burned, is the oxygen balance. The delivery of oxygen from the external environment to the tissues, its utilization, as well as the removal of carbon

dioxide from the body in case of burn disease are significantly impaired. Respiratory disorders can occur in any link of gas exchange - in the respiratory system, blood, blood circulation, as well as at the tissue level. These disorders underlie many complications and are often the cause of death of victims. Arterial hypoxemia persists after the elimination of the burn cheek. The main causes of arterial hypoxemia are disorders of ventilation-perfusion relations, intrapulmonary bypass of venous blood, diffuse disorders in the lungs [1-4].

Due to the lack of information on the differentiated assessment of the severity of the condition, the characteristics of the stress reaction of external respiration, changes in the oxygen saturation indicator during the period of toxemia in different age groups, we considered it necessary to study the data of monitoring the respiratory rate indicator, oxygen saturation, to determine the relationship with the systemic inflammatory response in order to increase effectiveness of treatment, optimization of prognosis.

Purpose of the study. To study the circadian rhythm of the respiration rate and oxygen saturation index during the period of toxemia of burn disease in adults.

Material and research methods. The results of monitoring the respiratory rate and oxygen saturation 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. The systemic inflammatory response was studied by monitoring the hourly continuous recording of body temperature, vegetative tone in patients with severe thermal burns in three age groups - 1 group 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 features characteristic of 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 the area of deep skin burn lesions did not differ significantly between the groups. The highest IF indicator was revealed in group 1, which determined the longest duration of intensive care in ICU in the youngest group. Thus, the most pronounced burns in terms of area and depth were found in patients in group 1.

Results and discussion.

There were no significant deviations in the mesor of the circadian rhythm RR and the oxygen saturation index on the first day and the period of toxemia of severe burns in patients. However, some of the discovered features of changes in the structural characteristics of the circadian rhythm allowed us to consider it possible to share noteworthy interesting data in diagrams. As you know, the respiratory system takes an active part in numerous compensatory mechanisms aimed at maintaining other systems of homeostasis in critical situations. We were able to identify or confirm some of them. So, in patients of group 1, the most pronounced tendency to increased respiration was observed in the later periods of toxemia - on days 19-20, in group 2 - on days 12, in group 3 - on days 1, 14, 15, 16, 24 (fig. 1). The revealed tendencies suggest that a more pronounced tendency to increase respiration on day 1 may have a prognostic significance in the development of ARF at longer periods of severe toxemia in persons over 61 years of age. The closest to normal RR indices were observed in group 2, that is, the least pronounced increase in RR corresponded to the minimum of all groups of the burn area of grade 3B, $11.9 \pm 8.9\%$ (tab. 1).

Dynamics of the mesor of the circadian rhythm of respiration rate per minute

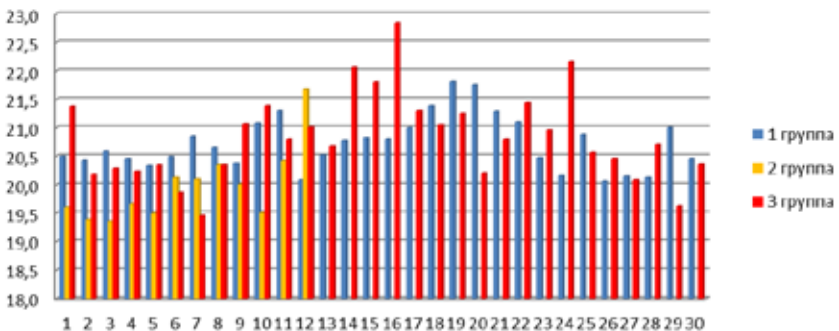
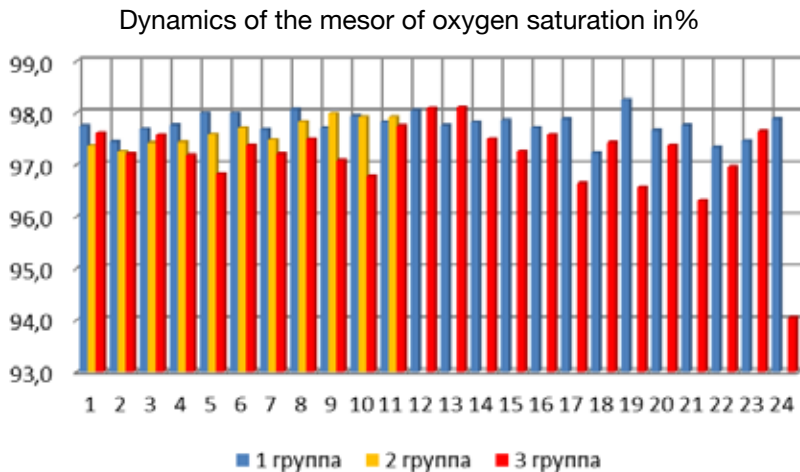


Fig.1

**Fig.2**

There were no significant deviations of the circadian rhythm mesor in the oxygen saturation indicator in groups 1 and 2, while in group 3, a tendency to decrease in the indicator after 16 days during the period of toxemia was found within acceptable values, in the absence of clinical signs of ARF (fig. 2).

Average for the period of toxemia hourly rate of respiration in the circadian rhythm

**Fig.3**

The average hourly rate of respiration in the circadian rhythm for the period of toxemia (fig. 3) revealed the most favorable state of the respiratory system in group 2, a tendency towards an increase in respiration regardless of the time of day in group 1, and a more pronounced tendency towards an increase in respiration rate in 17-21 hour in group 3.

Average for the period of toxemia, oxygen saturation in the circadian rhythm

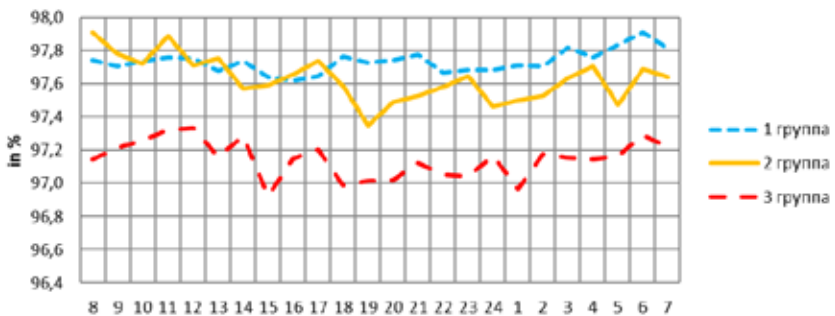


Fig.4

In group 3, a tendency towards a lower level of oxygen saturation was revealed with a greater tendency towards increased respiration regardless of the time of day. The revealed feature can be explained by the higher cost of breathing, that is, to maintain the oxygen saturation indicator at 97%, the respiratory system spent more efforts than at a younger age, despite the relatively shallower depth and surface of the burnt skin surface (fig. 4). While in group 2 an average respiration rate of 20 per minute corresponded to an oxygen saturation of 97.6%, and in group 1 an average oxygen saturation rate of 20.8 per minute corresponded to an oxygen saturation rate of 97.8%. Thus, in old age (group 3) during the period of toxemia, the respiratory system spends more effort, and, therefore, increases the need for oxygen and oxygen debt than in patients of groups 1 and 2.

Migration of acrophase and bathiphase of the circadian rhythm of the respiratory rate in group 1



Fig.5

It was revealed that the severity of the displacements of the acrophase and bathiphase peaks corresponded to the severity of the burn injury, characterizing the activity of compensatory mechanisms during adaptation during the period of burn toxemia. So, in group 1, the most significant displacements of the acrophase were detected at 11 (18 hours clockwise), 19 (14 hours), 21 (21 hours), 27 (13 hours), 30 (19 hours clockwise) days, Bathiphase shifts at 15, 11, 23, 12.10 hours were observed on days 2,4,12,16,30 (fig. 5). The normal projection of the RR acrophase was observed during 10% of the toxemia period, within the daytime 72%, the RR circadian rhythm inversion during 18% of the toxemia duration (fig. 8). In group 2, the most significant shifts in acrophase were 19 hours on day 3, 13 hours on day 6, and bathiphase on day 9 and 16 hours (fig. 6). That is, in comparison with group 1, group 2 showed less pronounced migrations of acrophase (fig. 8). In group 3, the displacement of the acrophase on days 4, 7, 15, 18 was 12-13 hours. That is, a more frequent inversion of the RR circadian rhythm was revealed in persons aged 71.3 ± 7.0 years, which confirms the progression of ARF - worsening respiratory function at night for a longer time -30% than in group 1 (fig. 8).

Migration of the acrophase of the respiratory rate in group 2 in hours



Fig.6

Migration of acrophase and bathiphase of respiratory rate in group 3



Fig.7

The most pronounced displacement of the bathiphase in group 3 occurred within 13 hours on the 8th day, 16 hours on the 21st day (fig. 7). The severity of shifts in acrophase and bathiphase in group 3 was less noticeable than in group 1. It was found that the average indicators of RR migration in hours were 9 ± 6 hours in acrophase in group 1, 8 ± 2 hours in 2

group, and 14 ± 5 hours in 3 group. The average values of the bathyphase shift in group 1 were 10 ± 5 hours, in group 2 - 7 ± 3 , in group 3 - 15 ± 5 hours. Thus, the most pronounced shifts in the mean indices of acrophase and bathyphase were found in patients of group 3, confirming the relatively more pronounced ARF in older burned patients.

Duration and severity of displacements of the acrophase of the circadian rhythm of the respiratory rate

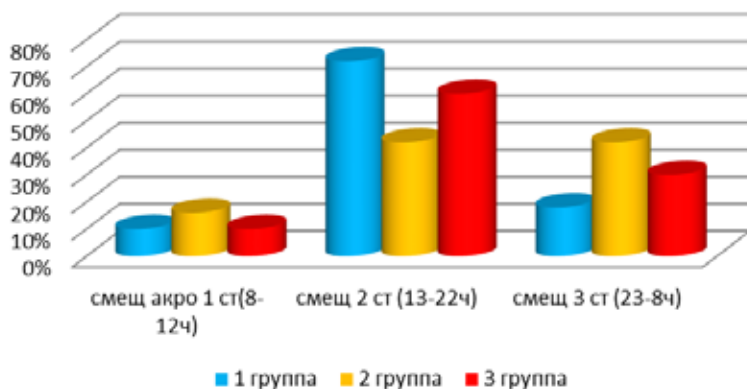


Fig.8

Dynamics of the amplitude of the circadian rhythm of the respiratory rate depending on age



Fig.9

The highest value of the amplitude of daily fluctuations in RR was found in group 1 on day 4, amounting to 5 breaths per minute, and in patients of group 3 on day 24, amounting to 3 breaths per minute (fig. 9).

Correlation relationships of respiratory rate with hemodynamic parameters and body temperature

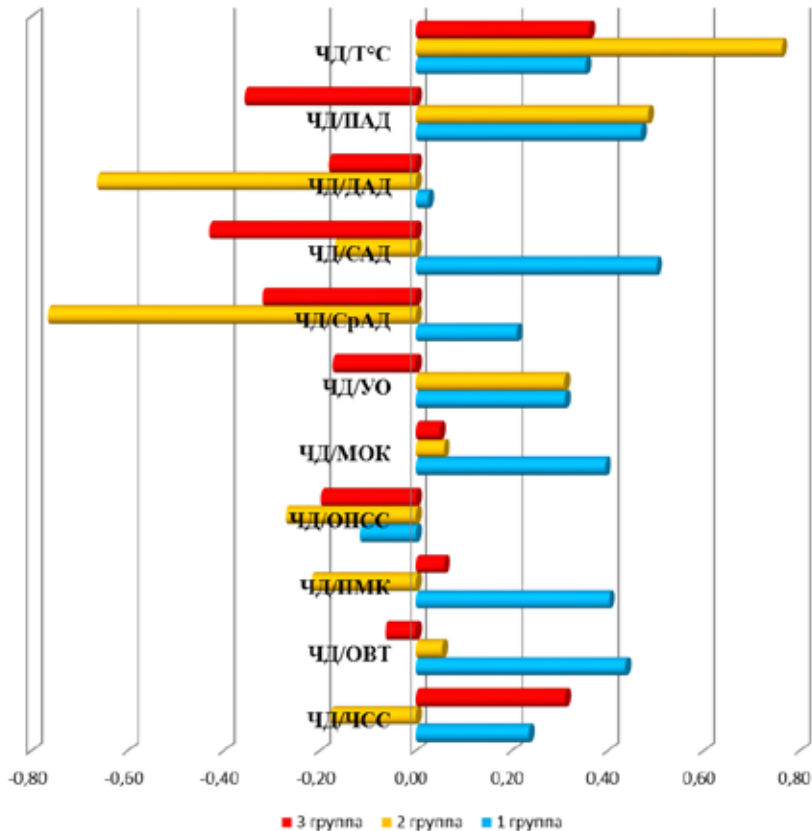


Fig.10

Only in patients of group 2 (fig. 10) a reliable direct dependence of RR on the level of body temperature (0.75), and an inverse relationship of changes in RR and average BP (-0.75) were revealed. From this it follows that an increase in the total area and depth of skin damage by more than $54.3 \pm 16.5\%$, grade 3B by more than $11.9 \pm 8.9\%$, IF by more than

92.5±20.8%, causes disturbances in adaptive reactions, when compensatory mechanisms of changes in the functional activity of the respiratory system and hemodynamics are lost, possibly due to the failure of the corresponding organs and systems of the body.

Correlation relationships of oxygen saturation index with respiration and hemodynamic parameters, temperature

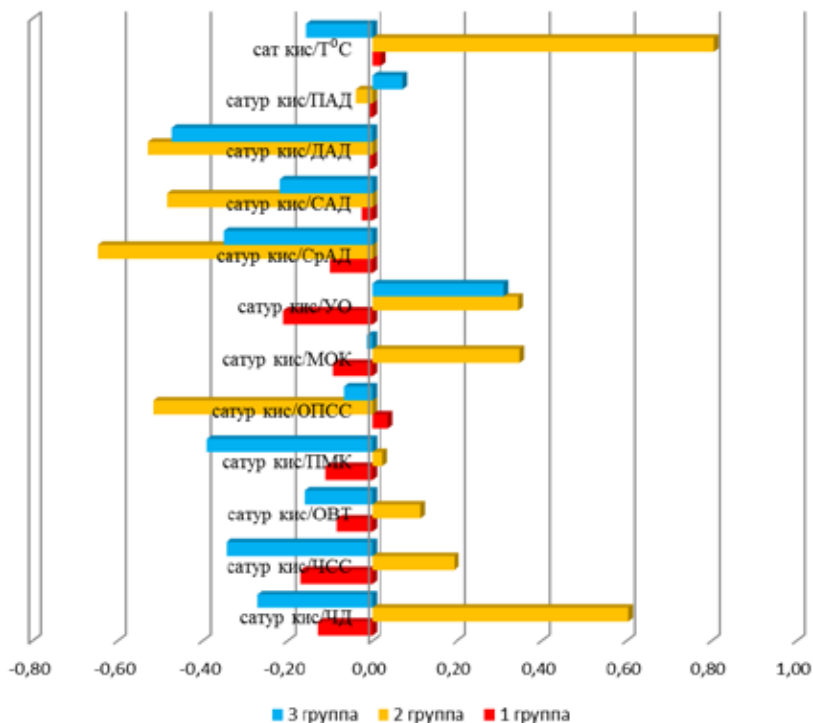


Fig.11

A direct strong relationship was found between oxygen saturation and body temperature (0.8), and a slightly less significant relationship between oxygen saturation and RR (0.6) in patients of group 2 (fig. 11).

Conclusion. A more pronounced tendency to increase respiration on day 1 may have a prognostic significance in the development of ARF in the later stages of severe toxemia in persons over 61 years of age. A pronounced tendency to faster breathing at 17-21 hours was found in group 3. The least pronounced increase in RR corresponded to the minimum

of all groups of the burn area of 3B degree of $11.9 \pm 8.9\%$ in group 2. The average hourly rate of breathing in the circadian rhythm for the period of toxemia revealed the most favorable state of the respiratory system in group 2, a tendency towards an increase in breathing regardless of the time of day in group 1, and a more pronounced tendency towards an increase in respiration at 17-21 hours in group 3. A more frequent inversion of the RR circadian rhythm was revealed in persons aged 71.3 ± 7.0 years. In old age (group 3) during the period of toxemia, the respiratory system spends more effort, increasing the need for oxygen, than in patients of groups 1 and 2. The most pronounced shifts in the average parameters of acrophase and bathiphase were found in patients of group 3, confirming the relatively more pronounced ARF in older burned patients. An increase in the total area and depth of skin damage more than $54.3 \pm 16.5\%$, grade 3B more than $11.9 \pm 8.9\%$, IF more than $92.5 \pm 20.8\%$, accompanied by ineffectiveness of compensatory mechanisms of the response of the respiratory rate and mean BP, possibly due to the failure of the corresponding organs and systems of the body.

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CHANGES IN THE CIRCADIAN INDEX AND CIRCADIAN RHYTHMS OF HEART RATE DURING TOXEMIA OF BURN DISEASE IN ADULTS

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The stress response of the sinus node during burn toxemia in young people was more pronounced than in groups 2 and 3. A direct relationship was found between the degree of hyperfunction of the sinus node and CO, tachycardia and increased myocardial oxygen demand, the severity of hypersympathicotonic effect on the function of the sinus node in adults with burn toxemia. The mesor of the circadian rhythm HR in patients of groups 2 and 3 at 8 o'clock in the morning was less than in group 1 by 15% and 18%, remaining consistently lower than in group 1 regardless of the time of day. An increase in sympathetic influences on the function of the heart at night is more typical for burned young people than in older age. A decrease in CI HR throughout the observation period in all patients indicated a decrease in myocardial contractility and a high risk of developing chronic heart failure.

Keywords: circadian index, heart rate, toxemia, burn

Relevance. In practical medicine, deviations of this circadian index are observed both upward and downward. The norm of the circadian index in adult men and women should be in the range of 1.24-1.44. The indicator is not affected by either the age or gender of the subject. a normal circadian profile indicates a stable autonomic organization of the circadian rhythm. If the CI is increased, this is a sign of a high sensitivity of the myocardium

to sympathetic stimulation. In some cases, an enhanced circadian profile is an individual norm of a person accustomed to intense physical activity. **A decrease in the index** is considered an indicator of cardiovascular disorders. Decrease in CI is an unfavorable sign indicating autonomic denervation of the heart. This means that the sympathetic and parasympathetic divisions of the ANS do not regulate myocardial contractions correctly. With a persistent deviation of the indicator to the lower side, we can say that the contractility of the myocardium has decreased, and the patient has developed irreversible changes in the myocardium and chronic heart failure. A drop in the circadian index to 1.2 is a sign of heart failure with a probability of death. HR rigidity during treatment is a poor prognostic sign, upward growth is a guarantee of the adequacy of the prescribed therapy. However, there is insufficient information in the literature on the features of changes in CI HR in severe burns, which prompted us to study this issue [1-4].

Purpose: to study and assess the changes in the circadian index and circadian rhythm of the heart rate during the period of toxemia of burn disease in adults.

Material and research methods. The results of monitoring the heart rate (HR) 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, anti-bacterial, infusion therapy, correction of protein and water-electrolyte balance disorders, early surgical, delayed necrectomy, additional parenteral nutrition, syndromic, symptomatic therapy were performed. The systemic inflammatory response was studied by monitoring the hourly continuous HR recording 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 is made according to the formula:

CI = Average HR during the day (from 7:00 to 22:00)/Average HR at night (from 23:00 to 7:00).

Table 1
Patient characteristics (25)

	Age, years	Height, cm	Weight, kg	Total burn area, %	Burns 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 tab. 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 the area of deep skin burn lesions did not differ significantly between the groups. The highest IF index 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 in group 1.

Table 2.
Dynamics of the mesor of the circadian rhythm of cardiac function
(beats per minute)

Days	Group 1	Group 2	Group 3
1	102.9±3.7	99.6±6.6	87.7±4.3
2	103.4±1.2	86.6±1.8"	90.2±2.1"
3	101.1±0.8	86.6±1.9"	88.6±1.4"
4	107.1±1.6	97.8±2.0"	87.3±2.6"
5	106.1±1.5	98.7±2.3"	91.8±3.3"
6	106.0±1.4	100.1±2.4"	92.7±2.2"
7	111.0±2.3*	97.3±1.9"	92.0±2.5"
8	111.0±2.1*	96.8±3.6"	91.5±1.4"
9	112.3±2.1*	95.7±2.1"	96.5±3.5"
10	110.6±2.4*	93.6±3.0"	93.4±3.4"
11	105.3±2.1	91.9±3.2"	100.2±8.2
12	106.4±4.1	87.2±1.6"	98.0±4.0

13	104.2±3.1		94.1±4.9
14	109.6±2.9		102.0±3.6
15	113.1±2.6*		96.6±5.5"
16	111.5±2.8*		88.9±1.8"
17	112.6±2.5*		87.0±1.8"
18	110.6±1.8		89.9±1.9"
19	110.0±1.1		93.7±4.4"
20	111.1±2.7*		90.2±6.0"
21	110.3±2.3		79.7±1.7"
22	112.1±1.4		85.9±5.3"
23	110.7±1.3		89.9±3.4"
24	110.4±2.3		112.0±11.6
25	112.9±3.1*		80.9±6.8"
26	113.4±3.8*		87.9±2.0"
27	109.9±1.5		94.9±5.7"
28	108.7±1.5		80.2±6.8"
29	113.3±2.9		89.0±4.5"
30	111.8±2.0*		92.7±3.5"

* - reliable relative to the indicator in 1 day

" – reliable relative to the indicator in group 1

As shown in tab. 2, the initial level of the mesor of the circadian rhythm HR was significantly increased by 30% only in patients of group 1, while in groups 2 and 3 only a tendency to tachycardia was observed.

A distinctive feature of the reaction to stress of the sinus node during burn toxemia in young people was more pronounced than in groups 2 and 3, which turned out to be 8-9% more by 7-10 days ($p < 0.05$), 15-17 by 9 -8% ($p < 0.05$), 20 by 8%, 25-26 by 9-10% ($p < 0.05$), 30 days by 8% ($p < 0.05$).

Table 3

Average HR in the circadian rhythm over the period of toxemia
(beats per minute)

Hours	Group 1	Group 2	Group 3
8	109.3±3.7	92.9±3.4*	88.4±4.3*
9	109.0±3.8	91.8±4.3*	91.6±5.1*
10	109.1±3.4	94.7±6.0*	89.7±4.9*
11	108.4±3.5	95.1±5.1*	90.4±5.6*
12	109.0±2.8	94.7±6.0*	89.5±5.0*
13	107.5±3.6	92.4±3.1*	92.1±5.8*
14	107.9±3.3	93.4±3.9*	92.6±5.1*
15	108.7±3.2	93.1±3.3*	91.7±5.4*
16	109.9±2.8	94.7±5.5*	91.5±5.1*
17	110.2±2.9	95.7±4.9*	91.8±6.0*
18	108.8±2.8	94.3±4.9*	91.4±5.0*
19	109.5±3.4	96.1±4.7*	92.3±7.1*
20	110.1±3.0	93.3±5.6*	91.3±6.7*
21	109.8±3.2	96.3±5.6*	93.3±8.4*
22	109.5±3.9	94.4±5.5*	92.4±7.0*
23	109.3±2.9	93.5±5.1*	92.5±5.9*
24	108.5±2.9	93.1±4.0*	91.8±5.6*
1	109.9±3.9	95.7±4.9*	92.5±6.7*
2	109.4±3.9	94.2±5.6*	91.7±6.7*
3	111.4±5.0	95.2±5.0*	91.8±6.2*
4	110.3±4.1	96.1±5.3*	92.3±6.1*
5	110.8±4.3	96.0±5.6*	92.2±6.6*
6	108.2±3.0	93.1±3.7*	90.7±6.1*
7	109.6±3.7	93.1±4.8*	91.0±6.0*

*- reliable relative to the indicator in group 1

As shown in tab. 3, the hourly assessment of the average values of the HR mesor during the day for the period of toxemia revealed reliably significant age-related features of the HR circadian rhythm. So, HR indicators in group 1 were increased by 30-40% of the norm. The indicator of the mesor of the circadian rhythm HR in group 2 was lower than in group 1 throughout the entire observation by an average of 15% both in the daytime and at night. In group 3, the mesor of circadian rhythm HR at 8 am was less than in group 1 by 18% ($p < 0.05$), remaining consistently significantly lower than in group 1, regardless of the time of day. Thus, during the period of toxemia, there were no significant differences in HR values in the morning, evening, and night hours (fig. 1).

Average HR for the period of toxemia in the circadian rhythm

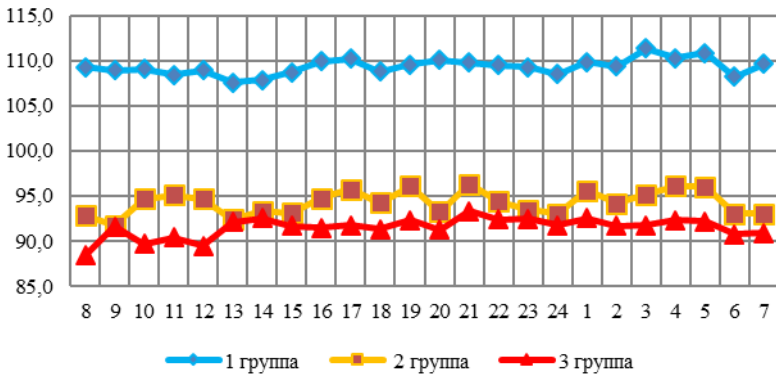


Fig.1

Dynamics of the amplitude of the circadian rhythm of the HR in burn
toxemia

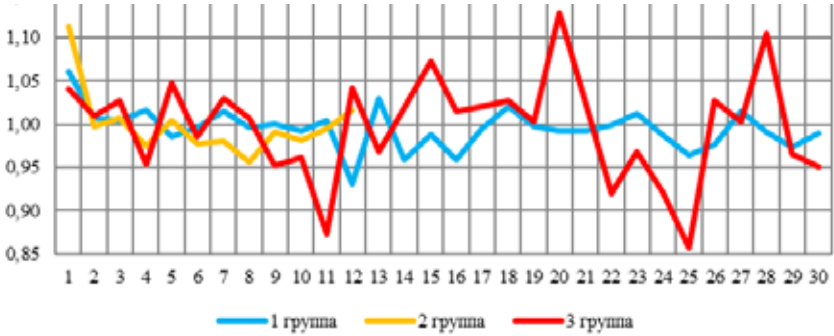


Fig. 2

The smallest daily heart rate fluctuations were found in young people of group 1 patients (fig. 2). Changes in the amplitude of daily HR fluctuations during the period of toxemia were limited to 3-10 beats per minute, were wavy in nature with the highest values of the HR circadian rhythm amplitude at 1, 12-14, 20, 25, 29 days, the oscillation period 10, 9, 4, 4, 4 days. The instability of the near-week biorhythm of the sinus node function can be associated with the severity of burn injury in group 1.

Circadian HR index during toxemia in adults



Fig.3

The circadian index during the period of toxemia in group 1 was in the range of 0.93-1.03 on the 12-13th day, in group 2 1.12 - 0.96, the lowest rates were noted in group 3 0.86 - 1.12 on 11 and 20 days (fig. 3). Thus, changes in CI HR towards a stable decrease over the entire observation period in all patients indicated a decrease in myocardial contractility due to, possibly, irreversible changes in the myocardium and a high risk of developing chronic heart failure.

The inversion of the HR circadian rhythm in group 1 was 50%, in group 2 - 42% and in group 3 - 31%. In all patients, almost half of the duration of treatment in the ICU revealed a displacement of the acrophase within the daytime. Thus, in group 1, a moderate shift in the acrophase of the circadian rhythm HR was 47%, in group 2 - 42%, in group 3 - 46% (fig. 4). Thus, in the age aspect, it is for young burns that an increase in sympathetic influences on the heart function at night is more characteristic, as well as a more active participation of the HR circadian rhythm in adaptive mechanisms during burn toxemia than at an older age.

Duration and severity of displacement of acrophase

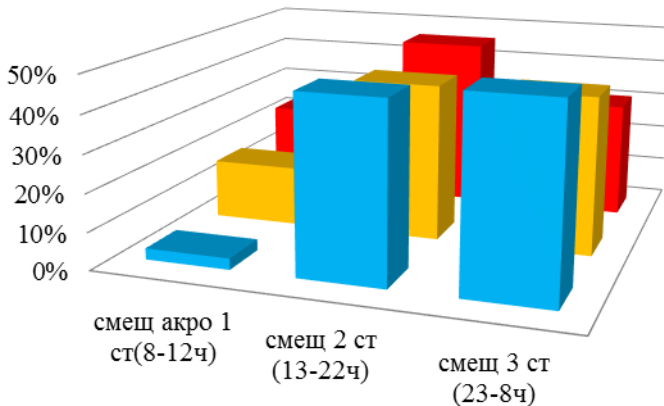


Fig.4

Correlations between HR and other hemodynamic parameters and body temperature

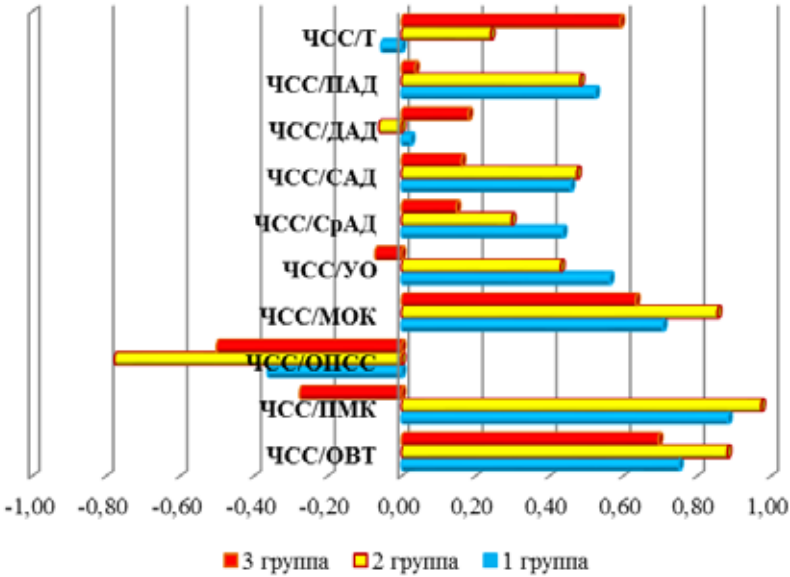


Fig.5

Table 4.
Correlation of HR with other parameters of hemodynamics and body temperature

Groups	HR/AVT	HR/MVP	HR/TPVR	HR/CO	HR/SV	HR/AvBP	HR/SBP	HR/DBP	HR/PBP	HR/T
1	0.75	0.88	-0.36	0.71	0.56	0.44	0.46	0.02	0.52	-0.06
2	0.88	0.97	-0.78	0.86	0.43	0.30	0.48	-0.06	0.48	0.24
3	0.70	-0.28	-0.50	0.63	-0.07	0.15	0.16	0.18	0.04	0.59

A direct dependence of HR on the state of autonomic tone was revealed in all patients (0.75; 0.88; 0.7, respectively), in groups 1 and 2 (fig. 5), a strong direct dependence of myocardial oxygen demand on heart

rate was observed (0.88; 0.97, respectively), which became slightly negative in group 3 (-0.28). The decrease in TPVR in group 2 increased the heart rate (-0.78). The hyperdynamic type of hemodynamics was carried out mainly due to the increased heart rate in groups 1 and 2 (0.71; 0.86, respectively) and to a somewhat lesser degree in group 3 (0.63). Thus, a direct relationship was found between the degree of hyperfunction of the sinus node and CO, tachycardia and increased myocardial oxygen demand, and the severity of hypersympathicotonic reaction in adults with burn toxemia (tab. 4).

Conclusion. The stress response of the sinus node during burn toxemia in young people was more pronounced than in groups 2 and 3. A direct relationship was found between the degree of hyperfunction of the sinus node and CO, tachycardia and increased myocardial oxygen demand, the severity of hypersympathicotonic effect on the function of the sinus node in adults with burn toxemia. The mesor of the circadian rhythm HR in patients of groups 2 and 3 at 8 o'clock in the morning was less than in group 1 by 15% and 18%, remaining consistently less than in group 1 regardless of the time of day. An increase in sympathetic influences on the function of the heart at night is more typical for burned young people than in older age. A decrease in CI HR throughout the entire observation period in all patients indicated a decrease in myocardial contractility due to, possibly, irreversible changes in the myocardium and a high risk of developing chronic heart failure.

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DETERMINING ROLE OF ASTROGLIA ON THE SENSITIVITY OF INTERNEURONAL SYNAPSES TO DOPAMINE, SEROTONIN AND OTHER MEDIATORS IN A MODEL OF SCHIZOPHRENIA

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Clinic for pathology of higher nervous activity

Astroglia plays a leading role in the pathogenesis of schizophrenia. Antipsychotics are aimed at correcting the amount of mediators in interneuronal synapses. But the sensitivity of synapses to dopamine, serotonin, GABA and other neurotransmitters is completely controlled by astroglia. Normalization of the cytokine balance in most cases can restore harmony. The sensitivity of synapses to dopamine and other neurotransmitters tends to normal. As a result, patients recover. Schizophrenia can be stopped exclusively by immunological methods without the use of psychotropic drugs.

Keywords: pathogenesis of schizophrenia, astroglia, glymphatic system.

Modern mass psychiatry uses antipsychotics, antidepressants, tranquilizers for the treatment of schizophrenia and cannot do without them. A cocktail made up of these chemical molecules can help minimize deviations in patient behavior and "control symptoms." **Antipsychotics really stop excitement, hallucinations, sometimes even delirium, but do not eliminate the very cause of their occurrence. Defects are inevitable.** Therefore, antipsychotics are prescribed for life, and a cure for schizophrenia is considered impossible.

Recent discoveries in pathophysiology, somnology, neuroimmunology, biochemistry of the central nervous system (CNS), especially the discovery of the glymphatic system of the large brain, allowed us to formulate and clarify in this article a fundamentally new and almost universal model of the pathogenesis of schizophrenia. Like a giant jigsaw puzzle, our model has connected numerous, scattered in the past, symptoms and

syndromes. Many conclusions and observations made by researchers from different countries and different years have taken their place in it. We admit that there are still not enough pieces of the "puzzle" in our model...

First, a little digression into modern brain science. It is needed, just to understand this article. Key points will be highlighted in bold. **All over the world, most psychiatrists profess the dopamine theory, and therefore** have outdated ideas about the work of interneuronal synapses, do not understand the mechanisms of the formation of pseudohallucinations and delusions, the reasons for impaired attention, changes in the phase structure of sleep, and often have very vague ideas about the mechanisms that ensure the movement of the cerebrospinal fluid along the glymphatic system. Let's start with the fact that **the brain and spinal cord are completely immersed and, as it were, "float" in a liquid - (cerebrospinal fluid)**. As it seeps through the branched glymphatic system, the cerebrospinal fluid washes every square millimeter of brain tissue. It can be compared to a sponge immersed in a cramped container of liquid. But the liquid in a cramped vessel just saturates the sponge and does not move anywhere, and the cerebrospinal fluid moves continuously - flows. **Especially intensive "washing" of the brain occurs in the third and fourth phases of slow wave sleep**, the failure of which, to varying degrees, is registered in all patients suffering from schizophrenia, and not rarely in their blood relatives [15,21].

The brain does not come into direct contact with blood anywhere. The blood vessels of the brain have a particularly dense wall through which only small molecules penetrate into the cerebrospinal fluid. Blood brings oxygen, glucose and carries away carbon dioxide. Exceptions are anatomical structures - gray tubercle, funnel and posterior lobe of the pituitary gland [2]. Each beat of the pulse filters a new portion of cerebrospinal fluid into the lateral ventricles of the brain. The filtration process is carried out through the choroid plexus inside the ventricles, creating constant pressure in them. Further, the cerebrospinal fluid flows through the glymphatic system - between the tightly closed legs of astrocytes that surround each blood vessel and an even denser wall of the blood vessel. **Absolutely all metabolic products of the intensively working brain are carried away by the cerebrospinal fluid, which is continuously moving along the glymphatic system.** No toxic metabolic products enter the bloodstream. Astrocytes take everything they need only from the cerebrospinal fluid and pass through themselves to provide neurons. **Neurons are not energetically independent and are completely dependent on the surrounding astroglia both energetically and trophically.**

What mechanisms, normally, cause the cerebrospinal fluid to move through the system of glymphatic channels - it became clear quite recently. 13 people took part in the experiment of scientists from Boston University. Thanks to the fact that the subjects were able to fall asleep in a noisy MRI machine, the researchers were for the first time able to obtain images of the activity of cerebral fluid in the brain during sleep. It turned out that the speed of CSF movement is closely related to the activity of brain delta waves and blood flow [20]. Study co-author Laura Lewis stated: "Until now, we were unaware of the pulsation of cerebrospinal fluid during sleep. Now we just need to look at an MRI to assess the state of the brain." CSF flow and slow wave activity promote the flushing of toxic proteins from the brain [13]. But this process occurs mainly in delta sleep and looks like this: The pressure of the blood flowing through the vessels slowly decreases, then gradually increases. With a drop in pressure, the inner tube of the vessel decreases in diameter and loses in volume, while the outer tube, consisting of the legs of astrocytes, retains its diameter. As a result, up to 60% of the bed of the glymphatic system is released. This volume is quickly filled with cerebrospinal fluid, which removes all metabolic products from the brain. The process goes through the numerous aquaporin channels of the astrocyte legs. When the pressure in the blood vessel rises, the cerebrospinal fluid is squeezed out and accelerates its flow through the glymphatic system. Objectively, the whole process is visible on MRI. The mechanism of regulation of these fluctuations is not yet understood. This happens only in deep delta sleep, which is not enough for any form of schizophrenia. [21]. For example, patient "O". 42 years. From the age of 34, the diagnosis was F20 (disabled person 2 gr.) (Figure 1).

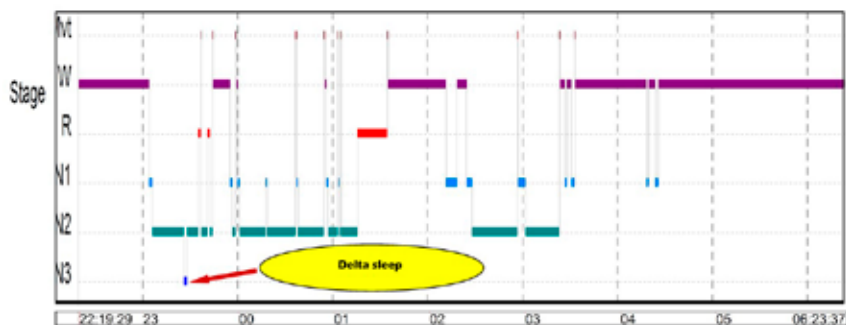


Figure 1. The somnogram shows a small delta sleep interval in Patient "O" (42 years old. From 34 years old, diagnosed with F20, disabled person 2 gr.)

And sometimes there may be no delta sleep at all, like patient L. (Fig. 2)

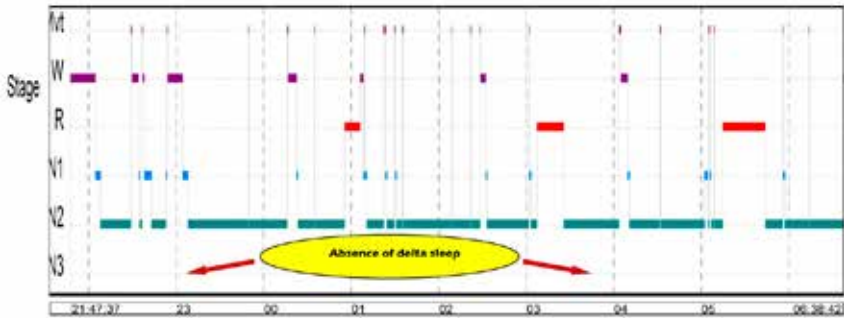


Figure 2. The somnogram shows the absence of delta sleep in patient "L" (52 years old. From 30 years old, diagnosis F20, disabled person 2 gr.). [4, 16]

For comparison, look at the amount of delta sleep in patient "I" with persistent complaints of insomnia, but not suffering from schizophrenia. (Fig. 3)

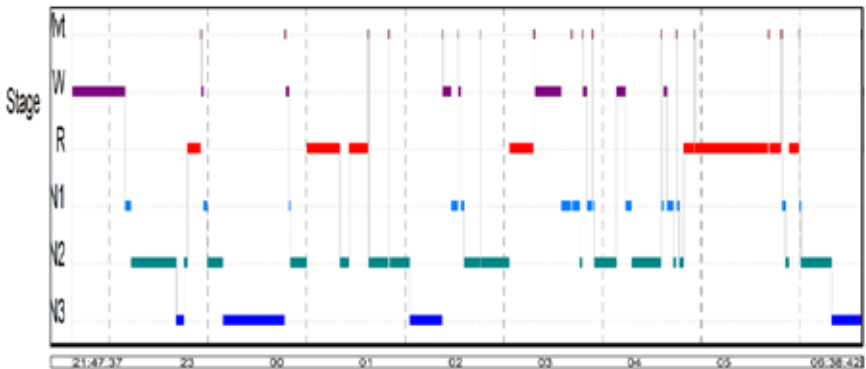
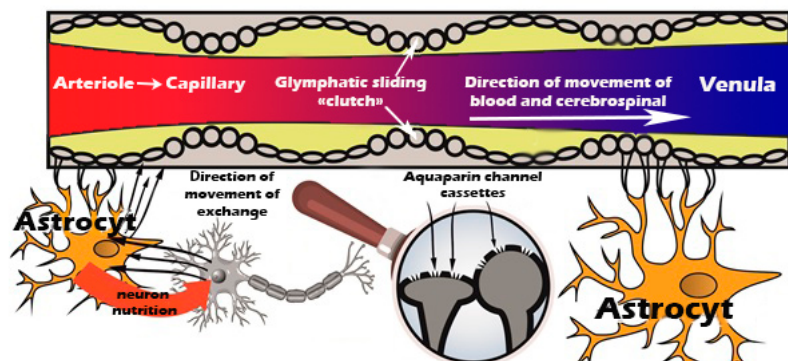


Figure 3. The somnogram shows the duration of delta sleep in patient "I" 50 years old

The second mechanism, which advances the cerebrospinal fluid through the glymphatic system around the clock, was described by us two years ago [6], although still theoretically [21].



Group swelling of the "legs" of astrocytes forms "couplings", as if sliding one after another and "squeezing" the cerebrospinal fluid from the narrow paravascular space. The continuous flow of the cerebrospinal fluid is created by the harmonious operation of the aquaporin channels. An imbalance of Th1 and Th2 cytokines destroys this harmony. Breakdown of the draining sleep delta machinery is at the heart of the pathogenesis of schizophrenia.

Figure 4. Schematic diagram of the functioning of the cerebral glymphatic system, which organizes delta sleep of 0.5-2 hertz. Formerly called the blood-brain barrier.

The legs of astrocytes, interconnected by slotted calcium channels, regularly and consistently swell and fall off in groups (domains) pushing the cerebrospinal fluid along the vascular bed. In all F20 patients, the glymphatic system (GS) organizes the pumping of cerebrospinal fluid poorly, ...but to varying degrees. With an increase in the severity of attacks and the duration of the disease, consecutively, both "pumps" of the glymphatic system fail. In the course of movement of the cerebrospinal fluid, congestions are formed, where the cerebrospinal fluid accumulates (Virchow-Robin spaces). On a magnetic resonance imaging (MRI 3 Tesla), mainly in the hippocampus, trunk, frontal lobes - Virchow-Robin spaces are recorded in the form of gliosis areas. This is often a scattering of small foci. As the duration of the disease increases, these foci merge and form whole "fields" [6]. But that's not all the trouble. **The high resistance of the glymphatic system, characteristic of F20 patients, causes an increase in cerebrospinal fluid pressure in the ventricles. Therefore, the choroid plexus, which are under excessive pressure, appear coarse on MRI, and the ventricles expand excessively [7].**

We believe that the onset of schizophrenia is characterized by an imbalance of Th1/Th2 cytokines [9], which provokes an autoimmune attack of anti-brain antibodies on the legs of astrocytes. The result is an imbalance in the domain interaction of astrocytes and a slowdown in the process of CSF movement along the glymphatic system. Studies have shown that on a recovery night, after sleep deprivation, schizophrenic patients, unlike any other diseases of the central nervous system, do not tend to compensate for the deepest slow-wave sleep (4 stages). It is this circumstance that helps to distinguish schizophrenia from other mental illnesses, for example, from bipolar disorder and, of course, from healthy subjects [17]. The glymphatic system of the brain is quite comparable to the branched sewer system of a large city. The city sewerage system works day and night. Glymphatic system most intensively removes metabolic products only during delta sleep, and only during its deepest stages. Only in dolphins can the cerebral hemispheres take turns sleeping. Such a mechanism is absent in humans.

A healthy person's sleep at night consists of 4-6 identical, alternating cycles, about one and a half hours each. **The cycle always begins with slow wave sleep followed by REM sleep.** Then the cycle repeats. The slow-wave sleep phase is conventionally divided into four stages: 1. nap, 2. light sleep, 3 and 4 - moderately deep and deep sleep. In stages 3 and 4, slow high-amplitude delta oscillations appear on the encephalogram. Therefore, the entire phase of slow sleep is usually called delta sleep. But **the glymphatic system intensely pulsates only in the last two stages of delta sleep, flushing out all toxins accumulated during wakefulness.** In personally patients [1] and their blood relatives, this system cannot cope with the excretion of metabolic products, but to a different extent. With an exacerbation of psychosis, delta sleep suffers first. It is either very little or not at all [3,15]. During slow wave sleep (delta sleep), all brain activity is aimed at getting rid of metabolic products. And in REM sleep, the efforts of the central nervous system are aimed at consolidating memory, removing spent receptors, preserving daytime impressions or emotions in memory. This period is characterized by vivid dreams and rapid eye movement under closed eyelids. In the brain, four types of microglial cells move between neurons and "bite off" the used synapses. Then again slow sleep produces "cleaning - washing out" of everything that the microglia "bit off". Then the cycle repeats. Actually, to prepare for the perception of something new in the morning, the brain tidies up and gets rid of yesterday's "old".

During sleep, the brain is maximally fenced off from the outside world,

closes the eyes, even in the inner ear there is a special muscle that relaxes during sleep and the sleeping person does not respond to most sounds. The condition is dangerous, especially in the wild, where enemies are everywhere. Not without reason, the Romans erected a monument to geese, which raised a noise and woke up the guards when they heard sneaking enemies - Gauls. We have described in more detail the mechanisms of sleep and their role in the pathogenesis of schizophrenia in previous articles for 2018 [5, 6]. This article presents only the points necessary for understanding the pathogenesis of F20 psychosis.

Following the phase of slow wave sleep, there is a phase of REM sleep (it is called "sleep with rapid eye movement"). In the first half of the night, slow sleep takes most of the time, and in the morning, REM sleep [19]. Awakening usually occurs from REM sleep.

The process can be compared to general cleaning of the house. First, all surfaces are washed, and then vases, books, small objects are placed in their places. The brain does this "cleaning" 4 - 6 times a night. At the end of the night, in a dream with a quick movement of the eyes, it devotes more time to "building coziness", the brain "arranges everything in its proper order".

Brain histology in schizophrenia has also been enriched by a number of relatively new facts. **The modern understanding of the work of interneuronal receptors has changed dramatically.** Astrocytes secrete adenosine triphosphoric acid (ATP), gamma-aminobutyric acid (GABA), serine, and many other neurotransmitters. The close contact of the processes of astrocytes with the presynaptic and postsynaptic terminals of neurons modulates the work of synapses [18,11,12]. **Most of the interneuronal synapses (up to 90%), especially in the area of the hippocampus, pons varoli, olfactory brain, are controlled by nearby astrocytes.** Under conditions of cerebrospinal fluid intoxication with metabolic products, **astrocytes change the sensitivity of receptors to dopamine and other neurotransmitters.** The normal dopamine concentration for a healthy person becomes too high for F20 patients. All dopamine theory and all neuroleptic therapy are based on the binding of dopamine to D-receptors by antipsychotics. We believe that a similar modulation occurs with respect to most other mediators (serotonin, monosodium glutamate, GABA, etc.). Synapses react in different ways, but as a result of an imbalance in the overall balance, the entire system loses its original harmony.

The neuron is not energetically independent. Astrocytes restore the damaged ribosomes thrown out of the neuron and return them back. In addition, they give neurons their own full-fledged ribosomes.

[8]. These processes are due to calcium-dependent mechanisms. From the astrocyte, the neuron receives lactic acid lactate, restores it through the tricarboxylic acid cycle to pyruvate, from which it receives the main amount of energy in the form of ATP [14].

Astrocytes form a network structure in the brain. It includes several varieties of stellate cells. Each type of astrocytes performs its own function in this network. As the duration of the disease increases, the ultrastructure of astrocytes is progressively disrupted. The numerical density and volume fraction of mitochondria in astrocytes significantly decreases [7]. Neurons are completely dependent on their "breadwinners" - astrocytes. If astrocytes have nothing to share with neurons, the latter remain without mitochondria and energy. **Therefore, the longer the illness lasts, the less energy the patients have. Clinically, this manifests itself as autism: withdrawal into the inner world, avoidance of social contacts, special "Oblomov" laziness [21].**

In patients F20, during polysomnography, we observed sleep spindles and K-complexes during wakefulness, when they were actively hallucinating (recording from cameras). According to the literature, the pathological activity of the wakefulness system fundamentally changes the phase structure of sleep, and "sleep spindles" appear during the day [20, 21]. This observation and the data obtained by other researchers reinforce the idea that pseudo-hallucinations in schizophrenia are closely related to delta sleep deficit caused by impaired astroglia. **Probably, in patients F20, pseudo-hallucinations against the background of wakefulness are episodes of REM or the first phases of slow wave sleep [21].**

The accumulation of metabolic products in the cerebrospinal fluid seriously disrupts numerous functions of astrocytes, since astrocytes derive all their needs from toxic cerebrospinal fluid. Astrocytes initially initiate a process that disrupts delta sleep. As a result, they themselves suffer from intoxication. The cause gives rise to an effect that multiplies the cause. There are several such "vicious circles" due to the "self-poisoning" of astrocytes in the central nervous system. Superimposed on each other, they create a motley picture of fancifully grouped clinical symptoms of F20, each time "special".

Self-poisoning of the brain primarily affects the largest glial cells - oligodendrocytes. Their number drops sharply, and the rest are unable to provide full-fledged myelination of axons [7].

In the toxic cerebrospinal fluid, **two out of four types of microglia practically disappear at once - ramified and round glia.** Both act primarily in REM sleep. Their disappearance seriously changes the charac-

teristics of REM sleep [7].

We consider pathogenesis as a dynamic pathophysiological process in which successive failures in the operation of one system cause the failure of another, and often several systems at once. There are many related processes in the brain that form several "vicious circles" at once: For example, an autoimmune attack on the legs of astrocytes - disrupts one of the "pumps" of delta sleep: the cerebrospinal fluid stops effectively washing the brain, toxins accumulating in the cerebrospinal fluid inevitably enter astrocytes and seriously disrupt their many functions, each of which triggers the next vicious circle.

"Poisoned" astrocytes that surround most of the three-membered synapses modulate the signals of these synapses, changing the sensitivity of synapses to dopamine and its usual amount is "too high" (antipsychotics bind dopamine, reducing the excessive activity of receptors, but do not eliminate the cause of their increased sensitivity to dopamine). A similar process underlies other neurotransmitter theories: serotonergic acid, gamma aminobutyric acid (GABA) and other mediators.

The next vicious circle also starts after the "poisoning" of astrocytes with metabolic products from the extremely slow flowing cerebrospinal fluid - the number of mitochondria and lactic acid lactate in astrocytes decreases, and they reduce the energy support of neurons - they stop sharing ribosomes and lactic acid lactate with them, do not restore and do not give damaged ribosomes ejected by them to neurons [4, 8].

Another vicious circle is triggered: neurons generate weaker signals that control delta - oscillations of the bloodstream in slow sleep - the glymphatic system works worse - this further increases the self-poisoning of astrocytes.

In the toxic cerebrospinal fluid, oligodendrocytes begin to die, and the survivors cannot sufficiently ensure the previous myelin isolation of the axons. Axonal dyelinsation triggers three more vicious circles. The axons deprived of myelin begin to contact each other. There is a so-called "worn-out wire symptom". At the initial stage, when the energetic capabilities of neurons are still sufficient, this gives rise to non-trivial thoughts, "brilliant" solutions. When the energy potential of neurons decreases significantly, this leads to philosophical intoxication, fruitless philosophizing, and the formation of delusional ideas.

The neural impulse, normally rapidly running along the interceptions of Ranvier, loses its former speed after the thinning of the myelin sheath. Clinically, this is expressed in getting stuck, "stopping thoughts", "stealing thoughts", loss of the ability to follow the thoughts of the interlocutor.

Difficulties arise with orientation in the social space.

The very first thing that happens due to the loss of the myelin sheath by axons is the dispersion of the impulse. Clinically, this is manifested by attention disorder, difficulty concentrating, inability to concentrate. Instrumentally, this phenomenon is recorded by a decrease in pre-pulse inhibition (PPI) indicators down to negative values. This simple test also detects decreased attention in blood relatives of F20 patients. It is on the basis of low PPI values that volunteers and laboratory mice are selected for the study of schizophrenia.

We take the liberty of proposing a pathogenetic model capable of uniting and connecting logically most of the existing autoimmune, neurotransmitter, infectious, genetic and other hypotheses based on experiment [21]. The pathogenesis is based on the genetic vulnerability of astroglia. We cannot change genes and we cannot save the patient from a possible next attack either. But! ... that trying to bring the immune balance back to normal using cytokines, we often achieve clinical success. Three years ago, we built the first working model of the pathogenesis of schizophrenia [21]. In this article, we finalized some important details and tried to prove the central idea - **by restoring the cytokine balance, we act on the root cause of schizophrenia - ASTROGLIA, which cannot cope with the modulation of interneuronal synapses.** As soon as we manage to harmonize astroglia, the delta sleep organized by it is restored, the brain gets rid of toxins, astrocytes cease to "nightmare" interneuronal synapses, the sensitivity of synapses to dopamine and other mediators tends to normal, and we get a stable clinical remission.

The vulnerability of glia is genetically inherited, the cellular structures of which in the central nervous system are quantitatively many times superior to neurons.

Now let's try to present the whole process once again, but succinctly and consistently: astrocytes, putting out tightly closed "legs" from all sides, close the brain with their bodies from the penetration of foreign substances. The dense structure of astrocytic legs is immersed in the cerebrospinal fluid. Liquor flows like a river washing the bank. Astrocytes take from the cerebrospinal fluid and pass everything they need through their body, all waste products of metabolism are sent to the same cerebrospinal fluid. By contracting and swelling in groups (domains), astrocytes largely contribute to the advancement of the cerebrospinal fluid through the glymphatic system, regulating the flow rate of the "river" of cerebrospinal fluid. It is the acceleration of the flow of cerebrospinal fluid that is the main purpose of delta sleep. The legs of astrocytes are ex-

posed to an autoimmune attack. This introduces an imbalance in the work of the gap calcium channels and disrupts the connections between the legs. [2,10] Harmonious domain contractions and swelling give way to chaos. The movement of the cerebrospinal fluid is greatly slowed down, and in some areas it stops altogether. Virchow-Robin's perivascular spaces expand in problem areas [2]. On MRI, we record this phenomenon as gliosis. With each beat of the pulse, the amount of cerebrospinal fluid in the ventricles increases, and the throughput of the glymphatic system in schizophrenia is reduced - as a result, the pressure in the ventricles increases, **the plexuses become coarser, the ventricles expand. This is clearly seen on MRI [6].** Moreover, the cerebrospinal fluid almost does not carry away metabolic products. These products accumulate and, according to the principle of a vicious circle, poison astrocytes for the second time, since astrocytes still pass toxic liquor through their bodies. As a result, the number of ribosomes in astrocytes decreases and they have nothing to energetically support neurons with [2,15]. Clinically, this is manifested by irresistible weakness, a drop in motivation, and autism. Compensation of delta sleep in schizophrenia is not possible due to the defeat of the same astrocytes and self-poisoning of the brain is increasing all the time. Oligodendrocytes are the first to die. The isolation of axons is impaired, which causes dispersion of the axonal signal and decreases its velocity. We clinically define this as a drop in attention, inability to concentrate, slipping, etc. Instrumentally we fix a decrease in PPI down to negative values. It is this test that serves as a criterion for the diagnosis of schizophrenia in mice in antipsychotic trials. As you can see, astroglia is at the center of pathogenesis. The process begins with it, it also becomes a victim of this process and, becoming such, launches a whole series of destructive vicious circles, in which the rest of the glial cells are directly involved. In this case, neurons also suffer, but they almost do not die, but remain practically in the same number as at the beginning of the process. Therefore, the patients retain their intellect, but they live simultaneously in two worlds - an illusory hallucinatory and a forced real, especially in a physiological sense. Astroglia is capable of reproduction, proliferation. This stretches the process over time. Occasionally it can even lead to spontaneous remissions.

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OXIDATION-REDUCTION (REDOX) REACTIONS IN ORGANIC CHEMISTRY

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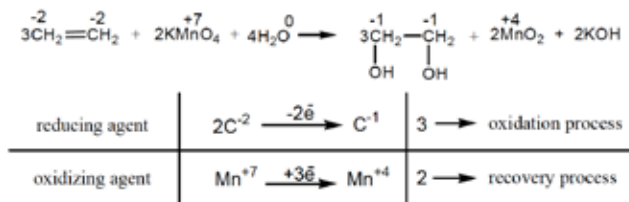
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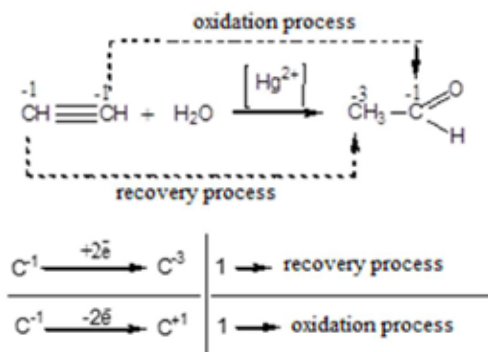
This article is devoted to the explanation of redox reactions (OVR) found in school organic chemistry. In this article, as well, a determination is made of the degree of oxidation of elements in a convenient way in organic compounds. The main dryness of OVR in organic chemistry is clarified, it is proved that some reactions that are not OVR at first glance are actually OVR, and examples are shown on this subject.

Keywords: oxidizing agent, reducing agent, oxidation process, reduction process, intramolecular redox reaction, intermolecular redox reaction, oxidation state

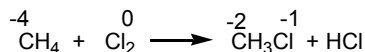
In organic chemistry, oxidation-reduction reactions (ORR) are also reactions that change the oxidation state. Oxidation and reduction processes, related processes. Since, the electrons transferred by the reducing agent are taken by the oxidizing agent. In organic chemistry, too, there are many redox reactions [1-5]. For example:



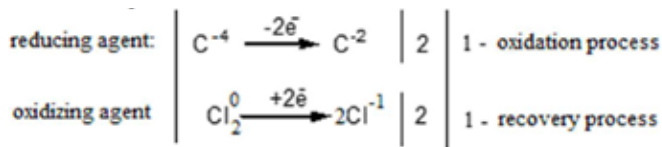
Halogenation, dehydrogenation, oxidation of alkanes, reactions of alkenes with halogens, hydrogen, oxidizing agents and other reactions are referred to as oxidation-reduction reactions. At first glance, some organic reactions do not belong to oxidation-reduction reactions, but in fact, with a deep analysis, it becomes clear that they are intramolecular oxidation-reduction reactions. For example, despite the fact that the catalytic hydration of acetylene at first glance cannot be considered as an oxidation-reduction reactions (ORR), in fact, this reaction can be considered an intramolecular ORR, since it occurs with a change in the oxidation state of carbon atoms:



As already noted, reactions with a change in the oxidation state are called oxidation-reduction reactions. For example:

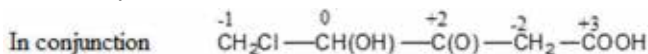


In this reaction, CH_4 is a reducing agent and Cl_2 is an oxidizing agent. Since the oxidation state of the C atom in methane increases from -4 to -2, i.e. it, having given two electrons, is restored. The oxidation state of the chlorine atom in the chlorine molecule decreases from 0 to -1, i.e. it, accepting one electron is restored (and 2 Cl atoms takes 2 electrons). The electronic equations of this reactions:



It should be noted that the oxidation state of a carbon atom can be any value from -4 to +4 (even 0 and a fractional value). In the molecule of any organic compound, carbon atoms can have different oxidation states.

The oxidation state of elements, especially carbon atoms in organic compounds, is usually determined by recording the structure of the compounds. For example:



The oxidation state of the 1-st carbon atom +3;

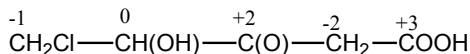
The oxidation state of the 2-nd carbon atom -2;

The oxidation state of the 3-rd carbon atom +2;

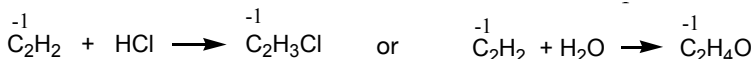
The oxidation state of the 4-th carbon atom 0;

The oxidation state of the 5-th carbon atom is -1.

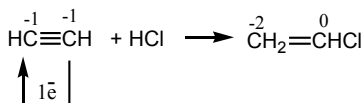
Thus, when determining the oxidation state of each carbon atom in a molecule, all C-C bonds are considered non-polar, and C-E (where E represents any chemical element) bonds are considered polar. Comparing the electronegativity of the element E with the electronegativity of C, using its oxidation state, the oxidation state of the carbon atom with which it is directly connected is determined by calculation. It also takes into account - I, -M and + I, + M effects of atoms and functional groups. For example:



As in inorganic chemistry, in organic chemistry, oxidation-reduction reactions also obey general principles and rules: their classification, the method of electronic balance in the equalization of the reaction, etc. But there are some differences; since, oxidation-reduction processes in organic chemistry are primarily considered in accordance with a given organic compound and is associated with a change in the oxidation state of the carbon atom, which is the reaction center in the molecule. These reactions can occur as a result of fusion, rupture, substitution, and other types. For example, the hydration of acetylene (Kucherov's reaction) or the reactions of its combination with HCl, at first glance, are not considered oxidation-reduction reactions:

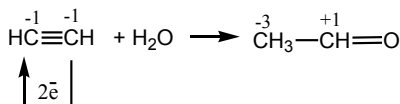


In fact, both of these reactions are intramolecular oxidation-reduction reactions:



In this reaction, the first carbon atom gives one electron to the second carbon atom, as a result, between the 1st and 2nd carbon atoms, an intra-

molecular electronic transition (migration) occurs, the first carbon atom is oxidized (that is, acts as a reducing agent), and the second carbon atom is reduced (that is, acts as an oxidizing agent). A similar thing also happens in Kucherov's reaction:



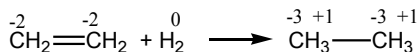
Often, oxidation-reduction reactions in organic chemistry are accompanied by the combination of the substrate with hydrogen or oxygen atoms (respectively, hydrogenation or oxidation and combustion reactions) or reactions with their detachment from the substrate (respectively, dehydrogenation or deoxidation reactions).

There are many examples of ORR in organic chemistry:

1. Hydrogenation of hydrocarbons (hydrogenation of double and triple bonds) - in these reactions, the substrate (here, the substance that reacts with H_2) is reduced (is an oxidizing agent), and hydrogen (here it is a reagent) is oxidized (is a reducing agent). These types of reactions include:

1. Hydrogenation of hydrocarbons:

a) Hydrogenation of alkenes. For instance:

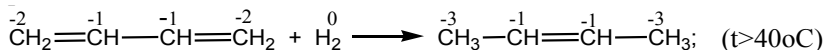


Ethylene homologues are hydrogenated at different rates, depending on their structure. Since, with a double bond, an increase in the number of substitutes significantly reduces the reaction rate. The decrease in the rate of hydrogenation of ethylene hydrocarbons occurs as follows:

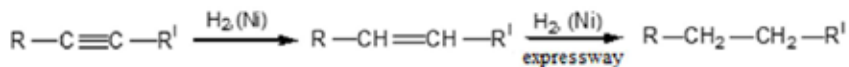


b) Hydrogenation of alkadienes - in the reaction of H_2 with bound alkadienes in a 1:1 molar ratio, in the state of 1,2- and 1,4-, the yield of the compound products mainly depends on the temperature. When the temperature increases ($t > 40^\circ\text{C}$), the yield of the compound product in the 1,4- state decreases, and when it decreases ($t < 0^\circ\text{C}$) in the 1,2- state, it increases.

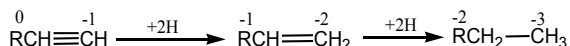
For instance:



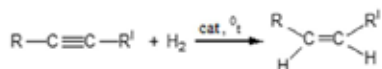
c) hydrogenation of alkynes.



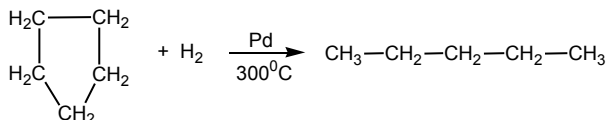
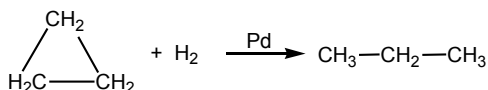
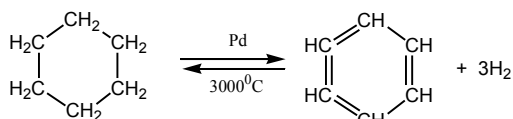
Acetylene is readily hydrogenated. On platinum soot or with the participation of Raney nickel, the process of conversion to ethane takes place. Thus, depending on the nature of the catalyst and the conditions for the hydrogenation of alkynes, the reaction can be carried out in stages:



With the participation of a Lindlar catalyst (Pd, PbO and CaCO₃), alkynes can be reduced to alkenes (cis compound to a triple bond):



d) Hydrogenation of cycloalkanes - three-, four- and five-membered cycloalkanes are catalytically hydrogenated - the cycle opens, 1 mol of H₂ is combined and the corresponding alkane is obtained. As the cycle grows, the connection becomes more difficult. When cyclohexane is heated with hydrogenation catalysts, it dehydrates, aromatizes, and turns into benzene:



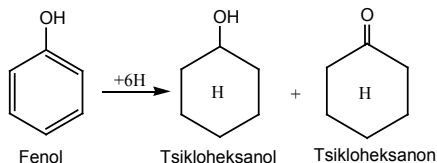
e) Hydrogenation of arenes - at normal pressure benzene on a nickel catalyst at 200-220°C 80-90% is hydrogenated with cyclohexane (reduced - is an oxidizing agent):



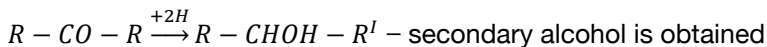
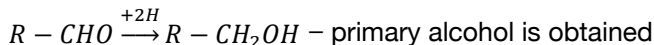
2. Hydrogenation of oxygen compounds:

a) hydrogenation of phenols:

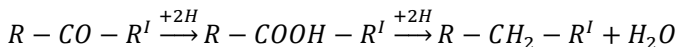
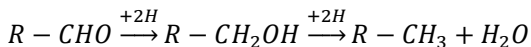
Catalytic hydrogenation of phenol can be carried out on a nickel catalyst at 180°C or under hydrogen pressure in the liquid phase. As a result, in addition to cyclohexanol, a small amount of cyclohexanone also appears:



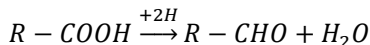
a) Hydrogenation of aldehydes and ketones - in reactions with the reduction of hydrogen with oxygen-saving groups interact with - carbonyl-, carboxyl-, nitro-, etc. and reduce them. There are reductive reactions with the release and non-release of water. Reactions with the reduction of aldehydes and ketones on alcohol are reductive reactions with no release of water:



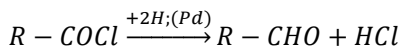
The complete reduction of aldehydes and ketones to hydrocarbons is accompanied by the separation of water:



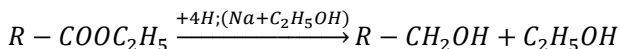
Since the carboxyl group is highly stable, it is practically impossible to carry out the reactions of acids with reduction to aldehydes according to the following scheme:

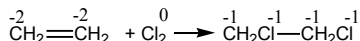


However, catalytic reduction of acid chlorides with hydrogen is possible:

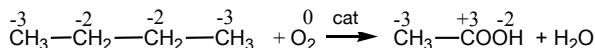
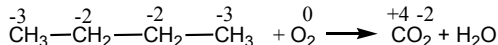


By the Bouveau-Blanc method, carbon dioxide esters can be reduced to alcohol by boiling sodium in anhydrous alcohol:

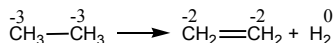




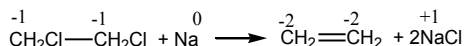
7. Complete combustion and catalytic oxidation reactions. For example:



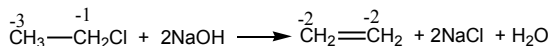
a) dehydrogenation reactions. For example:



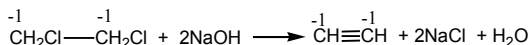
b) dehalogenation reactions. For example:



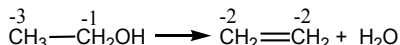
c) reactions of dehydrohalogenation of monohalogen derivatives. For example:



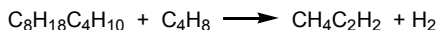
However, the dehydrohalogenation reactions of dihalogen derivatives are not OBR. For example:



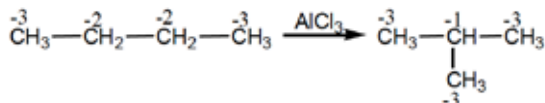
e) dehydration reactions. For example:



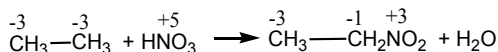
f) cracking and pyrolysis reactions. For example:



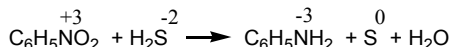
8. Isomerization reactions can also be considered intramolecular as OBR. For example:



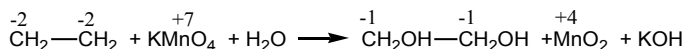
9. Nitriding reactions. For example:



10. Zinin reaction - reduction of nitro compounds to amines. For example:



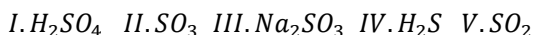
11. Wagner reaction - acidification of ethylene with an aqueous solution of KMnO_4 :



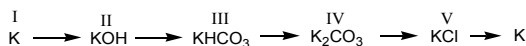
In organic chemistry, many other examples of reactions related to ORR can also be cited.

Exercises

1. With what simple substances is hydrogen an oxidizing agent? Give examples and write down the reaction equations.
2. In what ways is chlorine a reducing agent? Give examples and write down the reaction equations.
3. What simple substances are only reducing agents? Give examples and write down the reaction equations.
4. Which ions are only an oxidizing agent? Give examples and write down the reaction equations.
5. Which ion is both an oxidizing agent and a reducing agent? Give examples and write down the reaction equations.
6. In what substances does sulfur have the highest - maximum and lowest - minimum oxidation state:

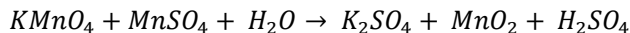


7. What is the oxidation state of the phosphorus atom in position $3s^1 3p^3 3d^1$?
8. At what stages in the scheme are oxidation-reduction processes observed:



Write down the reaction equations and justify your answer.

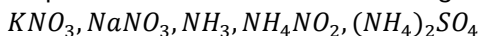
9. Determine the coefficients of the oxidizing agent and reducing agent:



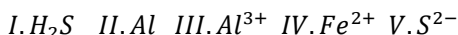
10. In which compound the oxidation state of nitrogen is maximum:



11. In which compound the oxidation state of nitrogen is the minimum:



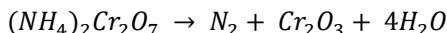
12. What is only a reducing agent:



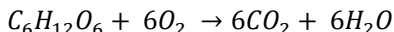
13. What is only an oxidizing agent?

I. H_2S II. H_2 III. HNO_3 IV. Cl_2 V. Al^{3+}

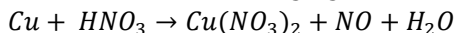
14. Determine the number of electrons that the oxidizer receives in this reaction:



15. Determine the number of electrons that the reducing agent transfers in this reaction:



16. Determine the mass of the acid and the coefficient in the reaction equation used to oxidize 2 mol of reducing agent:



17. Place the coefficients using the electronic balance method:

- 1) $NH_3 + O_2 \rightarrow NO + H_2O$ 2) $PH_3 + Cl_2 \rightarrow PCl_3 + HCl$
3) $CH_4 + Cl_2 \rightarrow CCl_4 + HCl$ 4) $CuO + NH_3 \rightarrow Cu + N_2 + H_2O$
5) $P + N_2O \rightarrow N_2 + P_2O_5$ 6) $NO_2 + H_2O \rightarrow HNO_3 + NO$

18. How many g of dry residue will remain in the pot when 24.5 g of Berthol's salt is split in an open pot?

19. Place the coefficients using the electronic balance method:

- 1) $KMnO_4 + K_2SO_3 + H_2SO_4 \rightarrow MnSO_4 + K_2SO_4 + H_2O$
2) $KMnO_4 + K_2SO_3 + H_2SO_4 \rightarrow MnO_2 + K_2SO_4 + KOH$
3) $KMnO_4 + K_2SO_3 + KOH \rightarrow K_2MnO_4 + K_2SO_4 + H_2O$
4) $KMnO_4 + H_2S + H_2SO_4 \rightarrow MnSO_4 + K_2SO_4 + S + H_2O$
5) $K_2Cr_2O_7 + SO_2 + H_2SO_4 \rightarrow Cr_2(SO_4)_3 + K_2SO_4 + H_2O$
6) $K_2Cr_2O_7 + KJ + H_2SO_4 \rightarrow Cr_2(SO_4)_3 + K_2SO_4 + J_2 + H_2O$
7) $K_2Cr_2O_7 + H_2S + H_2SO_4 \rightarrow Cr_2(SO_4)_3 + K_2SO_4 + S + H_2O$

20. Determine in which reactions hydrogen peroxide is an oxidizing agent, and in which it is a reducing agent, and set the coefficients using the electronic balance method:

- 1) $KJ + H_2O_2 \rightarrow J_2 + KOH$
2) $J_2 + H_2O_2 \rightarrow HJO_3 + H_2O$
3) $HClO + H_2O_2 \rightarrow HCl + O_2 + H_2O$

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**THE RESULTS OF TREATMENT FOR MASTITIS-METRITIS-
AGALACTIA SYNDROME IN PIGS IN THE CONDITIONS OF THE
"RZHEVSKY BACON" SUBDIVISION OF THE "AGROFIRMA
"DMITROVA GORA" JSC, TVER OBLAST**

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The effectiveness of the treatment used is 69.77% on average over three years, largely dependent on the correct obstetrics by veterinary specialists, as well as on the correctly selected veterinary drugs.

Thus, the causes of the MMA syndrome, in our opinion, are year-round keeping of sows without walking, a concentrate type of feeding, the placement of large livestock in limited areas, the joint stay of sick and healthy animals in maternity wards. But the main direct etiological factor in the occurrence of postpartum diseases in sows is their injury and seeding with opportunistic microflora during farrowing.

Keywords: Sows, metritis, mastitis, agalactia, mma syndrome, uterus.

Introduction

Under the conditions of industrial technology for the production of pork, free and fixed keeping of sows, as well as a concentrated type of feeding of pigs on reproductive farms, often lead to postpartum diseases in sows, which are registered in 30-50% animals [1,2].

A significant inhibitor of the rate of reproduction of pigs is the mastitis metritisagalactia syndrome (MMA) in sows. MMA syndrome occurs in the postpartum period, when the genitals and mammary glands are infected with diplo, staphylostreptococci, Escherichia coli, or mixed microflora [2,3].

Relevance of the problem

Diseases of the reproductive system in broodstock pigs are widespread and cause great economic damage to pig breeding. Therefore, the study of the spread of postpartum pathology in the form of metritis-mastitis-agalactia syndrome remains relevant.

Material and research methods

The research was carried out in Tver Oblast at the Agrocomplex "Dmitrova Gora" branch of "Rzhevsky Bacon", located in the village of Glebovo, which is 15 kilometers from the city of Rzhev.

The object of research is sows of large white breed. The main indicators of therapeutic efficacy were the duration of the course of treatment, the percentage of recovery; when analyzing the prophylactic efficacy of drugs, the percentage of manifestation of postpartum diseases after the use of the drug for prophylactic purposes was calculated [5,6].

The research results were subjected to statistical processing in accordance with the instructions of N.A. Plokhinsky (1969) and G.F. Lakina (1990) using the Microsoft Excel XP software package.

Research results and discussion

Table 1 - Clinical status of healthy and sick animals

Indicators	Healthy animals	MMA
Temperature, °C	39.2±0.08	40.6 ±0.3
Pulse beats per minute	63.3±0.8	72.08±0.7
Breath per minute M±m	17.5±0.3	21.4±0.2
Farrowing time minutes M±m	177.2±3.5	206.6±0.8
Time of disease onset/days after farrowing	-	2.6±1.7
Discharge/days after farrowing	-	2.4±0.4
Onset of mastitis/days after farrowing	-	2.5±0.6

The duration of farrowing in healthy sows averaged 177.2 ± 3.5 minutes; in sows who subsequently developed MMA disease, the duration of farrowing averaged 206.6 ± 0.8 minutes.

Research results show that temperature, pulse and respiration in sows with MMA disease did not change significantly.

MMA syndrome is a common disorder of the reproductive system resulting in decreased productivity, agalactia and hypogalactia. Based on the data in Table 1, with the disease, an increase in the body temperature of the animal is noted, there may be a loss of appetite, general depression, subsequently purulent discharge appears, sometimes with an admixture of blood. Subsequently, inflammatory diseases develop in the udder and mastitis develops.

Treatment of sows should be aimed at stopping the development of the pathological process in the animal's body in a short time, restoring the general condition, taking feed and water. For this, the following means are used: "Amoxicillin", "Kobaktan", "Dexa VMD".

Table 2 - Treatment regimen for postpartum diseases

Drug	Method of drug administration	Dose	Days
"Amoxicillin"	Intramuscularly or subcutaneously	20 ml every 48 hours	3-5
"Kobaktan"	Intramuscularly	16 ml with an interval of 24 hours	3-5
"Dexa VMD"	Intramuscularly	10 ml	once

The main indicators of therapeutic efficacy were the duration of the course of treatment, the percentage of recovery; when analyzing the prophylactic efficacy of drugs, the percentage of manifestation of postpartum diseases after the use of the drug for prophylactic purposes was calculated.

Table 3 - The effectiveness of therapy for MMA syndrome of pigs

Indicators	2019
Number of animals in the group, heads	2386
The number of recovered, heads	1663
The effectiveness of therapy, %	69.7
The number of successfully inseminated from the 1st time, %	76
Preservation of young animals, %	84.1
Average weight of a piglet at the time of weaning, kg	8.0

As can be seen from the data presented, MMA syndrome is quite treatable. And although the microbial factor in this disease is the leading one,

it is not enough to use antimicrobial agents alone. Treatment of animals should be comprehensive, aimed at suppressing the inflammatory process in the mammary glands and genital tract.

Table 4 - The effectiveness of therapy for postpartum diseases

Indicators	Far-rowed, heads	Infected		Recovered		Rejected		
		heads	%	heads	%	heads	%	% of farrowed
2017	9201	1273	13.83	904	71.01	369	28.99	4.01
2018	10845	1654	15.25	1140	68.92	514	31.08	4.74
2019	12356	2386	19.31	1663	69.7	723	30.3	5.85
Total	30402	5313	17.48	3707	69.77	1606	30.23	5.28

The effectiveness of the treatment used is 69.77% on average over three years, largely dependent on the correct obstetrics by veterinary specialists, as well as on the correctly selected veterinary drugs.

According to table 4, it can be seen that the number of cull animals from farrowing over three years was 5.28% and varied within 4.01% - 5.85% in 2017 and 2019, respectively.

These data are presented more clearly in figure 1.

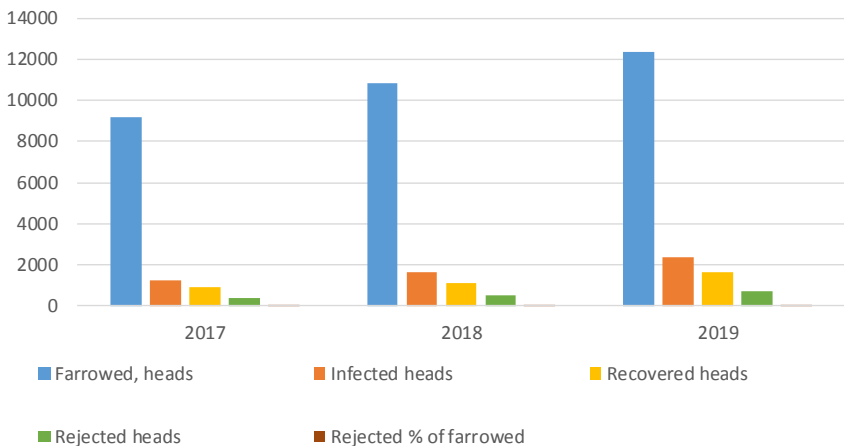


Figure 1 - Dynamics of rejection of animals with postpartum diseases of sows in 2017-2019

Conclusions

Thus, the causes of the MMA syndrome, in our opinion, are the year-round keeping of sows without walking, the concentrated type of feeding, the placement of large livestock in limited areas, the joint stay of sick and healthy animals in maternity hospitals.

But the main direct etiological factor of the occurrence of postpartum diseases in sows is their trauma and sowing with opportunistic microflora during farrowing.

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RESEARCH OF THE DURABILITY OF HYDRAULIC TECHNICAL CONCRETE OF TUNNELS OF HYDRO POWER PLANTS

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The article summarizes the results of testing the durability of concrete in the construction tunnel of the HPP. In the composition of the original concrete, chemical additives from sulphite-yeast mash and organosilicon liquid were used, which contributed to the formation of a high-density structure, providing a significant increase in the strength of concrete under conditions of long-term operation of the tunnel.

Keywords: chemical additives, concrete, cement, strength, durability, corrosion.

During the operation of hydraulic structures under the influence of ground saline waters and other aggressive substances, concrete can undergo corrosive destruction, leading to a premature loss of its durability. Usually, to prevent the corrosion destruction of concrete, chemical and mineral additives are introduced into its composition at the preparation stage, which can regulate the processes of structure formation of cement stone to increase its impermeability [1]. In this work, the effectiveness of additives for increasing the durability of hydraulic concrete structures is confirmed by testing the strength of samples of industrial concrete of twenty-two years of age.

The concreting of the tunnels was carried out from hydro-technical concrete of classes B15, B22.5 and B30. Sulphate-resistant cement M400 and aggregates from heavy rocks of local deposits were used in the concrete compositions. Hydraulic concrete compositions are: 1) M200 (class B15) - 1:2.29:2.79 (cement M400: sand: crushed stone) with a specific consumption of cement $C = 350 \text{ kg/m}^3$ and $W/C = 0.609$; 2) M300 (class B22.5) - 1:1.69:1.84 (cement M400: sand: crushed stone) with a specific cement consumption $C = 448 \text{ kg/m}^3$ and $W/C = 0.507$; 3) M400 (class B30) - 1:1.06:1.92 (cement M400: sand: crushed stone) with a specific

consumption of cement $C = 543\text{kg/m}^3$ and $W/C = 0.416$. Dimensions of aggregates: sand - 0.14–5 mm; crushed stone - 50% from the fraction 5–20 mm and 50% from the fraction 20–40 mm. The design compositions of these concrete mixtures without plasticizing additives had an initial mobility in the draft of a standard cone of 2–4 cm, however, when they were used for concreting tunnels, chemical additives were introduced into their composition: sulphite yeast mash (SYM) as a plasticizing additive and an organosilicon liquid of the type HOL for concrete hydrophobization. The consumption of chemical additives was, respectively, for SYM -0.2%, and for organosilicon fluid - 1.5% each in the compositions of concretes M200 and M300 and 2% of the mass of cement in the composition of concrete M400. As a result of the action of chemical additives, concrete mixtures were plasticized, and their mobility corresponded to 18 - 22 cm in the draft of a standard cone.

As in any facility built in a mountainous area, the concrete of the tunnels is affected by groundwater, frequent changes in humidity and temperature, power loads from the movement of vehicles along them and other negative factors leading to aging and destruction of concrete. The influence of groundwater is especially strong, which can cause corrosion of the cement stone in the concrete, leading to structural destruction of the concrete layer of the tunnels.

The condition of these tunnels was examined, including the experimental determination of the strength characteristics of concrete. For this, according to the scheme in fig. 1 according to the method [2], cylindrical core samples were drilled and their strength was tested by compression on a hydraulic press. The actual strength of the concrete was calculated from the strength values of the samples. The density of the concrete at the time of testing was also determined. Fig. 1 shows photographs of core drilling and strength testing. The compositions of concrete, sampling sites and the results of testing the density and strength of concrete samples are given in tab. 1 and 2.

Comparison of the results of Table 1 shows that over the past time, the strength of concrete M300 (class B22.5) has increased significantly. The increase in concrete strength ranges from 73.9% to 175.3%. The same regularity of strength increase is observed for concrete of construction tunnel №2.

Table 1
Composition of concrete, sampling sites and results of testing the density and strength of concrete samples of a construction tunnel

№	Concrete sampling point	Concrete sampling depth, m	Geometric parameters of the sample		Physical parameters of the sample		Compressive strength test results of a concrete sample					Actual brand and grade of concrete	Design brand and grade of concrete	Increase in concrete strength, %
			Diameter, mm	Height, mm	Weight, g	Density g/cm³	Destructive force, N	Concrete core strength, MPa	Coefficient α	Coefficient η_1	Actual concrete strength, MPa			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	PC 4 + 75 vault	1	88	180	2535	2.316	290814	47.83	1.0	1.2	57.40	M550 B40	M300 B22.5	91.3
2		88	180	2610	2.385	328568	54.04	64.85			M600 B45	116.2		
3		88	180	2595	2.371	329589	54.21	65.05				116.8		
4		88	161	2400	2.451	349997	57.57	62.93			109.8			
5	PC 5 + 75 vault	1	88	179	2620	2.407	264284	43.47	1.2	52.16	M550 B40	M800 B60	73.9	
6		2	88	181	2670	2.426	418364	68.81			82.57		175.3	

Table 2
Composition of concrete, sampling sites and results of testing the density and strength of concrete samples of a construction tunnel

№	Concrete sampling point	Concrete sampling depth, m	Geometric parameters of the sample		Physical parameters of the sample		Compressive strength test results of a concrete sample					Actual brand and grade of concrete	Design brand and grade of concrete	Increase in concrete
			Diameter, mm	Height, mm	Weight, g	Density g/cm ³	De-structive force, N	Concrete core strength, N	Coefficient α	Coefficient η_1	Actual strength of concrete, N			
1	2	3	5	6	7	8	9	10	11	12	13	14	15	16
1	PC 0+25	1	87	167	2600	2.36	290000	48.82	1.0	1.2	58.59	M600 B45	M300 B22.5	86.12
2	wall	2	88	184	2610	2.33	248750	40.98			49.18	M450 B35	M200 B15	145.9
3	PC 0+25	1	87	185	2645	2.40	305000	51.35	1.0	1.2	61.62	M600 B45	M300 B22.5	105.4
4	vault	2	87	184	2580	2.36	137500	23.15			27.78	M300 B22.5	M200 B15	38.9
5	PC 1+05	1	87	170	2480	2.45	230000	38.72	1.0	1.2	46.47	M450 B35	M300 B22.5	54.9
6	wall	2	87	182	2605	2.40	225000	37.88			45.46	M450 B35	M200 B15	127.4
7	PC 1+05	1	86	180	2475	2.36	307500	53.02	1.0	1.2	63.62	M600 B45	M300 B22.5	112.1
8	vault	2	86	182	2502	2.37	290000	50.0			60.00	M600 B45	M200 B15	200.0

9	PC 1+85 wall	1	87	189	2665	2.37	295000	49.66	1.0	1.2	59.60	M600 B45	M300 B22.5	98.7
10		2	87	180	2595	2.42	285000	47.98			57.58	M550 B40	M200 B15	192.8
11	PC 1+85 vault	1	87	185	2595	2.36	178750	30.09			36.11	M350 B25	M300 B22.5	20.4
12		2	87	181	2540	2.36	177500	29.88			35.86	M350 B25	M200 B15	79.3
13		1	88	182	2650	2.39	275508	45.31			54.38	M550 B40		36.0
14	PC 0+25 tray	2	88	180	2640	2.41	280610	46.15			55.38	M550 B40		38.5
15		5	88	181	2570	2.34	234692	38.60			46.32	M450 B35		15.8
16		6	88	180	2530	2.21	185713	30.54			36.65	M350 B25	M400 B30	-8.4
17		1	87	179	2560	2.41	221427	37.28	1.0	1.2	44.73	M450 B35		11.8
18	PC 1+05 tray	2	88	181	2640	2.40	225508	37.09			44.51	M450 B35		11.3
19		5	88	176	2610	2.44	242855	39.94			47.93	M450 B35		19.8
20		6	88	180	2690	2.46	314283	51.69			62.03	M600 B45		55.1

Thus, the increase in strength of M200 concrete ranges from 38.9 to 200%, M300 concrete - from 20.4 to 112.1%, and M400 concrete - from 11.3 to 55.6%. In only one case, concrete has a low strength compared to the project: on PC 0 + 25, a core taken from a depth of 6 m showed strength of 36.65 MPa versus 40 MPa according to the project.

The increase in the strength of concrete can be explained by the influence of its age and the actions of the applied chemical additives: over a period of more than 20 years, more complete hydration of cement occurred in the structure of concrete, which ensured high concrete strength.

However, in our opinion, the main contribution to the increase in the strength of concrete, especially to high values, belongs to the chemical additives SYM and organosilicon liquid, introduced into the composition of the concrete mixture when concreting tunnels. The plasticizing effect of the applied chemical additives promoted the most complete hydration of the cement, leading to the formation of a high-density structure of the cement stone, which, in turn, ensured high concrete strength. The hydrophobizing effect of the organosilicon liquid also contributed to the increase in the durability of concrete.

It should be noted that when taking core samples from the concrete of the tunnel structures, no signs of cement stone corrosion were found: there are no signs of cement stone corrosion on the concrete surface, efflorescence from calcium carbonate and surface rejection of the concrete layer. The structure of the concrete was not damaged and the integrity of the coating in the tunnels was preserved. After testing concrete samples in their internal structures, no traces of corrosion of the cement stone were also found, which indicates a high impermeability of the concrete layer for filtering water through its thickness.

High strength and impermeability of the concrete layer ensured durability and operational stability of the tunnels.



a)



b)



c)



d)

Fig. 1. Photos of sampling and testing of concrete samples for strength: a) – drilling of concrete cores; b) – measurement of the core length; c) – core samples; d) – test of the strength of the concrete core

The obtained actual characteristics of concrete properties of 22 years old HPP tunnels, on the one hand, indicate the high quality of the construction work performed at this facility, on the other hand, confirm the effectiveness of modifying concrete with chemical additives to increase their resistance in aggressive environments. Both factors ultimately led to an increase in the durability of concrete structures, capable of ensuring the reliability and safety of the hydropower plant in the future.

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**STUDY OF THE STRUCTURE, PATTERN AND PROPERTIES OF
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This work concerns the study of the structure and properties of wear-resistant layers obtained by thermochemical treatment, in particular, to boronized layers. The main direction of the work was to reduce the fragility of boride layers by their fragmentation and dispersion, both by traditional methods of obtaining diffusion layers and by combined methods, which consist in additional processing of previously obtained layers with concentrated heating sources. Laser and electron-beam heating were used as such sources. The analysis of the mechanism of the formation of boronized layers at different temperatures and technologies showed wide possibilities of varying the phase composition and structure in order to ensure the specified operational properties. The most reliable information on the qualitative and quantitative phase composition of the composite boronized layers was obtained using Mössbauer spectroscopy. A detailed study of the dynamics of changes in the morphology of boronized layers during combined processing made it possible to recommend modes of exposure to concentrated sources for using the obtained structures under certain operating conditions. In the conclusion, a method is given for calculating the comparative wear resistance, based on the specific

characteristics of the layer and the degree of their change (hardness, relative elongation and shear stress) and the specified operating conditions (contact stresses, sliding speed and coefficient of friction).

Keywords: Boronized layers, fragility, fragmentation, dispersion, structure morphology, phase composition, Mössbauer spectroscopy, combined processing, laser heating, electron beam processing, hardness, shear stresses, comparative wear resistance, calculation method.

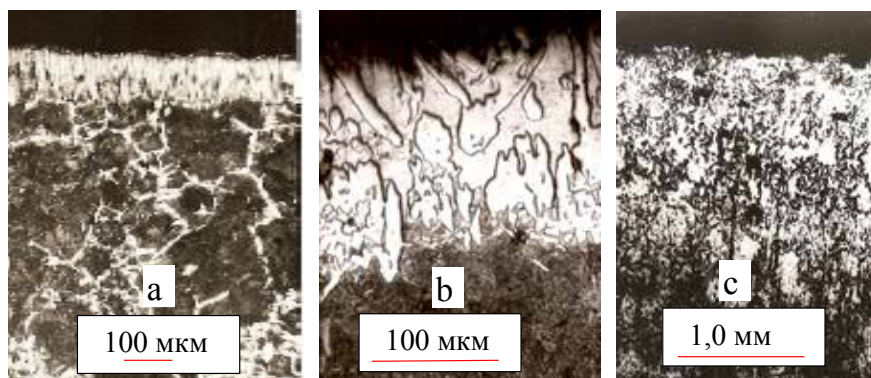
1. Introduction

The formation of diffusion borated layers with different processing methods proceeds according to two mechanisms: diffusion at low-temperature and medium-temperature saturation in the solid state of the layer formation zone and diffusion-crystallization at high-temperature borating in the liquid-crystalline state of the layer formation zone.

Without focusing on the temperature ranges and the state of aggregation of the zone of formation of layers, described in detail in the literature [1 - 5], we consider it appropriate to analyze the features of the study of layers with different structural morphology and properties.

2. Study of the morphology of borated layers

The operational properties of heterogeneous borated layers depend on the size, quantity, shape and mutual arrangement of phases and structural components. At the same time, the compositional heterogeneous structure of the borated layer makes it possible not only to increase its plasticity, but also to maintain its high wear resistance (Fig. 1).



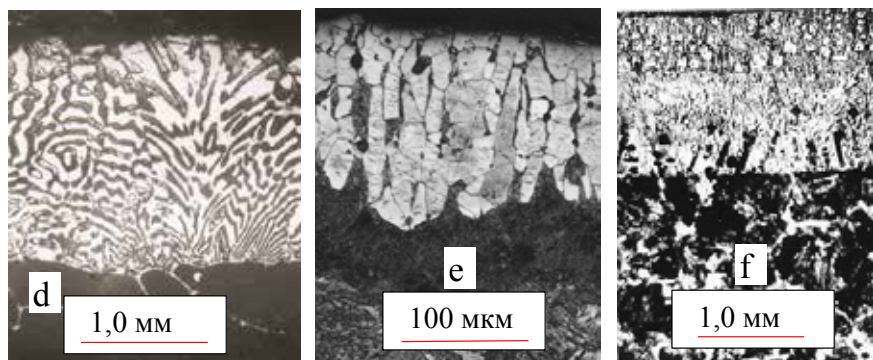


Fig. 1 Structures of boronized layers: a compact layer based on borides (a); layer with separated borides (b), pseudo-eutectic heterogeneous layer (c); eutectic heterogeneous layer (d); fragmented boride layer after laser treatment (e); heterogeneous layer after electron beam treatment:

$$R_{e.b.power} = 2.9 \times 10^4 \text{ W / cm}^2; T_{treat} = 1050 - 1100 \text{ }^\circ\text{C}, 50 \text{ s (f)}.$$

The layers were obtained in powder mixtures based on boron carbide (B_4C) at 950°C (a, b, e) and at a temperature of 1100°C (c, d, f). The composite structure was obtained using various methods, including the use of laser and electron beam heating. With the use of these types of heating, borated layers are obtained both by a direct method from mixtures and by a combined method, which consists in additional processing of borated layers obtained by different methods. The main task of using concentrated energy sources is the design of a layer with separated borides. In this case, it is expedient to replace the compact acicular or globular structure of borides with a dispersed one with an arbitrary orientation of borides.

All this makes it possible to control the properties of the borated layers. However, a reliable predictive calculation of performance requires reliable information on the phase composition and number of phases.

One of the structural components of composite layers is the eutectic component. An important stage in predicting the general structure of the layer and the formation of the eutectic component is reliable information about the temperature and concentration conditions on the treated surface, which are determined from the polythermal sections of the schemes of multicomponent state diagrams [4, 5]. The temperature of the eutectic reaction and the eutectic concentrations of the components in multicomponent systems were calculated using the statistical method [6], which uses only the melting temperatures of the phases included in the eutectic.

3. Determination of the phase composition of the layers

According to the results of X-ray diffraction phase analysis, the boride layers consist of the following phases: FeB, Fe₂B, Fe₃B, and α — a solid solution of boron in iron. When processing alloy steels, these phases contain alloying elements. The intensity of the reflection lines was used to judge the phase ratio in the surface zones of the layer.

The total hardness of the layers was estimated by taking into account the specific contribution of the hardness of each phase in accordance with its content:

$$HV = \sum_{i=1}^n HV_i * q_i \quad (1)$$

where HV_i - hardness of i - phase; q_i is the content of this phase in the layer.

However, depending on the composition of the saturating mixtures, the features of standard heating in furnaces, baths and heating by concentrated sources, the resulting composite structure has a different phase ratio, different dispersion and morphology not only on the surface, but also throughout the entire layer thickness. In this case, layer-by-layer X-ray diffraction and metallographic analyzes were used.

The high reliability of the results of the phase composition of the layer is ensured by the use of Mössbauer spectroscopy, which makes it possible to clarify the phase composition of the boride zone, determine the number of phases, and evaluate the effect on the phase composition of the electron beam during electron beam processing. The study was carried out using the non-destructive method of Mössbauer conversion spectroscopy, which does not require preliminary chemical treatment and sample grinding. In this method, Mössbauer spectra are recorded in the geometry of back reflection from the sample surface using a special flow-through proportional detector [7, 8].

With a change in the energy recording modes and variations in the gas atmosphere, either conversion resonant electrons or resonant characteristic X-ray radiation are recorded. In the first case, information is obtained on the phase composition of the surface region with a depth of up to 0.1-0.2 μm (depending on the degree of roughness), and in the second - from a depth of up to 20 μm.

Mössbauer spectra from the samples under study were recorded on an experimental setup with an electrodynamic-type vibrator, which made it possible to move the resonant absorber relative to the source in the velocity range from -10 mm / s to +10 mm / s, depending on the specified vibration amplitude. As a source of resonant γ-radiation with an energy equal to E = 14.4 keV, we used the active Co⁵⁷ isotope obtained in a cy-

clotron, introduced by annealing into a metal matrix. This technique for fabricating the sources allows one to obtain a single Mössbauer emission line with a width close to the natural level width.

Detection of γ -quanta was carried out using a scintillation detector with a NaJ (Tl) crystal 0.15 mm thick. The pulses registered by the detector are sent from the discriminator to various channels of the analyzer in such a way that the channel number becomes proportional to the movement speed. The Mössbauer spectrum obtained in this way was recorded on the display of a multichannel analyzer, and the numerical information was digitally printed and entered into the computer memory, where mathematical processing of the spectrum was carried out using a special program "UNIVEM".

The spectrum of the borated sample taken from the surface layer of 0.3 μm (Fig. 2, a) has a complex shape, indicating the formation of magnetically ordered iron boride phases in the surface layer. The Mössbauer parameters of such phases are well studied and differ very well from one another, which makes it possible to carry out a reliable phase analysis. Decomposition of the spectrum into its component components showed that it is a superposition of subspectra of magnetically ordered phases (FeB , Fe_2B , Fe_3B and $\text{Fe}_{(1-x)}\text{B}_x$ solid solution at $x < 0.4$) and a broadened paramagnetic doublet corresponding to a quasi-amorphous disordered solid solution $\text{Fe}_{(1-x)}\text{B}_x$ at $x > 0.4$ (Fig. 2, b). The spectrum of the same sample for a near-surface layer 20 μm thick (Fig. 2, c, d) differs significantly in shape: the central paramagnetic part almost disappears in it and a redistribution of the intensities of its constituent magnetic boride phases occurs.

The Mössbauer spectra of a preliminarily borated sample subjected to electron-beam treatment for 10 seconds are shown in Fig. 3. As can be seen from the figure, after electron irradiation, the spectrum of the near-surface region 0.3 μm thick (Fig. 3, a) changes very sharply in comparison with the spectrum of a simply borated sample (Fig. 2, a). The form of the spectrum becomes very close to the spectrum of the deep (20 μm) layer of a simply borated sample.

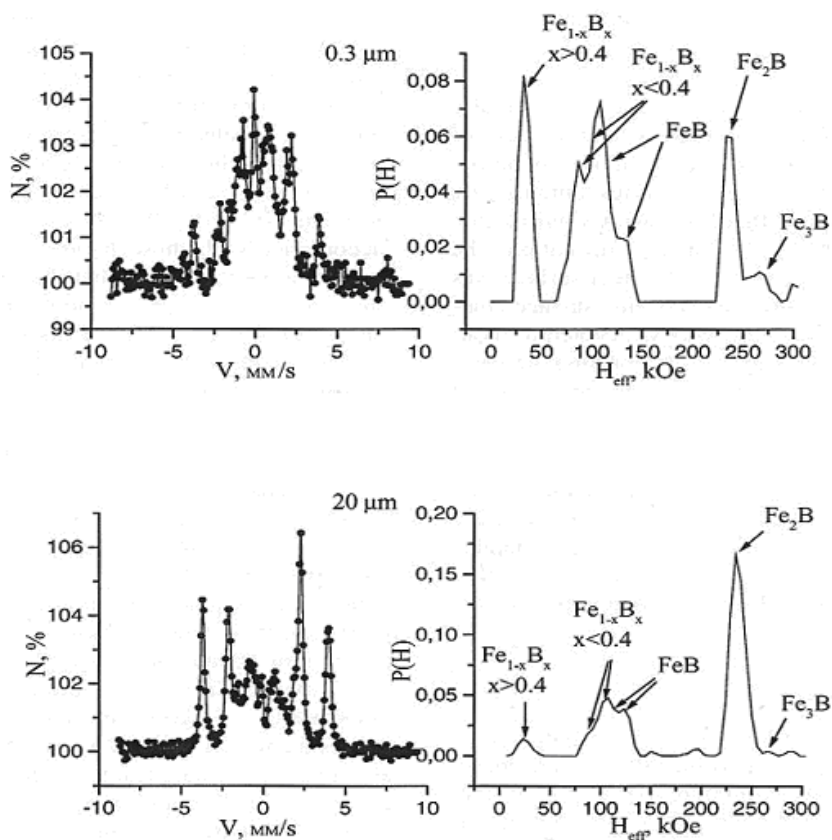


Fig. 2 Mössbauer conversion spectra of borated samples obtained from surface layers 0.3 μm thick (a, b) and 20 μm thick (c, d): $N\%$ is the intensity of the spectrum lines; $P(H)$ is the intensity of the magnetically split components

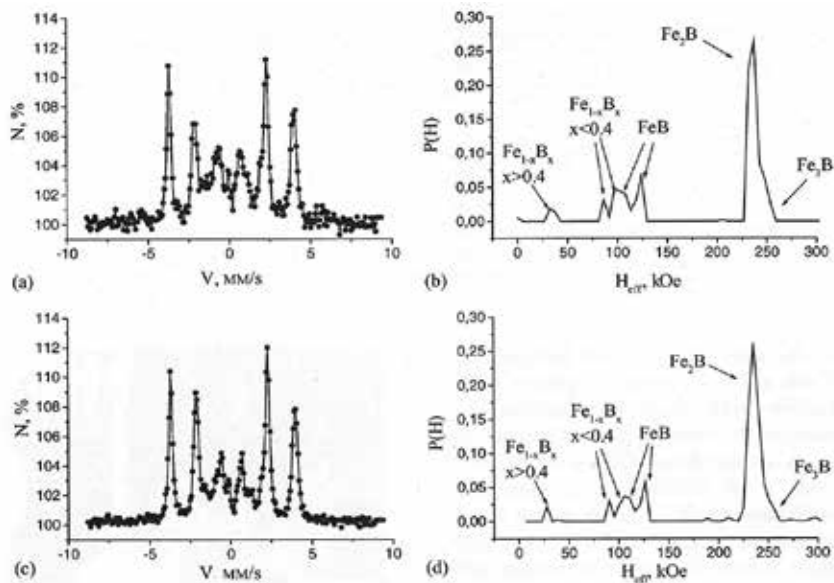


Fig. 3 Mössbauer conversion spectra of samples borated with subsequent processing by an electron beam, obtained from surface layers $0.3 \mu\text{m}$ thick (a, b) and $20 \mu\text{m}$ thick (c, d).

The spectrum of the $\sim 20 \mu\text{m}$ thick layer of the irradiated sample slightly differs from the spectrum of the surface layer itself (Fig. 3, c, d).

Mathematical processing of the Mössbauer spectra showed a significant difference in the phase composition of the layers obtained after solid-phase and combined boriding (Table).

As can be seen from the table, after treatment with an electron beam, the most significant changes in the phase composition occur in a thin surface layer: the relative amount of the Fe_2B phase increases very sharply, the amount of all other boride phases decreases to varying degrees, but the amount of the most boron-rich disordered phase decreases most sharply $\text{Fe}_{(1-x)}\text{B}_x$ ($x > 0.4$). At a depth of $20 \mu\text{m}$, the changes retain the same tendency, but the changes themselves become weaker.

Table. Results of processing Mössbauer spectra

Analyzed thickness layer, μm	Content of phases of borated layers obtained by various methods (vol.%)				
	FeB	Fe ₂ B	Fe ₃ B	Fe ^(1-x) B _x (x <0.4)	Fe ^(1-x) B _x (x> 0.4)
	Solid phase boriding				
0.3	21	14	17	26	22
20	18	59	4	19	4
	Combined boriding				
0.3	10	62	2	23	3
20	15	65	5	13	2

4. Conditions for laser combined processing

Laser processing was carried out on a scanner for spatial control of a laser beam, equipped with a Kometa-M laser installation and scanning devices for high-frequency oscillation of the beam, which provided wider possibilities for temperature control [9]. The radiation power was varied in the range of 700 ... 1300 W. The speed of the beam movement is 2 ... 50 mm / s. Laser heating of the boride coating was performed with a defocused and scanning beam in the direction transverse to its movement with a frequency of 220 Hz. The width of the zone of laser action was 2.4 ... 3.2 mm when processing with a defocused beam and 5.6 ... 6.1 mm when processing with a scanning beam. The processing mode was chosen so that the surface temperature did not exceed the melting point of the Fe-B-C eutectic, i.e. did not exceed 1100 °C.

Combined processing with the use of high-speed laser heating of boride layers and their cooling due to heat removal deep into the material leads to fragmentation of the boride structure and to the elimination of defects in the form of pores. Pore overgrowth occurs due to a sharp increase in volume upon local heating and the appearance of compressive stresses, as well as due to active diffusion processes involving iron atoms, base alloying elements, and boron. This structural modification enhances the wear resistance under conditions of friction without a lubricant, while local heating, in addition to structural changes, changes the stress state of the borated surface as a whole. Photographs of microstructures after laser treatment are shown in Fig. 1, f. The average microhardness of the columnar phases was 15000 MPa, and the gray zones located between the boride needles and below them were 7500 MPa. A decrease in the microhardness of borides is associated with the resorption of the high-

boron and more solid phase (FeB), as well as a decrease in the stress state level due to the formation of a fragmented structure. The dullness of boride needles and an increase in their thickness are also observed. All this, ultimately, provides some increase in the ductility of the boride layer.

Heating of the base material and cooling leads to the formation of a continuous zone of martensite in the sublayer (Fig. 4). The formation of a continuous layer of martensite is associated with the presence in the sublayer of an increased content of carbon obtained during borating due to its displacement by the growing layer of borides, and a sufficient rate of heat removal. Ferrite inclusions located at some distance from the boride layer are hardened and their microhardness becomes 1.5 ... 2 times higher than in the initial state. Thus, a favorable smooth distribution of microhardness from the surface to the depth of the sample is created.

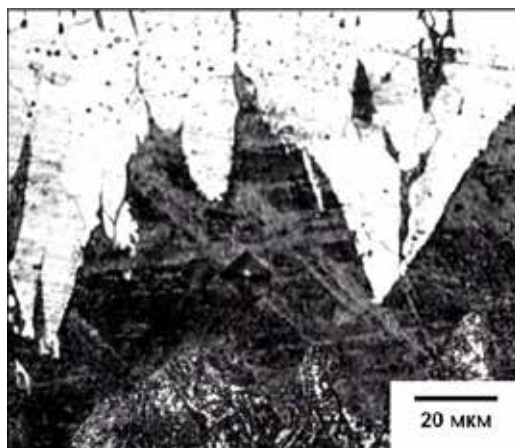


Fig. 4 Martensite structure in the boride sublayer after combined processing using laser heating

When the surface is exposed to a defocused laser beam in all modes, the boron of the layer is partially burned out from the surface. When processed with a high-frequency scanning beam, the topography of the surface layer has a smoother character and slightly differs from the initial state. This allows the use of a part with a boron surface modified by the high-frequency scanning beam without additional finishing or fine grinding.

The paths of laser treatment, due to the increase in plasticity, can play the role of relaxers of operational stresses on sufficiently long wear surfaces. In particular, their role is enhanced by the application of such tracks in

the form of a grid with an angle of 60° with respect to the sliding direction.

Such processing can be attributed to the discrete hardening of the surfaces of parts [10, 11].

To optimize wear resistance, the size of the mesh of the laser tracks, the angle of inclination with respect to the direction of friction and the depth of modification of the borated layer should be selected individually, based on the material of the part, the state of the base, saturation conditions and the structural type of the borated layer, the amount of permissible wear, the shape of the friction surface and conditions exploitation.

5. Conditions of electron beam combined processing

Combined processing using electron-beam heating, at the set power of the electron beam ($2.9 \times 10^4 \text{ W / cm}^2$), leads to the fact that complex processes occur in the boride layers due to the complex action of the electron beam on the surface at an elevated temperature. They are accompanied by the formation of a large number of point defects and the appearance of directed diffusion flows. The dynamics of the processes of change in the layer is as follows:

- as a result of radiation and thermal dispersion of borides on the surface of the layer and at the ends of the needles in the sublayer with the formation of a multichannel structure, predominantly parallel to the temperature, radiation and concentration gradients. The formation of such a structure should be associated with the formation of a large number of point defects in borides and with the appearance of two diffusion fluxes of boron and iron atoms. The first, from the middle part of the boride layer to the interfaces of borides with the external environment, and the second, from the middle part to the interface with the base metal (substrate). This is accompanied by the partial release of boron atoms into the surrounding space and the diffusion of boron atoms from the end of the boride needles into the base metal. In this case, an alignment of the interface between the layer and the substrate is observed, since there is no preferential growth of the polychannel structure in a certain crystallographic direction, i.e. eliminates the texture and acicularity of the boride layer at steady-state gradients of temperature, concentration and radiation exposure;

- in the surface layers within the multichannel structure, there is a natural selection of crystallites that are favorably oriented towards the surface radiation exposure and upward diffusion fluxes of iron and boron atoms, and in the sublayer carbon is displaced and alloying elements are accumulated with the formation of doped borides and carboborides. The favorable orientation is expressed in the cubic form of crystallites, which is characteristic of the tetragonal crystal structure of Fe_2B boride, which

in cross section has the form of squares with sides parallel and perpendicular to the diffusion flows. Unfavorably oriented crystallites undergo further dispersion, creating the basis for the nucleation of favorably oriented crystals. In this case, the high-boron FeB phase is absorbed and replaced by the Fe₂B phase, which is favorably oriented in the structure of the boride layer;

- the growth of favorably oriented boride crystallites in the near-surface zone due to diffusion flows from deeper layers and their radiation "loosening" from the surface. This is expressed in the formation of a structure of crystallites with an open area from the side of the action of the radiation flux, which are called borides of the type "Chinese characters". The formation of borides of the type "Chinese characters" under constant radiation exposure is accompanied by the formation of porosity in the surface layers. In the sublayer, due to the formation of areas with an increased concentration of carbon and alloying elements, it is possible to create conditions for the appearance of a liquid crystal state;

- further radiation loosening of the boride layer on the surface and, as boron atoms escape into the surrounding space, the formation in the layer of inclusions of an α -solid solution of boron in iron. The development of the layer structure on the inner side and in the sublayer is determined by the degree of substrate doping, the carbon content, and the process temperature. However, in all cases, it is also associated with the formation of carboborides and an α -solid solution of boron and alloying elements in iron, i.e. formation of a composite structure within the borated layer and sublayer with a different set of performance properties.

Dispersed and fragmented borated layers obtained by combined processing provide an expansion of the field of use of these layers. In particular, the following areas of application are recommended (with an electron beam power of $2.9 \times 10^4 \text{ W / cm}^2$):

- to increase the wear resistance of parts while maintaining the high hardness of borides, layers should be recommended after exposure to radiation for less than 30 s;

- for operating conditions in the presence of shock loads and intense wear, plastic layers with a hardness of $\approx 1400 - 1450 \text{ kgf / mm}^2$ should be recommended after exposure to radiation for 30 - 50 s;

- for operating conditions with alternating loading, torsion and bending, plastic layers should be recommended after exposure to radiation for 50 - 75 s, or layers obtained immediately after electron beam boriding.

6. Methodology for calculating comparative wear resistance

It is advisable to make a predictive assessment of the wear resistance

of diffusion layers taking into account the criterion values of the plasticity of a particular layer, the friction coefficient, sliding speed, stress state and contact pressures. The criterion for the plasticity of diffusion layers is their ability to resist chipping, which is called the shear stress (σ_{sh}) and is calculated by the formula:

$$\sigma_{sh} = 0.174 \frac{0.174 * P}{(2l^2 + c * l)} \quad (2)$$

where P is the load when measuring microhardness, kgf;

l - distance from the center of the indentation to the edge of the sample when measuring the microhardness, mm;

c - length of the diagonal of the print, mm.

Shear stresses with a high degree of reliability correlate with the hardness values of various layers (diffusion, not based on chemical compounds or solid solutions), as well as hardened layers) [5]. This regularity makes it possible to determine the magnitude of cleavage stresses at any distance from the surface from the values of hardness, which is either directly measured along the depth of the compact layer, or is determined by the calculation method for a composite multiphase structure of the layer from the values of the hardness of each phase according to formula (1).

To carry out a comparative predictive calculation, the following empirical formula is proposed for assessing the comparative wear resistance of diffusion layers:

$$W_r = 10(1 - \delta) * (\sqrt{\sigma_{sh}})^{-1} * HV * \exp\{\sqrt{m\sigma_{sh}} - n\sigma_k - kf - ev\} \quad (3)$$

where HV is the hardness of a homogeneous diffusion layer or a composite heterogeneous structure;

δ - relative elongation of the considered layer, in%. In the absence of this characteristic, it should be calculated by the formula: $\delta (\%) \approx 4 \cdot 10^{-3} \cdot (HV)^{-1}$;

b_k - specific contact pressure, kgf / mm²;

v - sliding speed, m / s;

m, n, k, e - empirical coefficients determined from the regularities of the influence of the corresponding factors;

f is the coefficient of friction.

With variable hardness, during the predictive calculation of the conditional wear resistance, the cleavage stresses and the friction coefficient were corrected. The calculated wear resistance was used as a comparative characteristic of the performance of various diffusion layers and compact materials under specific operating conditions. After determining the wear resistance, an assessment was made of the wear rate and durability of the diffusion layer under the conditions under consideration.

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ASSESSMENT OF THE STATE AND SUPPORT OF RESEARCH OF CLIMATE FACTOR CHANGE IN THE ARCTIC REGION

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The paper proposes a methodological aspect of the optimal solution to the problem of ensuring the preparation, substantiation and creation of a research system to assess the dynamics of changes in climatic factors in the Arctic region. In particular, the fundamentals of the energy kinetics of the ice-covered surface areas of the Arctic seas and oceans are considered, with the aim of substantiating and choosing over-ice technological objects, provided that the disturbance of the ice surface is minimized. In addition, a methodological approach is proposed for assessing the acceptability of the adopted technical solutions, based on the optimal choice of personnel components of the research system being created. At the same time, an indicator of efficiency is the minimization of the schedule for performing organizational work in the process of forming a system for speed.

Keywords: research, system, kinetics, power, equipment, ice cover, optimization, personnel components.

The phenomena of interaction of the technogenic system of the atmosphere and its natural factors with the external environment of our planet are based on a complex chain of energy processes formed in a certain way in time and space. At the same time, the physical essence of these phenomena is similar to global natural energy flows and their environmental consequences. Further, in this aspect, some provisions of the work [1] are stated.

Studying the phenomena associated with an increase in the thermal radiation of the sun and the effects of technogenic factors in the atmosphere, even at the simplest level, a chain of interrelated accompanying processes can be distinguished. Increase in ambient air temperature; intensification of ice melting; an increase in the movement of ice pack

fields; intensification of the formation of cracks and streaks; decrease in the average thickness of the ice cover; reduction in the area of ice cover in the Arctic zones; numerous phenomena associated with transformations of the food biological chain of the animal world, etc. In general, the arguments presented below are also valid for glaciers on land.

As in the idealized example with the activation of the solar thermal flux, as well as in the case of global technogenic warming, there is a process of exchange of qualitative and quantitative characteristics of the Arctic ice field system with the environment. All these phenomena are a collection of interrelated variables. In addition to variable quantities, the studied kinetic system has a set of certain parameters that do not change or slightly transform during observation of the system and characterize the conditions for the course of metabolic processes and the values of their rates. Here, for example, the density of ice, the acceleration of gravity, the density of sea water, the mechanical strength of the ice cover, etc.

The research methodology is adopted by analogy with chemical and biological kinetics. Let us consider a closed system of some ice field, in which processes of excessive external energy (power) impact and, as a consequence, a decrease in the area of ice cover, occur simultaneously. The question arises as to how the glaciological state (ice coverage of water) of the ice field changes over time and, in the end, a stationary state is established, when the number of cracks, streaks, wormwood (pure water) will not change - that is, to solve the problem of temporary forecasting.

Suppose at some moment of time t the concentration of cracks and openings on the ice field is N . The rate of change in the concentration of cracks and openings in the ice field dN/dt (m^2/ha , or derived units) is the sum of the rate of their appearance V_A and the freezing rate V_F .

In our case, let us assume that the rate of appearance of "pure water" per unit of time is proportional to its quantity at each moment of time, i.e.

$$V_A = c_1 N, \quad (1)$$

where c_1 – is the constant of proportionality, which in natural conditions depends primarily on the season, and in the case of man-made impacts from some technological external factors, for example, emissions of carbon dioxide and other gases into the atmosphere from human industrial activities. But in both of these cases, we bring this constant to an external energy (power) flow. The time factor in our case, taking into account the physics of the formation of "pure water (land)", it is advisable to consider rather long downstream (months, years).

$$V_F = c_2 N, \quad (2)$$

where c_2 – proportionality constant characterizing the intensity of freezing,

which practically depends on the same factors as c_1 .

Thus

$$dN/dt = c_1 N - c_2 N = cN, \quad (3)$$

where $c = c_1 - c_2$.

The solution to equation (3) is known:

$$N = N_0 e^{kt}, \quad (4)$$

where N_0 – concentration of cracks and streaks (pure water) at the initial moment of time t_0 of monitoring the system. It is obvious from (4) that all consequences in the state of the system depend on k .

So, for $c_1 = c_2$ it is fair to assume $N = N_0$, which is desirable if this ratio characterizes some glaciological equilibrium of the considered Arctic system.

Considering the proposed idealization of the simultaneously occurring processes of excessive external energy (power) impact and, as a consequence of the decrease in the area of the ice cover, it is legitimate to refer to the logistic equation of Verhulst [2].

In our case, this will be the desired (expedient) description of the Arctic ice area under consideration.

$$dN/dt = k_1 N((N_{max} - N)/N_{max}), \quad (5)$$

where N_{max} – the maximum possible, in terms of environmental friendliness, concentration of breaks and cracks in a given Arctic area.

It follows that any external over-ice technogenic impact on the Arctic territory requires a purposeful manager, in a broad sense, human impact to ensure

$$N_0 = N_{max} = N_{OPT}, \quad (6)$$

where N_{OPT} – in our case, the optimal (desired), in terms of ecological prerequisites, concentration of cracks and openings in a given Arctic area. From the point of view of kinetics, this is the desired stationary state of the system.

Thus, a simple open system of the type "natural and technogenic external energy ice impact - concentration of "pure water (land)" on the Arctic ice field" is considered. In which there is an exchange of property a – the concentration of the power flow of the over-ice technogenic natural impact (kW) and property b – the relative concentration of cracks and streaks – pure water or land (m^2/ha , or derived units) over the area of the ice field with the environment, and in addition, a reversible first-order process of transformation $a \leftrightarrow b$.

The values of the rate constants c_1 , c_{+2} , c_{-2} and c_3 are, in this case, phenomenologically generalized. Applying the methods of mathematical analysis in time t to properties a and b , we find that for $c_1 = c_2$ it is fair

to assume that $N = N_0$, which is desirable if this ratio characterizes some ecological balance of the considered Arctic system.

The solutions indicate that these quantities do not depend on the initial conditions of the system at $t=0$. That is, no matter what initial state the system is in, one stationary regime will eventually be established in it, in which $a=a', b=b'$.

Let the indicator $b=b'$ (dimensionless) in the considered Arctic system for a specific time situation be uniquely determined:

$$b=b'=B''/S, \quad (7)$$

where B'' - total area of openings and cracks (clean water, land) in the considered Arctic territory (km^2 , or derived unit), S - total ice (including clean water) area of the considered territory of the Arctic Ocean (km^2). We will call this parameter "pure water coefficient".

Let us assume at the moment $t=0$ this is the temporary position of the considered Arctic system, at which its stationary state fully ensured ecological balance in the historical aspect, that is, without technogenic impact, or with its acceptable level in terms of environmental consequences. That is, for this case $b=b_0$ is determined in some way from historical information. Nevertheless, in this particular technogenic-natural situation, the beginning of the time axis is essentially its own time point $t=0$, for which $a=a_0$ is given according to natural and external technological (industrial) conditions (technogenic factor). Moreover, this indicator carries an energetic physical meaning. Let it be the "external over-ice power" of the impact on the considered Arctic system. Accordingly, this inflow of external energy impact corresponds to some reduction (decrease in S) of the ice cover ΔS (km^2 , or a derived unit) with the formation of clean water or land.

We will proceed from the fact that in any stationary state of the considered technogenic Arctic system there is some commonality. To substantiate this generality, we introduce a parameter

$$K_L = \Delta S / a_0, \quad (8)$$

with a dimension, for example m^2/kW (or a derived unit). Physically, this is the rate of decrease of the ice field of the Arctic territory in the flow of power of external energy impact. In a specific case, this indicator is individual. However, if this parameter is used in combination

$$P_L = b/K_L \text{ (kW/m}^2 \text{ or kW/km}^2\text{)}, \quad (9)$$

you can come to relation

$$P_L = (a_0 B'') / (S \Delta S). \quad (10)$$

Taking into account the previously disclosed meaning of the correspondence components (10), and the logical analysis of their interrelation, the following conclusion is possible. It is expedient to define the synthe-

sized indicator P_L as the limiting (critical) specific external over-ice thickness according to the condition of the inevitable formation of clean water (cracks and streaks) or land. In a stochastic aspect, for all considered Arctic ice oceanic fields, this indicator is the same and constant, that is, in the considered systems $P_L = \text{const}$.

The above analytical relations (1) - (10) indicate the need, when using them, to quantify a number of phenomenological components of the mathematical model, for example, the proportionality constant k_p , the concentration of the over-ice energy (power) flow A , etc. In practice, this indicates that when solving real problems, for example, predicting the geocryological and glaciological consequences of the action of natural and technological factors in the Arctic, it will be necessary to empirically determine a certain list of parameters. This will require an appropriate set of research and technological equipment, for example, to measure the temperature regime of individual objects, or conduct geodetic surveys.

The initial idea of the proposed approaches is the creation of a multi-functional, mobile (in a broad sense - landing, self-propelled, floating) transport and technological system, taking into account the primary tasks of researching the Arctic and the stochastic specifics of operating conditions.

Of undoubted interest are the personnel components of the selected research system, that is, its crew of specialists. In this case, there is a process of optimal team building in the form of a synthesis of the control system as a formal distribution of the set of organizational tasks to be solved between the nodes of the system, that is, specialists.

The problem statement is as follows: there is a system of work performers, consisting of n crew members - or a subsystem J . To achieve the goal of the system (execution of work on time) comes the final deterministic flow of m requirements (for example, the development of operational work cards, the development of operational instructions for research equipment, etc.) to the list of work stages that are mandatory for each specialist of the proposed system. The possibility of the system under consideration is determined by the matrix

$$\|t_{ij}\| \quad (i=1 \dots, m, j=1 \dots, n) \quad (11)$$

where t_{ij} – the duration of the implementation of the i -th requirement by the j -th specialist. This time indicator is estimated on the basis of a statistical analysis of the parameters (expectation, variance) of the random distribution of a given quantity over known organizational measures performed in a similar field of applied knowledge by means of simulation modeling (for example, by the Monte Carlo method).

As a result, the solution to the discrete optimization problem serves as the criterion for the acceptability of the decisions made that ensure the optimality of the set of the selected equipment, individual plans of specialists and the schedule for performing organizational work on speed.

$$\mathbf{Max} \, T_j \rightarrow \mathbf{min},$$

$$1 \leq j \leq n$$

where $T_j = \sum_{i \in N_j} t_{ij}$ - total time of the organizational workload of the j -th specialist.

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DEVELOPMENT OF AN INFORMATION SYSTEM FOR MONITORING WATER OBJECTS

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The paper describes the software and technological complex of the water resources monitoring database.

The developed system is capable of ongoing monitoring of the state of water resources, both according to laboratory production control data, and in the mode of interaction with “smart” sensors of instrumental control in the mode of continuous determination of water pollution in the mining area. For this, the filling of databases on points of industrial environmental control has begun.

The structure of a Web-application for remote access to the water resources monitoring database is presented. Examples of filling in the database tables based on previously presented materials are given.

Keywords: ingredients, monitoring, surface waters, information system, databases, water bodies, water quality assessment methods

Databases (DB) together with database management systems (DBMS) are the most flexible way of storing and processing data. Currently, there are hierarchical, network, relational, object and NoSQL types of data models. The most popular and most versatile are relational and NoSQL data-

bases. The first type is used in the developed system. Within the framework of this model, for storing data, relations (tables) are used, which consist of attributes (fields, columns) and records (rows, tuples). Each table cannot have two identical rows. Each column has a unique name (within the table) and all values in one column are of the same type (number, text, date ...). For unique identification of records in relation to use primary keys (PK - primary key). Several types of relationships between tables are supported, including one-to-one, one-to-many, and many-to-many. To organize relationships, foreign keys (FK - foreign key) are used, which are formatted as attributes that refer to a field with a primary key in another table. A declarative programming language SQL (structured query language) is used to create, modify and manage data.

However, direct use of databases requires certain qualifications from the user and includes many routine operations (writing SQL queries, selecting values for foreign keys, etc.). In this regard, it becomes expedient to develop and use applications for practical tasks that act as a shell to the database. Such a solution allows you to simplify and speed up work, increase the flexibility of data manipulation, and implement complex methods of data processing and analysis.

Formation of databases on the state of water resources

The database for monitoring water resources (consumption of water resources at points of intake and discharge, hydrochemical composition of techno-natural waters at monitoring points) is shown in fig. 1. The "Water Resources" database consists of 47 tables.

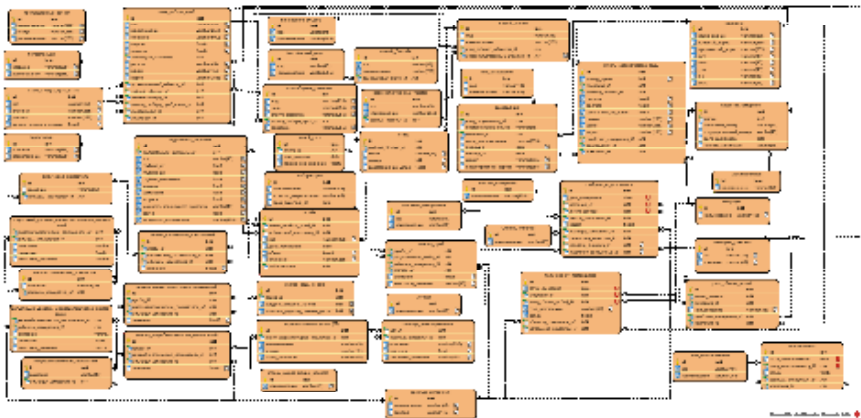


Fig. 1 - Scheme of the water resources monitoring database

Surface and groundwater monitoring database model

The database model can be roughly divided into two main blocks. In the first, the results of hydrochemical and hydrological monitoring are combined into a single structure. For this, the following approach has been chosen. The concept of a point (place on the map, point on the terrain) of water sampling is defined, which is associated with the enterprise and the water body. A sample (protocol) is attached to it, indicating the date and the results of hydrochemical, microbiological and parasitological analysis. At the same time, the preservation of hydrological observations is ensured through a group of tables: water body - section (monitoring point) - measurement (while maintaining the bottom profile, velocity, cross-sectional area and discharge).

The second block describes the data structure for the organization by the owners of water bodies and water users to record the volume of intake (withdrawal) of water resources from water bodies and the volume of wastewater and (or) drainage water discharge. Includes identifiers and classifiers of water bodies. The database displays the spillway and water intake areas (name of the organization operating the spillway and water intake facilities, the point of discharge or intake of water, the name of the means for measuring wastewater flow rates and water intake, the name of the water body). To account for water consumption and water disposal, tables have been created that contain information, respectively, on daily water consumption and water disposal, (date of measurement, readings of the measuring device, its operating time and water consumption).

The database contains a detailed description of water disposal and water consumption metering points (industrial enterprise, site, name, latitude, longitude, metering means, metering frequency, receiver or source of water).

Structure of a Web application for remote access to the water resources monitoring database based on laboratory control data

In the development of the information system, the principles developed by the authors for the creation of applied geoportals were applied [1]. The web application was developed using the Spring Roo rapid prototyping tool with subsequent code adjustments. Initially, a script was written that includes a description of entity classes that are mapped to the tables of the database discussed above, repositories, services, controllers and resources required for the application to work. Examples of descriptions are presented below.

An example of a description of entity classes:

```
entity jpa --class ~.domain.water.WaterBody --sequenceName water.  
water_body_id_seq --identifierStrategy SEQUENCE --schema water  
--entityFormatExpression "#{title}"  
entity jpa --class ~.domain.water.SamplingPoint --sequenceName  
water.sampling_point_id_seq --identifierStrategy SEQUENCE --schema  
water --entityFormatExpression "#{code} #{title}"  
entity jpa --class ~.domain.water.PhysicalIndicators --sequenceName  
water_db.physical_indicators_id_seq --identifierStrategy SEQUENCE  
--schema water --entityFormatExpression "#{title}"
```

An example of a description of table fields:

```
focus --class ~.domain.water.SamplingPoint  
field string --fieldName code --sizeMin 3 --sizeMax 45  
field string --fieldName title --sizeMin 3 --sizeMax 255  
field string --fieldName description --sizeMin 3 --sizeMax 255  
field number --fieldName latitude --type java.lang.Double  
field number --fieldName longitude --type java.lang.Double  
field string --fieldName region --sizeMin 3 --sizeMax 45  
field string --fieldName district --sizeMin 3 --sizeMax 45  
field string --fieldName address --sizeMin 3 --sizeMax 255  
field set --fieldName samples --type ~.domain.water.Sample  
--mappedBy samplingPoint  
field set --fieldName waterWells --type ~.domain.water.WaterWell  
--mappedBy samplingPoint
```

An example of a description of repositories:

```
repository jpa --entity ~.domain.water.WaterBody --interface  
~.repository.water.WaterBodyRepository  
repository jpa --entity ~.domain.water.SamplingPoint --interface  
~.repository.water.SamplingPointRepository  
repository jpa --entity ~.domain.water.PhysicalIndicators --interface  
~.repository.water.PhysicalIndicatorsRepository
```

An example of a description of service:

```
service --entity ~.domain.water.WaterBody --interface ~.service.api.  
water.WaterBodyService --class ~.service.impl.water.WaterBodyService  
service --entity ~.domain.water.SamplingPoint --interface ~.service.  
api.water.SamplingPointService --class ~.service.impl.water.  
SamplingPointService  
service --entity ~.domain.water.PhysicalIndicators --interface  
~.service.api.water.PhysicalIndicatorsService --class ~.service.impl.  
water.PhysicalIndicatorsService
```

An example of a description of controller:

```
web mvc controller --entity ~.domain.water.WaterBody
--responseType THYMELEAF --package ~.web.water --pathPrefix water
web mvc controller --entity ~.domain.water.SamplingPoint
--responseType THYMELEAF --package ~.web.water --pathPrefix water
web mvc controller --entity ~.domain.water.PhysicalIndicators
--responseType THYMELEAF --package ~.web.water --pathPrefix water
```

In general, the resulting model of the organization of application components is shown in figure 2.

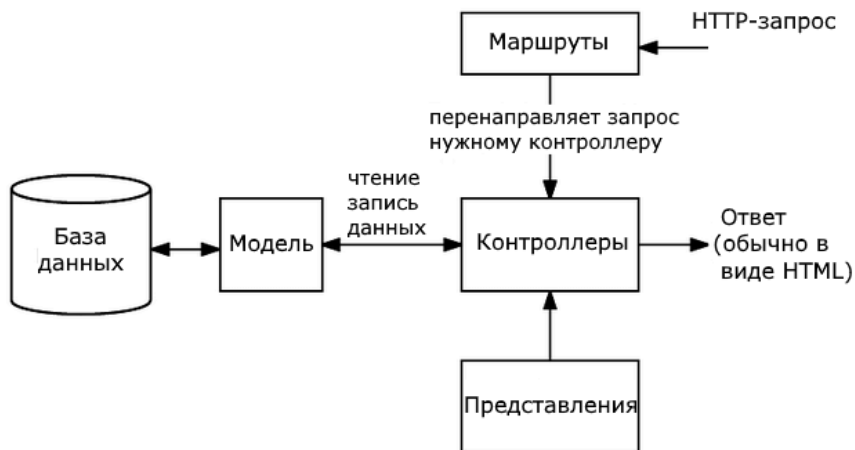


Fig. 2 - Application component organization model

Working with sections of the database for monitoring water pollution according to laboratory control data

The created application looks as follows (fig. 3). Each section has functions for viewing, adding, editing and deleting records. The add function is available from the toolbar above the table, the rest from the "Tools" column. In some sections (for example, "Selection points"), the ability to go to subsections is implemented.

ID	Наименование	Описание	Станция отбора	Серия	Вводные
2001	Заборная колодезьная МП (станд.)	Заборная МП (заборная), Тип: колодезь / Тип: колодезь	Тепло	Получено	✎ ✕ ✖
2002	Заборная колодезьная МП (станд.)	Заборная МП (заборная), Тип: колодезь / Тип: колодезь	Тепло	Получено	✎ ✕ ✖
2003	Заборная колодезьная МП (станд.)	Заборная МП (заборная), Тип: колодезь / Тип: колодезь	Тепло	Получено	✎ ✕ ✖
2004	Заборная колодезьная МП (станд.)	Заборная колодезьная МП (станд.), Тип: колодезь / Тип: колодезь	Тепло	Получено	✎ ✕ ✖

Fig. 3 - General appearance of the web application

To get started, the user needs to fill in the reference books "Units of measurement", "Types of water", "Type of water body", "Class of pollutants", "Methods of analysis" available from the top menu (fig. 4).

ID	Наименование	Описание	Станция отбора	Серия	Вводные
1	Тип водного объекта	Водный объект			✎ ✕ ✖
2	Водный объект	Водный объект			✎ ✕ ✖
3	Водный объект	Водный объект			✎ ✕ ✖
4	Водный объект	Водный объект			✎ ✕ ✖
5	Водный объект	Водный объект			✎ ✕ ✖
6	Водный объект	Водный объект			✎ ✕ ✖
7	Водный объект	Водный объект			✎ ✕ ✖
8	Водный объект	Водный объект			✎ ✕ ✖
9	Водный объект	Водный объект			✎ ✕ ✖
10	Водный объект	Водный объект			✎ ✕ ✖

Fig. 4 - Section menu

A separate group of reference books is formed by the sections "Pollutants", "Physical indicators", "Parasitological indicators", "Microbiological indicators". After filling them out, it is necessary to enter the permissible values into the items "Standard indicators", "Permissible level of parasitological indicators", "Permissible level of microbiological indicators".

After entering the necessary reference data, you can start entering the protocols of laboratory tests of water samples. To do this, go to the "Sampling points" section.

As a result, we receive a report on the volume and quality of the water body used by coal mining enterprises, formed in accordance with the legislation of the Russian Federation.

In the water monitoring information system, water quality is assessed using the specific combinatorial index of water pollution (SCIWP) [1], by associative indicators (AI) [2] and the entropy method [3].

Conclusions

The paper proposes a new approach to the creation of a water monitoring system based on modern information and telecommunication technologies.

The information system includes several blocks. The first contains tools for managing the data of hydrochemical and hydrological monitoring for enterprises and water bodies. It is possible to graphically display the concentration of pollutants over time. Access to them is carried out both from the main menu and from the electronic map in an interactive mode.

The second - includes the accounting of data on water consumption and wastewater disposal of enterprises, indicating the points of discharge and water intake, permits for them and measuring instruments. The accumulated information ultimately makes it possible to automatically generate reporting documents (2-TP Vodkhoz) on water use.

The third one contains methods for assessing water quality using the specific combinatorial water pollution index (SCIWP), associative indicators (AI), and data mining by the entropy method.

Service functions for managing data of enterprises and users are consolidated into a separate block.

It is possible to gain access to all information through the user's interaction with the objects of the electronic map.

The structure of the information system allows you to introduce new modules into it for receiving and assimilating data coming from devices belonging to the concept of the Internet of Things.

Thus, the developed information system optimizes the work of coal mining enterprises and allows digital monitoring of water resources using information updating tools based on data streams.

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COMPOSITE SORBENTS FOR THE DISPOSAL OF WASTE WATER CONTAINING CUTTING FLUIDS

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The composition of a complex adsorbent based on iron oxides for the disposal of wastewater containing cutting fluids (CF) is proposed. The parameters of utilization with the use of processing in the magnetic field of the suspension are determined. The optimal ratios of the adsorbent to CF have been determined.

Keywords: waste water, emulsified oil products, adsorbent, magnetic field.

Waste cutting fluids (CF) are a special type of wastewater that is very hazardous to the environment, since they contain a large amount of persistently emulsified petroleum products (EPP), mechanical impurities, free oils, degraded organic components formed during the decomposition of additives - sulfur -, chlorine-, phosphorus- and nitrogen-containing organic compounds, as well as additives of the alkylphenol type [1]. The content of mineral oils, emulsifiers and process lubricants in waste CF sometimes reaches 50 g/l, of which up to 15 g/l are emulsified.

Waste CF "Emulsol T" grade A, which is a mixture of triethanolamine salt of oleic acid grade "OM" and mineral oil, was chosen as the object of research.

Studies on the disposal of spent CF were carried out by the adsorption method in a magnetic field using complex sorbents based on iron oxides. Disintegrating electric steel-smelting slag and iron ore concentrate were

It was believed that for the sorption of hydrocarbons it is more expedient to use porous carbon materials - activated carbons, semi-coke, coke, synthetic polymer resins, etc. [5]. But recently, there has been a high cost of carbon adsorbents. At present, cheap inorganic sorbents are widely used for the adsorptive purification of wastewater from oil products, in particular, waste from metallurgical industries, which have a fairly developed surface.

Therefore, studies were carried out to study the adsorption properties of products and wastes of metallurgical industries in relation to oil products from an aqueous medium and to develop a wastewater treatment technology based on the properties of adsorbents using magnetic processing.

The research results presented in Figures 3 and 4 show the dependence of the degree of wastewater purification on the dispersion and percentage of the components of the complex adsorbent. The degree of extraction of impurities was monitored by the transparency of the solution, determined from the optical density by the photocolorimetric method. The light transmittance of the sample before cleaning was 0.09%.

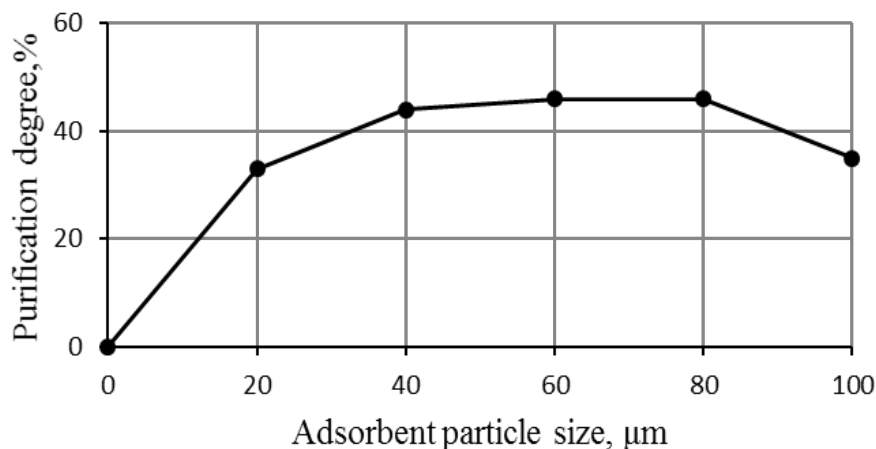


Fig. 3. Dependence of the degree of extraction of EPP from waste water on the dispersion of the adsorbent

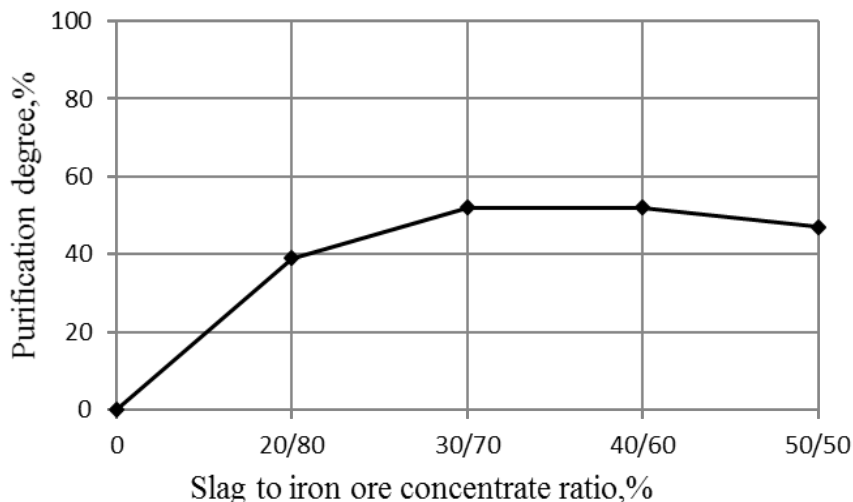


Fig. 4. Dependence of the degree of extraction of EPP from waste water on the ratio of components in the adsorbent

From fig. 3 it follows that the degree of purification from emulsified oil products (EPP) increases with a particle size (d) in the range $80 > d \geq 50 \mu\text{m}$. The increase in the degree of purification can be explained by the fact that there is an increase in the active centers of the adsorbent. When the size of fractions is less than 50 microns, the degree of purification decreases due to the highly dispersed adsorbent, as a result of which the operation of the vacuum filters decreases due to the deterioration of the distribution of the suspension over the filter cloth. When using the size of fractions $d > 80$ microns, the degree of purification decreases due to the insufficiently developed specific surface area of the adsorbent.

From the results obtained, shown in fig. 4 it follows that the optimal percentage ratio of the components of the adsorbent by weight slag/magnetite concentrate = 30-40/60-70%. When using slag less than 30%, the degree of purification of the EPP recovery is low, because the amount of the main adsorbing substance decreases. With an increase in the amount of slag over 40%, the degree of purification also decreases, because there is an increase in the amount of OH_- group due to an increase in the concentration of calcium oxides CaO and CaO_{free} . ($2\text{CaO} + \text{H}_2\text{O} = 2\text{Ca}(\text{OH})_2$), while the spent CF, having a negative sign of the charge, upon collision with the negative OH_- group leads to the repulsion of particles, as a result of which the degree of purification decreases.

The study of the dependence of the degree of extraction of emulsified oil products from waste water containing CF was carried out by introducing an adsorbent into the waste water in various ratios. This ratio is found as the amount of adsorbent taken to the amount of CF spent. The research results are shown in fig. 5.

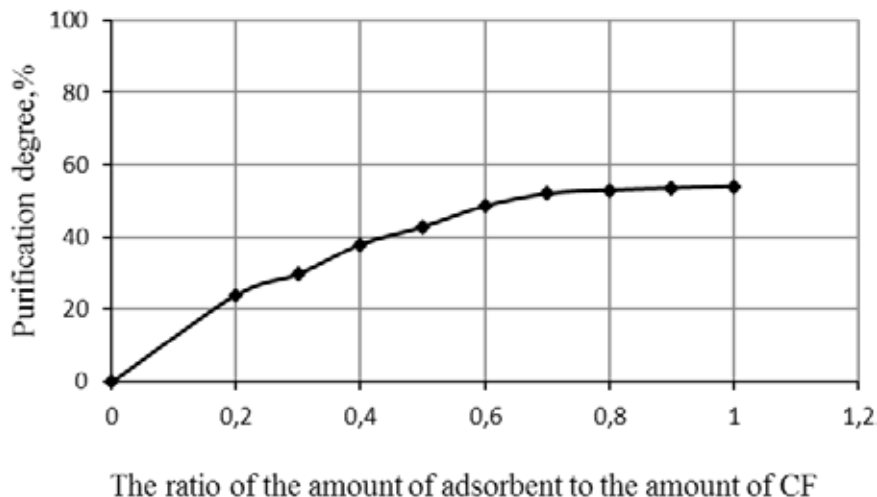


Fig. 5. Dependence of the degree of extraction of EPP on the proportion of adsorbent in the suspension

From the results presented in the graph, the optimal ratio of adsorbent to CF is 0.7. The use of a ratio below this value greatly reduces the degree of purification due to the insufficient amount of adsorbent. With a ratio above 0.7, with good cleaning from organic matter, the suspension loses fluidity and is difficult to filter.

The study of the effect of magnetic treatment was carried out on a laboratory electromagnetic installation, in which the suspension was in the zone of the magnetic field. The results of studies of the influence of the magnetic field on the degree of purification are shown in fig. 6.

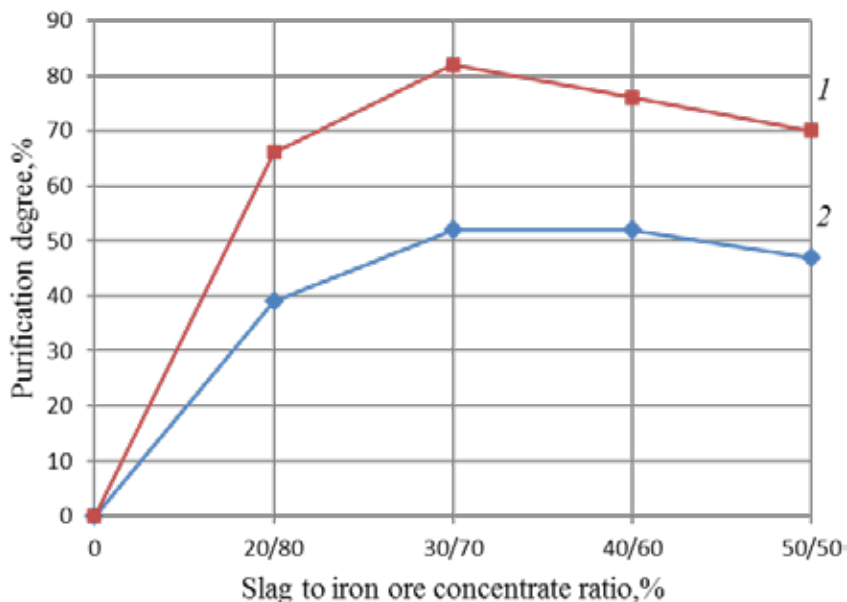


Fig. 6. Influence of the magnetic field on the spent CF, depending on the quantitative ratio of slag and iron ore concentration in the adsorbent

1 – in conditions of magnetic processing; 2 – in conditions without magnetic processing

From fig. 6 it follows that under the conditions of magnetic treatment with a slag ratio of 30% and a magnetite concentrate of 70% by weight and with a particle size of 50...80 microns, the degree of purification increases almost 2 times.

The optimum residence time of the suspension in a magnetic field was 120 seconds at a magnetic field strength of 180 a/m.

As a result of the research, it was determined that during the magnetic treatment of oily water in a magnetic field, there is an interaction of the field and charged and polar particles contained in the suspension and forces associated with a change in the flux of magnetic induction when a liquid enters the zone of action of a magnetic field and when it leaves it, which leads to a change in its structure and properties [6].

When determining the influence of the pH of the spent CF environment on the purification efficiency, it was revealed that the purification degree of the treated water increases with a decrease in the pH value. Under the

influence of acid, the structural and mechanical barrier is destroyed. That is, the destruction of the emulsion system occurs, which more sharply manifests the difference in the magnetic properties of oil particles and water, and also lowers the viscosity of the system, which, in turn, creates more favorable conditions for the movement of oil particles from the inter-polar space in a magnetic field.

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**SINGLE-PHOTON INTERBAND ABSORPTION OF POLARIZED LIGHT
IN A NARROW-GAP CRYSTAL****Rasulov Voxob Rustamovich**Ph.D, associate professor
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A quantitative theory of interband one-photon absorption of polarized light in narrow-gap crystals is constructed in the Kane model. The matrix elements of one-photon interband optical transitions are calculated. The spectral dependence of the interband single-photon absorption coefficient and its linear-circular dichroism are calculated taking into account the effect of coherent saturation in photoexcited charge carriers.

Keywords: interband one-photon absorption of light, linear-circular dichroism, coherent saturation effect, photoexcited current carriers.

Currently, in practice, nonlinear optical phenomena occurring in crystals are widely used [1-3]. In this context, the research of nonlinear absorption of polarized light is actual both from the physical point of view and from the point of view of application.

Note that in the case of one-photon absorption of light, optical transitions do not occur through virtual states at all. Therefore, linear-circular dichroism is not observed in single-photon optical transitions in crystals

with cubic and tetrahedral symmetry.

One- and multiphoton absorption of polarized light in crystals, caused by optical transitions between the subbands of the valence band, was researched in [4-11], where the contribution to the interband one-photon absorption of light from the effect of coherent saturation [6, 7], caused by the finite lifetime of photoexcited carriers current in the final state, to which this work is devoted.

If we take into account the contribution to the absorption of the effect of coherent saturation, then the coefficient of two-photon absorption of light will be written in the form

$$K^{-1} \omega, T = \frac{4\pi}{h} \hbar \omega \frac{1}{I} \sum_{k; s=\pm 1/2, m=\pm 1/2, \pm 3/2} f_{hh} - f_c \delta E_{hh} - E_c + \hbar \omega \left\langle \frac{|M_{CsV,m}^1(\vec{k})|^2}{\sqrt{1 + 4 \frac{\alpha}{\hbar^2 \omega^2} |M_{CsV,m}^1(\vec{k})|^2}} \right\rangle, \quad (1)$$

where $f_{hh}(f_c)$ and $E_{hh}(E_c)$ - distribution functions and energy spectra of holes (electrons), respectively, sign $\langle \dots \rangle$ means averaging over the solid angles of the wave vectors of current carriers, the rest are generally known values.

It can be seen from (10) that the coefficient of interband one-photon absorption of light $K^{-1} \omega, T$ consists of partial components that differ from each other in the type of optical transitions. In particular, for an optical transition of the type $|V, \pm 3/2\rangle \rightarrow |C, \pm 1/2\rangle$ it is expressed as

$$K^{-1} \omega, T = \frac{16e^2}{3c\omega \hbar^2 n_\omega} \mu_{c,L}^{(1)} \cdot k_{c,L}^{(\omega)} \cdot P^2 \cdot F(\beta, 1, \omega) \cdot \Im \omega \cdot [f_{hh}(E_{hh} k_{c,L}^{(\omega)}) - f_c E_c k_{c,L}^{(\omega)}] \quad (2)$$

here $F(\beta, 1, \omega) = [1 - \exp \beta \hbar \omega] \exp [\beta \mu - E_{hh}(k_{c,L}^{(\omega)})]$, $\zeta_c = 4 \frac{\alpha}{\hbar^2 \omega^2} \left(\frac{eA_0}{ch} \right)^2 P_{cv}^2$,

$$k_{c,L}^2 = \frac{2\mu_{c,L}^{(\omega)}}{\hbar^2} \hbar \omega - E_g, \quad \frac{1}{\mu_{c,L}^{(1)}} = \left(\frac{1}{m_c} + \frac{1}{m_v} \right), \quad \beta^{-1} = k_B T, \quad \Im \omega = \left\langle \frac{|e'_\perp|^2}{\sqrt{1 + \zeta_\omega |e'_\perp|^2}} \right\rangle.$$

Also, it can be seen from (13) that the linear-circular dichroism of one-photon absorption of light is determined by the quantity $\Im \omega$, which depends on the frequency and degree of polarization of light, the band parameters of the sample, which arises due to the complexity of the band structure of the crystal.

Note that if we disregard the effect of coherent saturation ($\zeta_\omega = 0$), then $K^{-1} \omega, T$ does not depend on the quantities mentioned above, in particular on the degree of polarization of light, i.e. is a constant number:

$\Im \zeta_{\omega} = 0 = \frac{4}{3}$, i.e. in this case, one-photon linear-circular dichroism is not observed. However, if we take into account the effect of coherent saturation, then $\zeta_{\omega} \neq 0$, which means that in this case one-photon linear-circular dichroism arises. This is due to the fact that for linearly polarized light

$$\Im_{lin} = \int_{-1}^1 d\mu \frac{1-\mu^2}{\sqrt{1+\zeta_{\omega}} \sqrt{1-\mu^2}}; \quad (3)$$

for circularly polarized light

$$\Im_{circ} = \int_{-1}^1 d\mu' \frac{\frac{1}{2} (1+\mu'^2) \mp P_{circ} \mu'}{\sqrt{1+\zeta_{\omega}} \left[\frac{1}{2} (1+\mu'^2) \mp P_{circ} \mu' \right]}, \quad (4)$$

where P_{circ} - degree of circular polarization of light, sign " \pm " refers to σ_{\pm} of the polarized light ϕ, ϕ' - angle between vectors \vec{e} and \vec{q} , $\mu' = \cos \phi'$, is the wave vector of a photon.

For example, in the case $P_{circ} = 1$ for linearly polarized light

$$\Im_{lin} = \zeta_{\omega}^{5/2} \left\{ \zeta_{\omega}^{3/2} + \zeta_{\omega}^2 \cdot \arcsin \left(\frac{\zeta_{\omega}}{1+\zeta_{\omega}} \right)^{1/2} - \zeta_{\omega} \cdot \arcsin \left(\frac{\zeta_{\omega}}{1+\zeta_{\omega}} \right)^{1/2} \right\}, \quad (5)$$

for circularly polarized light

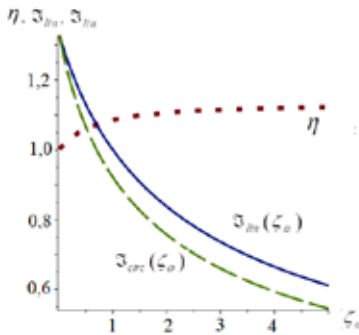


Fig. 1. Function graphs \Im_{lin} , \Im_{circ} and r_j factor of linear-circular dichroism depending on $\zeta_{\omega} \propto I$ (on light intensity) in Kane approximation in a narrow-gap crystal

$$\mathfrak{S}_{circ} = \frac{2 \zeta_{\omega}^{3/2} \sqrt{\zeta_{\omega} + 1} - \zeta_{\omega} \arcsin \sqrt{\zeta_{\omega}}}{\zeta_{\omega}^{5/2}} \quad (6)$$

Figure 1 shows the graphs of the functions $\mathfrak{S}_{lin} \zeta_{\omega}$ and $\mathfrak{S}_{circ}(\zeta_{\omega})$ depending on the value $\zeta_{\omega} \propto \left(\frac{eA_0}{ch}\right)^2 \propto I$. As can be seen from Fig.1, with increasing light intensity coefficient of interband single-photon linear-circular dichroism $\eta = \mathfrak{S}_{lin} \zeta_{\omega} / \mathfrak{S}_{circ} \zeta_{\omega}$ increases and tends to saturation, i.e. at very high intensity values ($\zeta_{\omega} \gg 1$) does not depend on the intensity and $\eta \approx 1.1$. For quantitative calculations, we used the data from [14].

Thus, one-photon linear-circular dichroism due to interband optical transitions in a narrow-gap crystal arises when the effect of coherent saturation is taken into account. However, in the case of interband multi-photon absorption of polarized light, linear-circular dichroism is observed regardless of whether the effect of coherent saturation is taken into account or not. This issue requires separate consideration.

Appedex

According to [12, 13], the effective carrier Hamiltonian for the three-band Kane model is expressed as follows:

$$\hat{H}^{eff}(k_z) = \begin{pmatrix} E_c & -i\sqrt{2/3}Pk_z & -iPk_z/\sqrt{3} \\ i\sqrt{2/3}Pk_z & E_v & 0 \\ iPk_z/\sqrt{3} & 0 & E_v - \Delta \end{pmatrix}, \quad (Ap.1)$$

whose eigenvalue is determined by the equation:

$$(E_c - E)(E_v - E)(E_v - \Delta - E) - P^2 k^2 (E_v - E - 2\Delta/3) = 0, \quad (Ap.2)$$

where $k_z = k = |\vec{k}|$. This equation has three solutions: $E_{cl} k, E_{lh} k, E_{so} k$.

From (Ap. 2) we have $k^2(E) = \frac{1}{P^2} \frac{(E_c - E)(E_v - E)(E_v - E + \Delta)}{(E - E_v + 2\Delta/3)}$ and with the help

of the last dependence the graph of $k^2(E)$ is built in Fig. 2. Fig. 2 shows that all energy bands are nonparabolic, and the quadratic dependence of the energy on $k = |\vec{k}|$ observed in the region of small values of the wave vector.

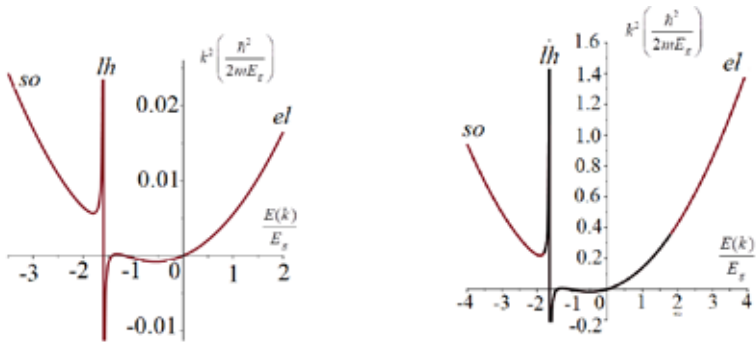


Fig. 2. Energy spectra of charge carriers in GaAs

($\Delta / E_g = 2,4$ $E_g = 1,42$ eV, $m_{el} = 0,067 \cdot m_0$) and
InSb ($\Delta / E_g = 3,4$ $E_g = 0,18$ eV, $m_{el} = 0,013 \cdot m_0$) in the three-zone
 isotropic Kane model, where the range of negative values of
 the quantity $k^2(E)$ correspond to the band gap and the spin-orbit
 splitting band.

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MARQUEURS GÉOCHIMIQUES DE LA RECHERCHE DES GISEMENTS PROMETTEURS DU MÉTHANE DE MINES DE CHARBON

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Les résultats de l'étude de la composition isotopique du carbone du charbon et du méthane dans les zones d'influence des déformations tectoniques sont présentés, ce qui permet de faire une conclusion d'une possibilité de la migration dans les couches carbonifères des gaz hydrocarbonés thermogéniques et d'une partie de la genèse abiogénique.

The results of research of isotopic composition of carbon of coal and methane are presented in the affected of tectonic violations which allow to draw conclusion about possibility of migration in the coal beds of hydrocarbon gases of thermogenic and some stake of abiogenic genesis.

Mots-clés: mine, charbon, méthane, isotope, carbone, gaz hydrocarboné, analyse.

Keywords: mine, coal, methane, isotope, carbon, hydrocarbon gas, analysis.

Au cours des dernières années, l'intérêt à la genèse, à la transformation et au potentiel générateur des hydrocarbures, qui forment des gisements du pétrole et du gaz, il a augmenté rapidement du fait du problème de l'épuisement des ressources naturelles et de la consommation industrielle universelle des matières premières. La recherche des sources d'énergie alternatives est un défi fondamental de notre époque.

Une alternative excellente du charbon, du pétrole et du gaz naturel peut être le gaz de mine, étant une matière première associée et, dans certains cas, une matière première autonome lors de l'exploitation des gisements de charbon.

L'utilisation du méthane provenant des mines de charbon comme source d'énergie autonome a été mise en valeur aux États-Unis après la première crise pétrolière. Après cela, l'industrie de méthane a pris une place digne

dans l'industrie énergétique, non seulement dans les États-Unis, mais aussi dans de nombreux pays européens.

Traditionnellement, on considère le méthane de mines de charbon lié génétiquement aux couches de charbon et à la matière organique dispersée dans les roches-hôtesse. Cependant, au tournant des XIX^e et XX^e siècles, pour le pétrole et le gaz naturel, et au début du XXI^e siècle, pour les gisements de charbon, les opinions des scientifiques se divisent en deux directions: la génération organique et inorganique des gaz hydrocarbonés. Récemment, l'exigence des vues et des concepts de la formation de gaz a été remplacée par la possibilité de la présence d'une petite quantité du gaz générée d'une autre manière. Ainsi, certains chercheurs pensent que la génération des gaz hydrocarbonés qui se passe dans le processus de la transformation diagénétique de la substance organique, tout en permettant la présence d'une petite quantité du gaz juvénile¹, les autres sont de l'opinion, que les hydrocarbures de la genèse abiogénique entrent dans la lithosphère dans la composition des fluides palléales par des fractures tectoniques profondes, sans nier le nombre insignifiant du gaz organique de la génération.

La théorie de l'origine organique du méthane est bien connue. Elle explique d'une manière exhaustive les lois générales de la diffusion du méthane dans les gisements de charbon sur la superficie et à la verticale dépendant de la composition de marque du charbon. Le travail est donc ciblé à la recherche des preuves de la genèse profonde du méthane, à l'étude des voies de sa migration et de son accumulation dans des pièges inconventionnels des couches carbonifères pour la récupération et l'exploitation à long terme.

Dès la seconde moitié du XX^e siècle, plusieurs savants de la Russie et de l'Ukraine: G.E. Boyko, K. N. Volossovitch, I. V. Grinberg, G. N. Dolenko, L. N. Kaptchenko, V. V. Kolody, A. I. Kravtsov, V. F. Linetsky, I. A. Petersilyé, Yu. F. Stepanik, E. B. Tchekaluk et d'autres, des idées de la synthèse inorganique des hydrates de carbone se développent intensément. Alors, on a reçu les données de laboratoires selon lesquels le méthane pouvait se polymériser aux hydrates de carbone lourds sous l'effet catalytique des silicates, des oxydes de fer et du nickel présents dans les masses minérales. Ces mêmes données ont montré que la synthèse des hydrates de carbone est possible de l'oxyde et du dioxyde du carbone et de l'hydrogène dans les conditions différentes en présence de roches catalytiques.

L'expérience des scientifiques étrangers confirme également la

¹On considère les gaz juvéniles comme les gaz migrants des formations carbono- et pétrolières plus profondes, générés suite aux réactions abiogéniques.

présence dans les roches sédimentaires du méthane de genèse abiogénique.

N.S. Beskrovnyi en résumant la confirmation de la possibilité du synthèse inorganique des hydrocarbures conduit aux faits:

1. Présence des réserves et des ressources du pétrole et du gaz dans les bassins sédimentaires ayant un lien génétique avec les grabens, les fractures profondes et les bords profonds des plaques lithosphériques, qui sont limités par des ceintures géodynamiques sismiques;

2. Présence des gisements du gaz naturel de l'âge néogène-quaternaire et de l'âge principalement cénozoïque des gisements du pétrole dans des roches-hôtes incompatibles à l'âge;

3. La présence des éléments optiquement actifs dans la substance spatiale, des composés organiques, y compris d'hydrocarbures;

4. La présence dans les produits du magmatisme d'origine palléale, du dégazage du manteau à chaud et des systèmes hydrothermaux du volcanisme moderne et ancien des composés hydrocarbonés, de l'hydrogène, du méthane, des alcools, du monoxyde de carbone, ainsi que d'hydrocarbures plus complexes.

5. Les résultats des études thermodynamiques, indiquant la possibilité de l'existence du méthane dans les conditions du manteau de la Terre aux températures à 1300-1500 °C et une faible volatilité de l'oxygène.

6. La présence du dégazage hydrocarboné de la substance du manteau dans des conditions «froides» non magmatiques, apparaissant sous la forme du dégazage hydrogène et méthano-hydrogène dans des zones perméables telles que la faille sismologique profonde de San-Andreas en Californie.

7. Loi de la diffusion du pétrole et du gaz à travers la coupe des régions pétrolières et gazières jusqu'au socle cristallin;

8. L'existence de la paragenèse de la minéralisation minérogène endogène à moyenne et basse température (les polymétaux, le mercure, l'uranium et d'autres) avec des teneurs non industriels d'hydrocarbures dans la périphérie pliée des bassins, ainsi qu'une haute concentration des métaux dans les gisements du pétrole à l'intérieur des bassins sédimentaires.

Il est bien connu que des grandes déformations tectoniques peuvent servir des voies de la migration des gaz profonds vers le massif carbonifère, pour cette raison un certain nombre d'études a été mené pour identifier les sources de génération des gaz hydrocarbonés.

Considérons les résultats des études isotopiques sur le méthane CH_4 et le dioxyde de carbone CO_2 , effectuées dans les mines «Zassyadko» et «Krasnolimanskaya» [1-4].

Sur le plan structurel et tectonique, le champ de la mine «Zassyadko» (couches l_1 et m_3) est compliqué par trois niveaux de charriage: Vetkovsky ($H = 15-60$ m), Panteleimonovsky ($H = 10-20$ m) et Grigorievsky ($H = 37-55$ m). H est une amplitude du niveau de charriage. L'analyse des matériaux à mesurage de l'échelle gravimétrique 1:200000 (réalisée par l'Université nationale des mines d'Ukraine) est établi que les niveaux de charriage énumérés étaient proches des failles du socle cristallin en termes d'orientation et de position.

Dans la mine «Zasyadko», des échantillons d'essai du gaz ont été prélevés dans des puits de dégazage forés dans la toiture de la couche de charbon l_1 , à l'approche des déformations tectoniques à petite amplitude, et dans des puits forés dans la couche de charbon m_3 à l'approche du niveau de charriage Vetkovsky. La composition chimique des gaz se déterminent avec le chromatographe LHM-8MD. La composition isotopique du carbone du charbon, du méthane et du dioxyde de carbone se déterminent sur le spectromètre de masse MI-1201B et le standard PDB est utilisé pour son analyse.

Lors de la transition successive par des travaux de deux zones des déformations tectoniques dans la couche l_1 , on notait la croissance en hydrocarbures lourds (à 8,6%), en hydrogène (à 0,14%) et en hélium (à 0,12%) dans la composition des gaz étudiés. On observait également une tendance à l'alourdissement du méthane et du dioxyde de carbone, le changement de la valeur de $\delta^{13}C_{ch_4}$ de -31,48 à -29,8 ‰, $\delta^{13}C_{co_2}$ de -24,9 à -17,2 ‰ avec $\delta^{13}C_{charbon} = -26,8 - 26,5$ ‰

Les deux zones de haute concentration du gaz du dépôt carbonifère se caractérisent également par l'approche de la composition isotopique du méthane et du dioxyde de carbone. Comme la convergence observée peut se produire soit avec la métamorphisation croissante du charbon, soit avec le fractionnement des isotopes du carbone entre CH_4 et CO_2 aux températures plus que 200°C. C'est pour ça, on observe la homogénéisation de la composition isotopique de CH_4 et de CO_2 indique que les zones détectées ont été formées par l'écoulement de gaz d'une source profonde.

La composition isotopique du carbone du charbon, du méthane et du dioxyde de carbone sélectionnés par paires de deux bouts du fond de trou de la galerie en couche m_3 à distances différentes du niveau de charriage Vetkovsky, présenté dans le tableau 1.

Tableau 1

N° échantillon d'essai	Distances du niveau de charriage Vetkovsky, m	$\delta^{13}\text{C}$, ‰		
		CH_4	CO_2	Charbon
1	206	-	-	-24,73
2	206	-42,50	-	-
3	206	-41,65	-	-
4	122	-24,36	-18,55	-
5	122	-35,13	-13,74	-
6	30	-30,30	-21,90	-23,63
7	30	-20,40	-21,35	-

À l'approche au niveau de charriage Vetkovsky, le carbone du méthane s'alourdit considérablement de -42,5 à -30,3 et -20,4 ‰. Ça indique une possibilité de l'écoulement du méthane lourd et ses apophyses (petites déformations mineures causées par le niveau de charriage principal) dans la couche carbonifère exploitée. Les valeurs de $\delta^{13}\text{C}_{\text{CH}_4} < \delta^{13}\text{C}_{\text{CO}_2}$ obtenues dans l'échantillon d'essai 7 indiquent la présence du méthane et du dioxyde de carbone génétiquement différents dans la couche de charbon. D'une part, la valeur élevée $\delta^{13}\text{C}$ peut caractériser le méthane équilibré avec des carbonates aux températures plus que 500 °C. Son écoulement le long du niveau de charriage Vetkovsky de la profondeur peut être suivi de la croissance de $\delta^{13}\text{C}$ de la composition générale du gaz. D'autre part, il est possible que le méthane généré aux fonds encore plus profonds ait migré le long du niveau de charriage Vetkovsky. Dans ce cas, la croissance des dégagements du gaz dans les mines peuvent être presque entièrement liées au gaz étranger.

Dans la mine «Krasnolimanskaya», des études de la composition isotopique du carbone du méthane et du dioxyde de carbone ont été effectuées dans le fond de la couche de la galerie de la couche k5 à l'approche de son fond à l'apophyse de la faille Gloubokoyarsky (H = 3,5m). H de la faille Gloubokoyarsky est de 20 à 86 m. La couche de charbon k5 et les roches-hôtes sur le site de la galerie sont modifiées par un réseau des déformations à petite amplitude. Lors de leur transition, on a enregistré un haut dégagement de gaz. En plus, on effectuait des études de la composition combinatoire des gaz dégagés des chaînes de montagnes. Les résultats des études ont montré que la concentration du méthane variait de 92,0 à 98,5 %, de l'éthane de 0,39 à 0,71 %, du propane de 0 à 0,36% et du butane – de 0 à 0,1 %. La concentration du hélium (de 0,05 à 0,19 %) et de l'hydrogène (de 0,0 à 0,002 %) croît dans les zones des déformations à

petite amplitude de la faille Gloubokoyarsky. Cela indique un écoulement hétérogène de ces gaz de la profondeur.

Les valeurs $\delta^{13}\text{C}$ du méthane dans le mélange des gaz de la couche carbonifère k_5 de la mine «Krasnolimanskaya» varient de -34,51 à -37,58 ‰, en témoignant une très faible tendance de la croissance à l'approche à la faille Gloubokoyarsky. Les valeurs $\delta^{13}\text{C}$ du dioxyde de carbone sont très dispersées - de -8,12 à -20,75 ‰ et diminuent à l'approche à la faille Gloubokoyarsky. Puisque l'enrichissement du dioxyde de carbone avec un isotope du carbone ^{12}C plus léger se produit à la croissance du degré de la incarbonisation du charbon, cette loi révélée témoigne l'écoulement du gaz carbonique léger des formations plus profondes.

La différence ($\delta^{13}\text{C}_{\text{co}_2} - \delta^{13}\text{C}_{\text{ch}_4}$) dans le mélange gazeux de la couche k_5 varie de 16,61 à 28,93 ‰ et diminue à l'approche à la faille Gloubokoyarsky. En généralisant les données sur les variations de valeurs $\delta^{13}\text{C}_{\text{ch}_4}$ и $\delta^{13}\text{C}_{\text{co}_2}$ au long de la galerie, on peut faire la conclusion que de la profondeur dans des déformations tectoniques entourantes la faille Gloubokoyarsky, le gaz s'élève, généré du charbon à un plus haut degré de l'incarbonisation aux valeurs $\delta^{13}\text{C}_{\text{ch}_4}$ и $\delta^{13}\text{C}_{\text{co}_2}$ plus proches de contenu en comparaison avec les valeurs propres à la couche k_5 .

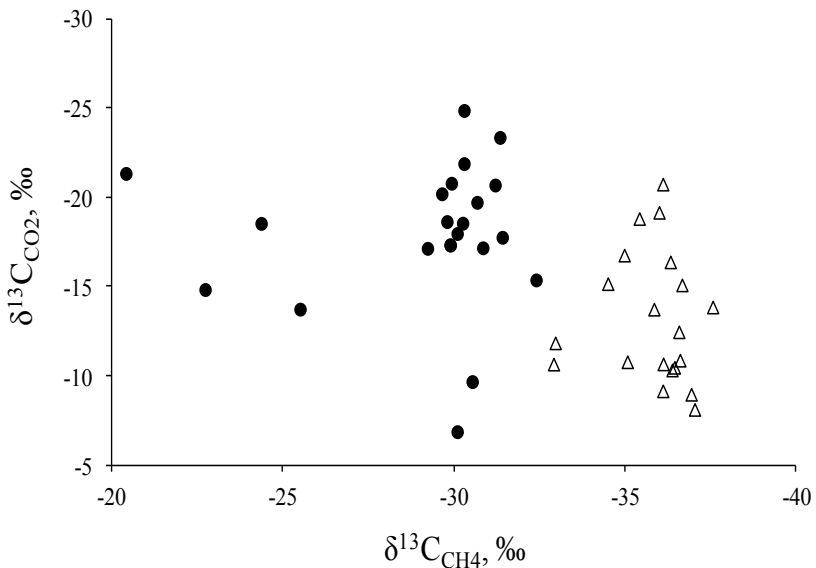
La comparaison des résultats des études effectuées dans ces deux mines est présentée dans le diagramme aux coordonnées $\delta^{13}\text{C}_{\text{ch}_4} - \delta^{13}\text{C}_{\text{co}_2}$ (img. 1).

Lors de l'examen de ce diagramme il faut également accorder l'attention à l'emplacement particulier des échantillons d'essai sélectionnés dans les mines Zassyadko et «Krasnoliman-skaya». Dans les échantillons d'essai de la mine Zassyadko on observe une variation significative des valeurs et $\delta^{13}\text{C}_{\text{ch}_4}$ (de -42,5 à -20,4) et $\delta^{13}\text{C}_{\text{co}_2}$ (de -24,88 à -6,5 ‰). Dans les échantillons d'essai de la mine «Krasnolimanskaya» il y a une grande dispersion des valeurs $\delta^{13}\text{C}_{\text{co}_2}$ (de -20,75 à -8,12 ‰), avec une petite dispersion des valeurs $\delta^{13}\text{C}_{\text{ch}_4}$ (de -37,58 à -34,51 ‰).. En moyenne, dans la mine «Zassyadko», la composition isotopique plus lourde du carbone a du méthane. Dans ce cas, plusieurs échantillons d'essai avec $\delta^{13}\text{C}_{\text{ch}_4} \geq 25$ ‰ contiennent du méthane avec une composition isotopique du carbone détecté dans les gaz volcaniques et les sources thermales. Dans la mine «Krasnolimanskaya», le gaz carbonique est plus lourd. Dans les zones des déformations tectoniques, ces différences sont considérablement intensifiées.

Il est à noter que les deux mines exploitent des couches de charbon de même composition de marque (marque de charbon G), mais elles sont situées dans des zones géologiques et industrielles différentes et exploit-

ent des mines aux profondeurs différentes (à la mine Zassyadko la couche l_1 – 1100 m, la couche m_3 – 1340 m; dans la mine «Krasnolimanskaya» la couche k_5 – 950 m). Ces conditions déterminent probablement les différences dans la genèse et les voies de migration du méthane profond dans les mines. Dans la mine «Zassyadko», on trouve du méthane proche de l'origine palléale, migrant à travers les fractures du socle cristallin et des déformations tectoniques dans l'épaisseur sédimentaire des couches supérieures du manteau. Dans la mine «Krasnolimanskaya» le méthane domine, formé dans le charbon à un degré de carbonisation plus élevé à la profondeur plus forte que celle de la couche k_5 , et a migré dans la mine à travers un ré-seau des déformations tectoniques.

Il faut dire que, selon les travaux de Voytov G.I. [5], Gavrilov E.Ya., Ermakov V.I. et Teplitsky G.I.[6] la composition isotopique du carbone du méthane des couches carbonifères de Donbass varie en mesures de -65 à -29 ‰, qui détermine la présence des gaz de charbon hydro-carbonés thermogénétiques et biogéniques ($\delta^{13}C_{ch_4} < -50 - -60$ ‰), et le carbone du méthane à la marque isotope -20 ‰ Colombo [7] peut être certainement estimé abiogénique.



Img. 1. – Diagramme de la diffusion des échantillons d'essai étudiées aux coordonnées $\delta^{13}C_{ch_4} - \delta^{13}C_{co_2}$. Les résultats du mesurage ont l'inexactitude de la méthode chimique $\pm 0,5\%$

La composition isotopique du carbone du méthane obtenue par l'auteur indique certainement la présence du gaz thermogénétique et probablement d'une certaine proportion du gaz abiogénique dans les zones d'influence des déformations tectoniques.

Selon ces idées, les zones d'influence des déformations tectoniques causées par des structures profondes et des failles cristallines peuvent être considérées comme des sites d'extraction des gaz hydrocarbonés qui, avec des réactions chimiques constantes dans les sous-sols de la terre, seront alimentées par le méthane d'origine profonde.

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