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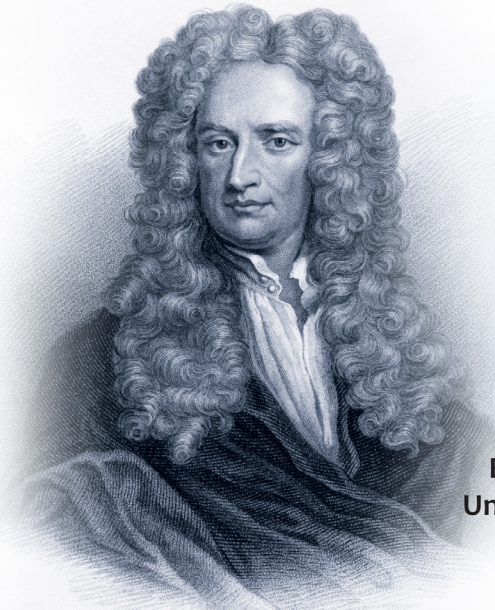

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CONTENTS

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SOME APPROACHES TO A DECREASE IN THE COSTS OF AGRICULTURAL PRODUCTS MANUFACTURING

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Abstract. The article describes some approaches to a reduce of production costs of agricultural producers. The main sources of information were: the results of experimental investigations, carried off in Verkhnevolzhsky Federal Agrarian Research Centre (Russia) in the field crop rotation; production and finance documentation of “Rassvet” APC (Ivanovo region) and “Suvorovskoe” CJSC (Vladimir region); photochronographic observations, conducted at some agricultural organizations. In the work the follow methods were used: system and situate approaches, methods of comparative analysis, analysis of breakeven, method of net cost calculation “Direct – costing”. The main approaches are: the use of scale effect and production diversification; choice of rational agricultural system, production intensification level, system of machines, fertilizer so on; choice of cheaper materials, selection of the less expensive technological operations and them combinations based on situational approach, in particular, taking into account weather conditions. As well as the matter of efficiency of input costs for crops cultivation is described.

Keywords: cost saving, scale effect, diversification, intensification level, fertilizer system, cheap materials, efficiency of costs.

Introduction

At present, it is obvious that such a segment of the organization's management as cost management is becoming more and more important. This is determined by the fact that in a market economy, the prices of a product tends to balance, and the economic entity that has lower production costs wins the competition. Besides, in conditions of an increasing importance of

the social component of society's development and an increasing occurrence of the force majeure situations, commodity producers have less opportunities to influence sales prices. For these reasons, an economic organization (market subject) should have a clear, effective cost management system [1].

During of an economic crisis, the role of cost management at the microeconomic level is not reduced, but on the contrary, increases, because the increasing degree of indetermination in the macro situation reduces the motivation to expanding production for commodity producers, and they can choose a less risky strategy - waiting and saving costs. In this regard, the issues about reserves for reducing the net cost of agricultural producers' products are relevant. The aim of this work is to develop basic approaches to reduce the net cost of agricultural products at the micro economic level, within of economic entities at agricultural branch.

Conditions, materials and methods

Subject of investigation was a saving cost at agricultural organizations and farms. The sources of information were: science literature, results of the experimental investigations, carried off in Verkhnevolzhsky Federal Agrarian Research Centre (Russia) in the field crop production. As well as we used production and finance documentation of "Rassvet" APC (Ivanovo region, RF) and "Suvorovskoe" CJSC (Vladimir region, RF), photo-chronographic observations, conducted by us at these agricultural organizations. In the work the follow methods are used: system and situate approaches, method of comparative analysis, analysis of breakeven, method of net cost calculation "Direct – costing". For empiric calculations, we used a special software tool "HOST -2.3" (no.2015610045 Certificate of state registration in Federal Service for Intellectual Property).

Results and discussion

We will describe some approaches to the cost reduction of agricultural products. At the first, we will clarify that this process in principle consists of 2 components: a reduction of costs per unit of production area or head of livestock or within structural sector and it's reduction per unit of products. In the approaches that will be developed below, these two processes are implemented in parallel; in this article, we do not separate them from each other. The approaches will be developed in the direction from general to specific ones.

1. At the first, the most common approach we call "the use of the scale effect". It is well known that in large enterprises the costs per a unit of product are lower compared to small ones [**2**]. This is from the lower share of overhead costs, distributed per unit of product, due to the significant volume of it production.

However, there is a critical size of the production scale at which an its further expansion will be associated with various types of risks, including the risk of "unsold" products. In this case, the company should adopt a “diversify production” strategy and expand the product range. This strategy is applicable to agricultural enterprises with any specialization and structure of commodity products, having both crop and livestock production lines. Diversification can be expressed in the introduction of new agricultural crops into production, for example, valuable feed crops, so the effect will be expressed in the cost reduction of livestock production. In case of introduction of crops, the products of which are in a demand on market, the additional costs will be compensated by excluding the risk of not selling. From an agro-economic point of view, it is very effective to improve crop rotation and this just is related to the diversification of production. We have found that the "crop rotation" factor produces an effect that is sometimes comparable to the "fertilizer" factor [3], when an impact on crop capacity, but the costs of introducing crop rotation (and in practice, as a rule, it is simply about keep up the developed crop rotation scheme) are minimal, while the cost of chemical fertilizers is extremely high. From the above, we can conclude that production costs are reduced when crop production is diversified and crops are grown in improved crop rotations, that does not contradict the "scale effect".

2. The Next approach from the category of the most general ones - the choice of a rational system of agriculture. In context of this article, it is advisable to focus on precision farming [4]. Most modern scientists do not doubt the importance of its application. But we identified, when studied thematic literature, that this concern mainly to a reduction of fertilizer expenses (by 20-30%) and fuel expenses. This researches were conducted in science establishments. However, in our opinion, precision agriculture is contrary to effect of scale and from this position can lead to an increase in costs.

Practically there is no research about how an expenses after introducing of a precision farming system will be changed within a typical non-Chernozem agricultural organization in terms of taking into account the entire number of factors in the aggregate. Undoubtedly, that in the some micro plots the savings of fertilizer and fuel costs will be achieved. However, in general, the company's costs may increase due an increase in wages of precision equipment workers (by 30-50%), as well as employees of the management apparatus. In addition, the downtime of technic means will increase, additional time will be required for re-completing of mobile aggregates, time and costs for them additional moving. It should also be

taken into account that the amount of depreciation charges will increase at purchasing of new equipment and modern control means, etc. So, the solution of problem about introducing of precision farming into production in agricultural organizations requires further serious scientific research namely in production conditions.

3. Selection of rational fertilizer systems, machines, seed production and the level of production intensification.

In each economic entity, in order to organize an effective cost process, it is important to determine the rational level of production intensification, which is associated with a certain level of costs. Currently, it is quite obvious that maximum input costs to the achievement of maximum crop capacity do not provide an highest income or the optimal level of costs is the level at which the maximum possible crop yield isn't achieved, but the maximum income. For example, Czech scientists [4] analyzed the relationships between crop yields, production costs, income, and grain quality. They found that the maximum investment required to obtain the maximum crop capacity does not provide the highest income. In the conditions of fertile soils of Central Moravia, the optimal income per hectare of winter wheat was obtained at a cost level of 11,000-12,000 CZK/ha or approximately 33,000 rubles/ha at the exchange rate of 11.05.2020. Moreover, the yield of winter wheat in this region was 10 t/ha or higher. The paper summarizes that high rates of profitability are achieved due to the efficiency of investments, and not by increasing their volumes.

Further, for comparison, we will present national data. In the conditions of the Vladimir opolye, according to experimental data of the Verkhnevolzhsky FARC (Russia) for the 3rd rotation of the field 7-section crop rotation (2009-2015), the maximum income in the production of winter wheat (in the amount of 29405 rubles/ha) was observed with an organic mineral fertilizer system in "M_{60} + $N_{40}P_{40}K_{40}$" variant with technological costs of 20280 rubles/ha. The yield was 5.23 t/ha, which is by 11% lower than the maximum one achieved with the intensive fertilizer system in the "M_{80} + $N_{80}P_{80}K_{80}$" variant, while the cost level is by 26% lower. These data confirm the conclusions made by Czech scientists. The choice of the level of production intensification should be implemented with accounting of the characteristics of soil and climatic conditions, properties of agricultural landscapes; production, labor and socio-economic potential of the enterprise. Our researches have revealed that on gray forest soils "extensive" agricultural technologies are the least expensive. Given the current ratio of prices between agricultural products and purchased means of production, they provide the highest cost recovery on technological expenses. However, the

use of extensive technologies leads to the degradation of agricultural landscapes, so we should make a choice between technologies of “normal” and “intensive” levels that do not cause environmental degradation [6].

According to our calculations, the return on technological costs associated with the use of organic-mineral fertilizer systems corresponding to the normal level of intensity is 2,48 rubles per 1 ruble of variable technological costs (without depreciation charges), and at the intensive level – 1,97 rubles/ruble. These are the results of the calculation at 2019 prices. A detailed calculation at 2017 prices was shown in the source [7]. From the above data, it follows that the cost and yield levels in the first example (Czech Republic) corresponded to the intensive level of production, in the second one (Central Russia) – normal one. In order to select a rational technology of a certain level for the production conditions of an each economic entity, a number of special computer software has been developed. In this regard, the scientists of the Kursk Federal Agricultural Research Center have created the special computer software tool "Support System for agricultural producers on the rational choice of highly profitable adaptive technologies for the cultivation of grain crops" [8].

For the conditions of Verkhnevolzhsky region, we recommend for the medium-term perspective to use agricultural technologies mainly of a normal level (in the production of cereals), although a number of enterprises have the production and technical potential for the introduction of intensive technologies. The suggestion made by us to expand potato planting in the Vladimir region is justified by the fact that the additional costs of intensive technologies in the production of this crop (in contrast to grain) are paid by additional revenue from the sale of products (in number experiments of Verkhnevolzhsky Federal Agrarian Research Centre). At the same time, the amount of precipitation and photosynthetic active radiation used by this crop is lower than by grain crops.

Regarding the choice of fertilizer systems, our previous research [7] proved that the use of mineral fertilizer system in comparison with organic-mineral fertilizer system requires 5-30% less investment per 1 rubles of product value. The calculation for modern conditions showed: direct variable costs (without depreciation charges) plus general company’s expenses at the using "$N_{40}P_{40}K_{40}$" system in the field crop rotation were 0,37 rubles per 1 ruble of the product’s value, and in the organic-mineral system "M_{60} + $N_{40}P_{40}K_{40}$" – 0,40 RUB/RUB (on crop rotation in whole). Since organic fertilizers are applied once over crop rotation in a productive fallow, it is interesting to compare the corresponding costs for spring wheat, which was cultivated after a productive fallow. Here the results are as follows: the

cost of the mineral system was 0,26 rubles/ruble of product, with organic-mineral – 0,43 RUB/RUB. These results were obtained on grey forest soils.

However, from the view point of medium - and long-term prospects, it is still advisable to use organic-mineral systems as environmentally more justified. The mineral fertilizer system can be considered as subsidiary for situations when the enterprise cannot use organic fertilizers with their transportation over a distance no more than 5 km, or when it plans to adopt a strategy of survival and cost savings during a crisis.

4. The following approach has a particular character and consists in an exchanging expensive materials with cheaper ones and the selecting less expensive technological operations (according to the situation). For example, we found that the technological costs of production and application to the soil for green manure (Vetch-oat mixture) were 1,2-1,7 times lower than for manure (depending on the distance of transportation of organic fertilizers). This dependence is observed in the absence of applying any fertilizers for the sideral culture [9]. Another example concerns the use of phosphogypsum as a meliorant and sulfur fertilizer. Already an comparison the purchase prices of phosphogypsum with the prices of sulfur-and phosphorus-containing fertilizers gives an idea of the economy when using the first. For reference: the price for 1 ton of phosphogypsum is 600 rubles, superphosphate - 23000-28000 rubles, ammonium sulfate 9300 rubles, potassium sulfate - 26600 rubles and more.

According to our calculations, performed on the data of All-Russian research Institute of Agrochemistry named after D. N. Pryanishnikov for 2013-2015 [10] in the crop rotation the link "potatoes-barley-potatoes", the lowest technological costs per ruble of the product's value (with a full production cycle) were observed at a dose of phosphogypsum 1,5 t/ha. They were 0,39 rubles/RUB, which corresponds to approximately 120% of the production profitability level. Interestingly, at the same dose of phosphogypsum, the highest yield was obtained. That is, the price of phosphogypsum is so low that it has not made any corrections to the dynamics of efficiency on product's yield at comparison with the dynamics on costs. At the same time, it was found that the productivity of the crop rotation link increased by 19,3-24,4% or by 30,2 – 38,1 t/ha due to the introduction of phosphogypsum in doses of 1.0, 1.5 and 3.0 t/ha in comparison with control variant. These results were obtained on sod-podzolic soils.

In agricultural organizations in the it's dairy farming sub – branch, cost savings of at least 2 times, according to experts, are provided by the use of a feed distributor-mixer due to a reduce of transport expanses and excluding of waste at the consumption of feed itself by animals.

Only through economy and thrift you can reduce costs, choosing beneficial suppliers of production means, observing the rules of storage of organic and mineral fertilizers, not using machinery and transport for perform "left" work, "manipulating" of technological parameters in depending on fluctuations in weather conditions.

Possible variants of technological techniques (operations) and their combinations in situations of "drought – over wetting" are presented in the table, also here the change in costs is shown at a change traditional technique (complex of techniques) with appropriate ones in an adverse weather situation. The table was compiled by us on the basis of expert survey, literature, our previous investigation and photochronographic observations.

Table - Changes in costs and production results when technology changes due to deviation of weather conditions from norm

Vegetation period, the stage of the production process	Weather conditions	Technological method (operation)	Change in cost
1. Soil preparation and the sowing of spring crops	High humidity of soil	Disking, cultivation, harrowing with a tooth harrow, rolling, seeding, post-seeding rolling	-
2. The same	Drought	Closing of moisture, minimal tillage and seeding with a combined mashine (implyisng that autumn plowing was realized)	Reduction of direct costs per hectare by 50% or more in the spring and by 15 % taking into account works of the not completed production (in autumn)
3. The same	Drought	Flat-cut processing: cultivation by KPE-3,8, harrowing by BIG-3 (implying that an autumn deep loosening without turnover of soil layer was realized)	Based on the full cycle of crop production in the field crop rotation when replacing traditional tillage with flat cutting it is possible to expect a reduction in direct costs per unit of product by about 3-4% *
4. The same	Overwetting	If the weather did not allow us to harvest annual grasses for hay on a productive fallow, we can plow down them as a green fertilizer	The technological costs of production and introduction of green fertilizer (vetch-oat mixture) by 1.2-1.7 times lower compared to the use of manure (without application of any fertilizers for sideral culture)

5. Harvesting of grain	Overwetting, plant stems are lying on the ground	Harvesting with harvesters equipped with stalk lifts	The minimum increase in costs is covered by the harvested crop
6. Spring and summer	Wet and cool weather, the grain is not ripe	Harvesting of grain crops for fodder purposes (grain- haylage)	Since feed of own production is included in the cost of livestock products as net cost, changes in costs are equal to changes in results
7. Spring	Drought	On potatoes - a change of a spring ploughing to deep loosening without turnover of soil layer	Costs are about 10% lower
8. Spring	Drought	We plant potatoes without preliminary formation of ridges	The cost of formation of ridges is not made
9. Spring and summer	Drought	On potatoes, instead of 3 hilling, we use a greater number of inter-row mechanized treatments, but shallow (to a depth of 2-6 cm) and only one hilling	The additional costs will be recouped by the value of additional harvest

*according to our calculations based on experimental data published at source [11].

For example, at a change of the traditional set of technological methods (operations) for preparing of soil and sowing of spring cereals (table, line 1) with the use of Rabe Mega Seed combined machine (line 2), the technological costs per hectare are reduced by 50% and more in the spring, and by 15 % taking into account the costs of works of the not completed production (in autumn). These data were obtained as a result of photochronometric observations, conducted in the “Rassvet” APC of Gavrilovo-Posadsky district of the Ivanovo region. Or another example: in the conditions of a dry spring, it is advisable to changed the dump spring plowing, for example, for potatoes, with a deep loosening without turnover of soil layer, that will reduce costs by about 10 %. In the same conditions, we can plant potatoes without preliminary formation of ridges, that is, there costs for conducting of this operation will be missing. As well as cost reduction can be achieved by applying flat-cut pre-sowing tillage (line 3).

5. In the context of this article, the last paragraph, in our opinion, should be devoted to the matter of the effectiveness of investments at agricultural

production. Indeed, saving on the purchase price or reducing material consumption, it is not always possible to achieve a real saving if we do not try to get the maximum return on the means of production. A number of scientists suggest such measures to improve the efficiency of funds invested in plant cultivation as fractional fertilization during the growing season, local method of their application, the use of precision technical means, the use of measures of interest and responsibility of workers for compliance of technological discipline [12], modern automated means of management and controlling for the production process.

Undoubtedly, one of the important ways to increase the efficiency of investments is to use a synergistic effect. This is a "win-win" option - to use as many factors as possible that affect crop yields. This conclusion is confirmed, in particular, by analysis of the experiment results on a 7-element field crop rotation [11]. According to our calculations, the sum of additional incomes from the action of each factor separately amounted to 2327,4 rubles from 1 hectare (of which 1780,4 rubles due to fertilizers and 547 rubles due to herbicides). From the combined action of these factors, the additional income amounted to 3854,9 rubles/ha, which is by 66% more with the same level of expenses.

Conclusion

The article described some approaches to a reduce of production costs at agricultural producers. The main they is: the use of scale effect and production diversification; the choice of a rational agricultural system, a system of machines, fertilizers, the level of production intensification; the choice of cheaper materials, the selection of less expensive technological operations and their combinations based on a situational approach, in particular, taking into account weather conditions. The matter about investment efficiency in cultivation of crops was also considered.

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TEACHING THE RUSSIAN LANGUAGE TO FOREIGN STUDENTS. NEW PEDAGOGICAL REALITIES: SPEECH OR SYSTEM?

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Abstract. The article deals with the issues of increasing the effectiveness of teaching Russian language to foreign students at the pre-university stage in the context of modern pedagogical conditions. The authors note the peculiarities of the organization of the content and procedural aspects of the educational process in distance learning. The necessity of priority development of speech and communication skills is substantiated, ensuring the possibility of successful mastering of scientific-subject courses and continuing education at the university. Working methods with educational material are proposed that increase the mental and meaning-forming activity of students, contributing to their participation in intercultural dialogue and the implementation of educational and professional activities.

Keywords: speech activity; distance learning; semantic activity of students; educational and professional competence; intercultural communication.

Improving the effectiveness of teaching foreign students in Russia is an important task for all levels of secondary specialized and higher educational institutions in the context of Russia's foreign policy and intercultural relations with other countries. The solution to this problem requires the study of modern pedagogical conditions that affect both the forms of organization of the educational process and the methods and means of teaching.

When analyzing the problems of increasing the efficiency of teaching Russian language to foreign students at the pre-university stage, we con-

sider it expedient to single out three interrelated groups of pedagogical conditions that determine the choice of adequate means and methods of interaction between the subjects of the educational process.

The first aspect is a set of issues directly related to the object of study - the Russian language, research and consideration of its specific lexical-grammatical, syntactic, compositional-textual features, as well as the peculiarities of its functioning in modern educational and scientific literature. The results of the study of this issue form the linguistic basis for the selection of linguistic means necessary for the implementation of the communicative, cognitive and the other Russian language functions.

The second aspect of the totality of pedagogical conditions is a complex of problems related to the student's personality - the subject of the educational process, his psychophysiological, national-ethnic, social characteristics, cultural and educational level. It is obvious that the identified personal characteristics of the trainees, their subjective experience play an important role in organizing educational material, choosing methods, forms and means of teaching.

The third component of the set of pedagogical conditions are considered the factors associated with the formal and organizational issues of training foreign students in Russia, the conditions of admission to universities, terms of study, the availability of modern teaching aids, as well as the forms of organizing training in the first year of the university.

Regarding the first aspect, that is, the subject of instruction, namely the Russian language, the main feature in the context of teaching foreign students should be highlighted - its dual function in the educational process: it is both the goal of learning and a means of obtaining a future speciality. It is important to note that teachers tend to consider the study of Russian as a goal, and students believe that they need Russian in the volume and quantity that would allow them to understand educational information in Russian and transmit it in a form that is understandable for the interlocutor [4].

Nevertheless, the curriculum for foreign students includes both the mastery of the general literary language, its lexical and grammatical system, and the language of the future speciality. It should be noted that the practice of teaching foreign students the language of the speciality has been around for sixty years. Its basic concepts are defined and substantiated; the training tasks and goals, the principles underlying the selection and organization of educational material are formulated; there are many textbooks for different stages of training and a variety of methods at the teachers' disposal; communication needs and competencies are determined, etc. [7]. At the same time, individual experience, teachers' personal

preferences detect a variety of approaches both to the issue of teaching the language of science in general and to the issue of preparing students for the study of general theoretical disciplines at the pre-university stage of education.

The purpose of the introductory-subject course is to ensure the assimilation by students of basic general scientific and terminological concepts in specialized disciplines, the main morphological and syntactic structures of the scientific style of speech. The basic scientific and subject information is represented by small texts introducing linguistic material [3]. When studying the introductory-subject course, in our opinion, it is necessary to pay special attention to mastering the phrases of the so-called organizational-incentive block. These are words and phrases such as “read the title of the text (topic, chapter)”, “read the first (next, last, etc.) paragraph of the text”, “name the topic of the lesson”, “find answers to questions in the text”, “translate and write down the meanings of unfamiliar words (terms)”, “correct mistakes”, “prepare for the test”, “log in to the platform and complete the assignment”, etc. Students also need knowing the interrogative words, such as *где* (where), *что* (what), *когда* (when), *откуда* (from where), *почему* (why), *сколько* (how much), etc.

However, it cannot be said with complete certainty that students have mastered this vocabulary well if they understand the questions in the assignments and answer them. It is necessary to take into account the peculiarity that when answering a question in the text, the context helps to understand the entire interrogative sentence and to answer using parts of the sentences, but the context is often incomprehensible at the lessons in general theoretical disciplines. This can be easily verified by asking students to translate each individual question word into an intermediary language. Students tend to have difficulties.

We can say that if a student is able to answer the questions *где?* (where), *что?* (what), *когда?* (when), he has mastered the first level of language proficiency. If he can answer the questions *почему?* (why), *для чего?* (what for), *зачем?* (for what purpose) – this is the second level; if a student can answer all these questions without a Google translator, he has mastered the third level.

The need for trainees to have good command of this vocabulary at the level of understanding is all the more obvious during video lessons. The teacher cannot walk around the classroom and point out in the textbook where to read from; the student does not have a classmate nearby who will promptly tell what to do. It should be understood that if we give students a list of the required vocabulary with an assignment to read, write, translate

and learn, then the result is unlikely to be positive. It is necessary to practice vocabulary, at least at the level of understanding. Further, as practice shows, students should master the skills of reading well, but not reading the learned or familiar words and texts. Students need the skills of quick reading, voicing of unfamiliar, polysyllabic, difficult to pronounce Russian words, including general scientific and special scientific terms.

It would seem a difficult task, but in practice it is all about motivating students. Of course, we can recommend reading textbooks on chemistry, biology, physics, any others. This is useful, but of little interest. Another thing is to suggest buying a colourful, illustrated magazine in Russian for reading. It turned out to be interesting. After such a recommendation, usually the next day, students willingly showed various magazines, looked at photographs and read, read. The results were amazing. They competed in reading speed and told how long they trained. By the middle of the second week of training, they read at a speed of 45 to 75 words per minute, and this is not the limit [10]. According to psychologists, correctly, confidently voiced and translated word is quickly and firmly remembered. Unsure, with difficulty, with hesitation and phonetic errors, the read word is not remembered in the text and is not recognized in the speech stream. Of course, we are not talking about understanding the content read, but this is a completely different story.

Another skill that students will need in general theoretical disciplines is, of course, writing. It should be writing legible, quick, understandable not only to the author. The student's ability to copy quickly from the blackboard or write out the necessary information from the book allows him more time to listen to the teacher and analyze what he heard. A student who reads and writes well feels confident and psychologically comfortable.

Further, we consider it necessary to note a skill, the development of which will ensure the formation of such an important competence in the process of teaching the Russian language as the ability to monologue (dialogical) speech. In addition to the sociocultural sphere of communication, this competence will allow students, first of all, to participate successfully in the educational process – to answer at seminars, exams, and speak at conferences [8].

As the experience of practical work shows, already in the first weeks it is possible to develop effectively the students' ability to retain in memory not only the words they heard or read, but also phrases, sentences, whole paragraphs. It is advisable to recommend that students adhere to the following rule – read, comprehend, repeat without looking at the text. If, in the process of completing lexical-grammatical or communicative tasks, stu-

dents systematically practice this, then they will not have problems with retelling large-volume biology texts.

And one more aspect that we would like to say in connection with preparing students for the introduction of general theoretical disciplines is to recommend them to open textbooks on chemistry, biology and other subjects in their native language more often and read the upcoming topic before the lesson. Students should understand that good knowledge of the Russian language does not help if the subject is poorly mastered at the school stage.

In connection with the above, questions remain open: “What about the cases, the prepositional-case system of the Russian language, etc.? What do trainees need to know?" We can say with confidence that students should know that there is a prepositional-case system in the Russian language. At the same time, the endings of most nouns, adjectives, etc. change, which practically do not change their lexical meaning (with rare exceptions); and to understand the word's meaning, you need to look at its center, that is, at the root. And students are well aware that the main objective at the lessons in general theoretical disciplines is a quick and correct comprehension of scientific and subject information and its response transmission in an understandable form. Of course, in Russian language lessons, where language acquisition is the goal, and compliance with language norms is a priority and an important criterion for the proficiency level in speech skills, students should use a different reading tactic.

The next question concerns the organizational aspect of the totality of pedagogical conditions. As it has already become obvious, its defining feature is distance online learning for nearly most levels of the educational system in Russia, including for foreign citizens admitted to Russian universities. This form of education is completely new for the most part of educational institutions; it demanded significant efforts in organizing the educational process. Special problems have arisen at preparatory faculties for the training of foreign students living not only in different countries, but also in different time zones and speaking different languages. The teachers, methodologists were faced with a difficult task – in a short time to prepare the necessary teaching aids, adequate to the new pedagogical conditions. Educational platforms were created in each department. They were supposed to become both electronic libraries and auditoriums where students could listen to lectures, independently complete assignments, control works and tests. Enthusiastic teachers, methodologists updated the learning and methodological base, created manuals that meet the requirements of the new educational conditions, and attracted electronic in-

formation resources from the Internet. In a short time, these platforms have become real electronic educational and scientific centers, where the best training literature for all specialities and profiles is collected.

Distance learning continues and gains momentum, constantly, gradually changing our usual ideas about the forms, methods, means of teaching, about the effectiveness of certain methods of presenting educational material, the expediency of developing skills in a given situation, etc. So, computer presentations are confidently included in the arsenal of methodological techniques in the process of teaching foreign students the language of the future speciality. They are aimed at the development of a scientific professionally-oriented conceptual base, mastering the linguistic means characteristic of the language of science, the formation of speech and scientific-subject competences, the intensification of the semantic-educational activity of students [2].

It must be understood that by pumping one system into another system, we get the system at the output as well. The Russian language training materials posted on the educational platform represent a specially organized system of the Russian language. Studying textbooks on their own, students work out primarily lexical and grammatical material, developing language skills. Of course, the textbooks present speech models, samples, but how to work them out – the trainees do not know. After all, the goal of teaching foreign students at the pre-university stage is to master speech activity, that is, the skills of reading, speaking (dialogical and monologic), writing (reproductive and productive), as well as listening, including listening and note-taking lectures in the speciality. However, as we can observe, with distance learning and independent work on an educational platform, students acquire almost only skills such as reading and writing with the help of a Google translator. If we talk about reading comprehension, about the ability to find the necessary information in the text, students will translate any text in a matter of minutes and answer any question using an electronic dictionary. Now we cannot even roughly imagine what the real stock of general literary and special vocabulary of a student is. Only reading the text in the classroom in the presence of a teacher will help answer this question. Is it necessary to demand from the learners to memorize new words, excluding, of course, the most communicatively significant, if it has become so easy to find out the meanings of words? Psychologists, teachers, methodologists still have to think about this seriously.

Obviously, in this situation, the only opportunity to transmit the theoretical knowledge and language skills obtained as a result of students' independent distant work to the level of speech communicative skills are video

lessons, during which real speech activity of a whole group of communicants is possible. The question arises of how to organize the content of the educational material and its procedural aspect most effectively.

As practice shows, an important factor that enhances semantic activity and increases its efficiency is the expansion of the information space when compacting content. We mean that the lesson's information space expands when its educational content is combined with facts, events, phenomena of the surrounding reality that go beyond the lesson. The density of the lesson's content is carried out when it is saturated with a variety of linguistic and speech structures, extralinguistic information, etc., which intensify the mental and semantic activity of students [1].

A good effect is achieved when several functions are superimposed on one language or speech model, structure. For example, at the beginning of the lesson we ask what date it is, what day it is. At the same time, these questions perform not only the function of an organizational moment, but also help to repeat or introduce interrogative words *какой, какая, какое* (which), and use them when working with adjectives and numerals.

Speaking about the intensification of the educational process during video lessons, we should also note the need to use various types of the integration of the educational material content, depending on the stage and forms of work with it. So, when working on lexical material, it is possible to compare the volume of meanings of lexical units in the Russian language and the intermediate language (interlanguage integration). Consideration of the word from the point of view of its use in different styles of speech (interstylistic integration), etc., is of considerable interest [6].

A particularly important place in the structure of the video lesson, in our opinion, should be occupied by work on the development of oral dialogical and monologue speech based on the text read or heard. This is the only way the teacher can assess the real skills of reading and comprehending text material. Only in the course of a conversation, a discussion on the content of the text in the conditions of the educational communicative situation created by a teacher, speech and communication skills develop. It should be noted that when working with the text, one should avoid direct questions (the students will easily see the answers to them in the text) and ask questions, the answers to which are only implicitly contained in the text: there is no direct answer in the text, but the information allows one to make the necessary conclusion.

In addition to the presentation of the most important lexical and grammatical material and the development of oral speech based on textual information, a certain place in the structure of the video lesson, in our opin-

ion, should be occupied by a block of material focused on the development of intercultural communication skills. This is especially important when trainees are deprived of the opportunity to get acquainted with our cultural traditions personally and communicate with Russian people directly. Obviously, since modern technical capabilities, the Internet allows everyone to get almost complete information on any issue, including country-specific one, there is no need to demonstrate ethnic materials during video lessons. Having received the task to view on the Internet or on an educational platform certain material about any fact of “foreign language” culture as a spiritual instance and express their attitude, their understanding of what they saw from the perspective of their culture, their national tradition, the students are ready to participate in intercultural communication. During the video lesson, the teacher and students, as equal participants in the process of intercultural communication, carry out a dialogue of cultures, using certain linguistic means and speech patterns [9].

In the modern educational environment conditions, the relevance of maintaining the openness of students' learning activities, their existential intentions, discovering the true motives and causes of trainees' certain manifestations, actively influencing their semantic-educational process, transferring actual universal values to the each student's personal level also increases [5].

So, distance learning is a new reality. Students master independent work on the educational platform, learn to understand the interlocutor in Russian, and communicate at a distance. But they also dream of coming to Russia, entering the classroom and meeting with a teacher who has already become a good acquaintance and even a close person. We all hope that the pandemic will end soon, students and teachers will return to the classrooms, but there will be slightly different students and other teachers. These will be students who have learned to work independently and take responsibility for their knowledge on themselves. These will be teachers who have already mastered not only modern forms of education, but also many functions of computer technology new for them, learned how to use them in the educational process, make the best use of a lesson time for the development of speech, communication, professionally oriented skills and competencies; to develop the educational level of students through interpersonal cultural dialogue, increasing spirituality and contributing to the formation of new semantic structures of the personality.

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TRAINING OF HIGHLY QUALIFIED PERSONNEL: A RETROSPECTIVE ANALYSIS

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Abstract. The article deals with the issues of training highly qualified personnel. A special feature is the study of educational trajectories in the context of scientific and educational research activities. The emphasis is on the art of choreography and dance culture.

Keywords: personnel, qualification, competencies, choreography, dance, pedagogy, team leadership.

Scientific analysis of pedagogical science requires researchers to consider a large source study and bibliographic base. Today there is no summary index on research problems 52.03.01. and 51.03.02, which would reflect dissertation research of the last quarter of the XX century and the beginning of the XXI century. This state of affairs complicates and complicates the activities of a young scientist and does not allow the introduction of existing research in this field into scientific circulation. Our article does not claim to be complete and to identify all available dissertation research in the declared specialty and is not an index in the direct sense of this word. Our article is only the first approaches to identifying and introducing into circulation the identified dissertation research in our area of training and profile.

The Higher Attestation Commission of the Russian Federation (HAC RF) recommends the following classification of scientific specialties: [07] Historical sciences; [09] Philosophical Sciences; [10] Philological sciences; [13] Pedagogical sciences; [17] Art history; [22] Sociological sciences; [24] Culturology, etc.

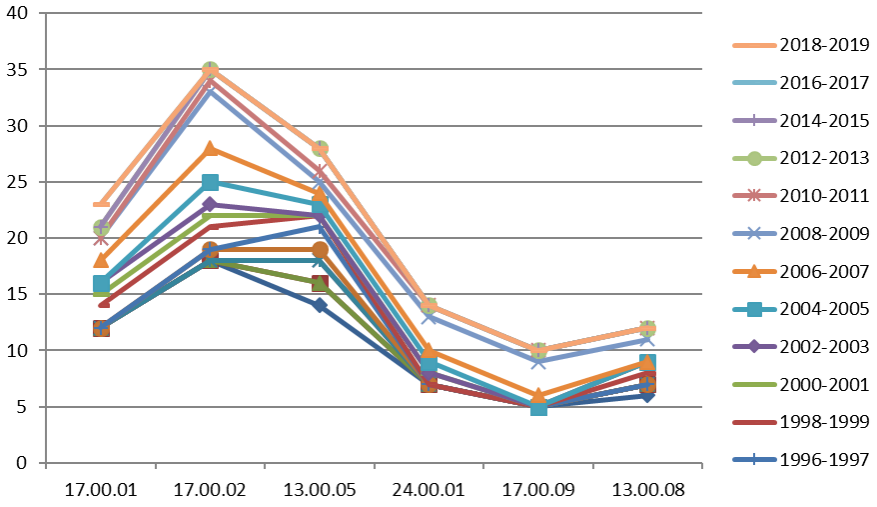
Almost all the humanities, as well as some others, to one degree or another, can study the training of personnel for higher educational institutions. We are interested in pedagogical sciences. Consider the classification of pedagogical sciences:

[13] Pedagogical sciences: [13.00.01] General pedagogy, history of pedagogy and education; [13.00.02] Theory and methodology of teaching and upbringing (by areas and levels of education); [13.00.03] Correctional pedagogy (surdopedagogy and typhlopedagogy, oligophrenopedagogy and speech therapy); [13.00.04] Theory and methodology of physical education, sports training, health-improving and adaptive physical culture; [13.00.05] Theory, methodology and organization of social and cultural activities; [13.00.06] Theory and methods of education (by directions and fields of activity); [13.00.07] Theory and methodology of preschool education; [13.00.08] Theory and methodology of vocational education.

Let's look at what specialties according to HAC RF codes addressed the issue of personnel training, as well as to the specialty: Direction 51.03.02 "Folk Artistic Culture". Profile "Leadership of an amateur choreographic group" and direction 52.03.01 "Choreographic art". Profile "Pedagogy". In our article, we addressed the issues that are raised in dissertation research by various authors from 1983 to 2018.

Our analysis showed that according to the classification of HAC RF 13.00.08 candidate of pedagogical sciences, only 6 works were presented. It is here that the authors consider the issues of professional training of a teacher-choreographer. This can be seen in diagram № 1.

Diagram 1



On the specialty "Theory and history of culture", 24.00.01 HAC code 7 works were presented. In this specialty, one doctoral work has been presented: "Dynamics of choreographic education in the artistic culture of Russia in the XVIII - XX centuries" 2011, Doctor of Culturology T.A. Filanovskaya.

6 Candidate theses were presented in the specialty theory and history of arts on 17.00.09. Also one doctoral dissertation "Interaction of ballet and plastic arts in Russian artistic culture of the late XIX - early XX centuries." 2009, Doctor of Arts T.V. Portnova.

It should be noted that in the specialty musical art on 17.00.02 one of the first in the industry doctoral dissertation was presented: "Problems of the formation of Kyrgyz choreography" - 1995, Urazgildeev R.Kh.

On the problem of choreographic creativity, 18 dissertations were completed. And again in 2011, a doctoral dissertation was completed: "Western European romantic ballet as a phenomenon of musical theater" 17.00.02, Doctor of Arts Grutsynova, A.P. 2011.

12 dissertations in the specialty 17.00.01 theater art. There is also a doctoral degree in this specialty "Balanchine and Stravinsky: on the problem of musical and choreographic synthesis" 2009, Doctor of Arts Naborshchikova, S.V.

In the specialty theory, methodology and organization of SKD, 14 dissertations were completed and presented. Of these, 4 were performed at the Dissertation Council D 210.05.03 at the Kazan State Institute of Culture: L.A. Kayumova, D.V. Mochalov, O. V. Oparina, M.A. Karimov. Speaking about the topics that we touched upon in the stated article - training of higher school personnel, only one dissertation is devoted to this problem - "Formation of the image of a future teacher-choreographer in a higher educational institution of culture": 13.00.05, Cherednyakova A.B.

What years were the most productive in creative and scientific research? We can find the answer to this question in Table № 1.

Table № 1

	Total	1983-1985	1986-1988	1989-1991	1992-1993	1994-1995	1996-1997	1998-1999	2000-2001	2002-2003
17.00.01	12							2	1	1
17.00.02	18						1	2	1	1
13.00.05	14		2		2		1 2	1		
24.00.01	7								1	
17.00.09	5									
13.00.08	6		1					1	1	

Table continuation

	2004-2005	2006-2007	2008-2009	2010-2011	2012-2013	2014-2015	2016-2017	2018-2019
17.00.01		2	2		1		2	
17.00.02	2	3	5	1	1			
13.00.05	1	1	1	1	2			
24.00.01	1	1	3	1				
17.00.09		1	3	1				
13.00.08			2	1				

As can be seen from the tables, the most productive years for scientific research in the field of choreography were 2008-2009. Only 5 works in the specialty of musical art 17.00.02. In descending order there are 2006-2007 3 works, also 17.00.02, 2008-2009 in the specialty 24.00.01 - 3 works, 17.00.09 - 3 works, 13.00.08 - 2 works, in descending order, two dissertation research 2006-2007 2 dissertations in specialty 17.00.01 theater arts, 2008 - 2 dissertations in specialty 13.00.08. For 1998-1999, in the specialty 17.00.01, 2 works were presented, 17.00.02 2 works. 1989-1991 in the specialty 13.00.05 2 works. 1983-1985 - 2 works.

Considering 2012-2013 in the specialty 13.00.05, we found 2 dissertation research: D.V. Mochalov "Formation of the culture of artistic creativity of the members of an amateur choreographic collective", M.A. Karimov "Creative self-development of members of an amateur choreographic group based on folk dance art." 2016-2017, two dissertation studies were found in the specialty 17.00.01. There are periods when there is only one dissertation research in all specialties, or they are absent altogether. Stable in the specialty 13.00.08, 13.00.05. Basically one Candidate thesis for each. It should be noted that earlier dissertation councils operated at the capital's universities, such as Moscow, Leningrad (St. Petersburg), the Moscow State Institute of Culture and the Leningrad State Institute of Culture named after N. Krupskaya. It is these postgraduate studies that provide the greatest percentage of presentations and training for higher educational institutions. Unfortunately, the years 2018-2019 did not give visible results in our search. Perhaps our search was limited to temporary resources.

In the context of a three-level training of highly qualified personnel (bachelor's, master's, postgraduate studies), the possession of information on completed dissertation research in the direction of training 52.03.01 and 51.03.02 is considered important. If earlier dissertation research was

in a certain demand, only among scientific workers, graduate students, and postgraduate studies previously operated only in the capital's universities. Today, thanks to Internet resources (Diserket, Cyberleninka, abstract banks, etc.), access and interest in them are shown not only by graduate students and masters. For example, the analysis of graduate qualification works in the direction of training 52.03.01 and 51.03.02 showed the appeal of students of the Kazan State Institute of Culture to these resources. We found that the dissertations of the following researchers are in greatest demand: L.A. Kayumova, D.V. Mochalova, O.V. Oparina, M.A. Karimov; Abyzova L.I.; Smetanina, B.O.; Vasilyeva, A.A.; Galyatina, A.V., etc.

As you can see, the range of dissertation research performed is much wider than confined within the specialty 13.00.05 and 13.00.08 (pedagogical science). Indeed, the disciplines taught by the teachers of the Department of "Choreographic Art" are much broader and more diverse than just "pedagogy". We believe that within the framework of scientific interests and subjects read by the teachers of the department, it is advisable to declare their dissertation research in other specialties, such as: 24.00.01, 17.00.01, 17.00.02, 17.00.09.

List of identified dissertation research in specialties

13.00.08:

1. Vasilieva, TI The use of corrective techniques in vocational training of ballet dancers (1983), Candidate of Art Criticism.
2. Valukin, M. E. The role of the personality of the teacher of choreography in teaching male dance (1999), Candidate of Art Criticism.
3. Borisov, A. I. Psychological and pedagogical aspects of training a teacher-choreographer (2001), Candidate of Psychological Sciences.
4. Perlina E.V. The development of choreographic coordination among students in the process of teaching classical dance at the university (2009), Candidate of Pedagogic Sciences.
5. Kulikova, A. V. Organizational and pedagogical conditions for the development of skills and abilities of classical dance among students of elementary grades of choreographic schools (2009), Candidate of Pedagogic Sciences.
6. Shestidesyataya, A. V. National ballet of Buryatia of the second half of the XX - early XXI centuries (2010), Candidate of Art Criticism.

in the specialty 13.00.05 Theory, methodology and organization of SKD:

1. Gerashchenko V.V. Pedagogical aspects of improving amateur choreographic creativity in club institutions: Candidate of Pedagogic Sciences / MSIC, (1985).

2. Ivleva L. D. Leading the educational process in an amateur choreographic collective / SPSIC, (1985).

3. Godovsky V.M. The relationship of artistic and pedagogical interaction in a children's choreographic collective / SPSIC, (1990).

4. Zhukenova S.B. Socio-pedagogical factors in the development of amateur choreographic art in Kazakhstan / MSIC, (1991).

5. Yatsenko I.P. The main directions of improving the activities of cultural institutions in the development of amateur choreographic creativity / MSIC, (1995).

6. Palilei A.V. Traditions of Siberian dance folklore in the creative and pedagogical activities of choreographers of amateur choreographic groups / MSIC, (1996).

7. Zholtaeva A.A. Traditional Kazakh dance in the system of ethno-art education / MSIC. (1997).

8. Nilov V.N. Choreography in the system of artistic education of primary schoolchildren: theory and practice / MSIC, (1998).

9. Kalashnikova T.S. Formation of readiness of students - choreographers for the development of artistic and creative potential of students / Ulan-Ude, (2004).

10. Cherednyakova A.B. Formation of the image of the future teacher-choreographer in the university of culture: dissertation ... Candidate of Pedagogic Sciences: / Yekaterinburg, (2006).

11. Oparina OV Formation of a creative personality by means of choreography in the field of leisure / Kazan, (2009).

12. Kayumova L.A. Formation of a culture of interethnic relations among adolescents by means of choreographic art: dissertation ... Candidate of Pedagogic Sciences: / Kazan, (2010).

13. Mochalov D.V. Formation of a culture of artistic creativity of members of an amateur choreographic collective: dissertation ... Candidate of Pedagogic Sciences / Kazan (2012).

14. Karimov M.A. Creative self-development of members of an amateur choreographic group based on folk dance art: dissertation ... Candidate of Pedagogic Sciences / Kazan, (2013).

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FOREIGN STUDENTS TRAINING AT THE PREPARATORY FACULTY IN THE CONTEXT OF CONTINUING EDUCATION

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Abstract. In this article the subject of pedagogical research is the analysis of foreign students training process at the preparatory faculty as a medical university structural department and its role in the continuity of future doctors' professional education. The components of Russian language teaching system and general theoretical disciplines in Russian and their relationship are considered; the role of educational informational contents is discussed; the main goal of training language at the pre-university stage of the medical university is underlined. As a result it is confirmed that practical application of continuous professional educational methods contributes to the implementation of the concept of developmental training.

Keywords: preparatory faculty; foreign students; continuous professional education; organization of the training process; educational contents; methodological information medium; Internet space; clip; clip thinking; continuing education.

The implementation of the idea of continuing education dictates the need to change the orientation of educational system from the assimilation of a certain amount of knowledge by the students to the formation of the ability to learn, to obtain information, to extract the necessary knowledge, abilities, skills from it, to strengthen the role of independent work as one of the leading forms of the educational process. Only if this condition is met the idea of "lifelong education"can be realized. As it is known, the new paradigm of education focuses on "lifelong learning" versus the traditional

focus on "lifelong education" [6; p.186-189].

With the traditional full-time approach to the initial (pre-university) stage of teaching foreign students the Russian language and general education subjects in Russian as a foreign language, communicative competence is considered as the goal of teaching language, as well as apart of the communicative-cognitive development of the students and the culture of their communication in educational -professional sphere [5; p. 630-634]. Perception, comprehension and conscious memorization of the studied material, brought to an understanding of its internal connections and relations, mastering the lexical and grammatical means of the studied language, applying knowledge in practice, realizing the importance of the cognitive tasks to be solved - all this contributes to the implementation of the concept of developmental education at this stage. Cognitive attitudes are aimed at developing thinking abilities of foreign students, at using the knowledge and experience gained during the educational activities of students - future doctors. The initial knowledge, abilities and skills acquired during the period of foreign citizens training at the preparatory faculty become the foundation for their further expansion, deepening and improvement at the advanced stage of training at a medical university. Thus, training at the preparatory faculty is a link in the chain of continuous education that occurs in the process of the educational potential growth (general and professional) of a man as a person throughout his life [4, p.139-142].

The aim of the proposed work is to generalize the traditional and identify the new forms of educational activities of the students to create, master the techniques of processing and rethinking the increasing flow of information. A modern person should not only have a sufficient amount of knowledge, but also be able to learn: to look for and find the necessary information, using a variety of sources for solving certain problems, constantly gain additional knowledge. The practical application of the methodology of continuing professional education ensures the optimal development of students, the formation of their ability to analyze, synthesize, generalize, concretize, abstract, which is the basis of creative thinking [9; p.513-514].

The basic principles of lifelong education orient a person towards self-development and self-improvement throughout his life, towards the ability to learn independently. In this regard, the organization of informational education, improving the informational culture of a person who has the necessary computer literacy, owns new informational technologies, acquires particular importance.

The epidemiological situation in the world and in the country associated with COVID-19 and the Federal Target Program «Electronic Russia for

2002-2010» [12]. determine the search for the new forms, methods, technologies for teaching foreign students, orient the staff of the departments to intensify the creation and improvement of educational and methodological electronic resources (electronic study guides, educational videos, multimedia presentations, Olympiads, exhibitions) and the continuation of the informational resource base accelerated formation, including the preparatory faculty.

A specially organized complex of components that ensure the system integration of informational technologies into the educational process at the initial stage of training foreign students in order to increase its efficiency and create educational and methodological resources represents the informational environment of the additional educational unit of the medical university.

Informational methodological environment of additional education for foreign students must have and provide:

• availability of informational funds, informational resources, a single database of the faculty and the possibility of access to them for staff and students;

• data entry with the possibility of subsequent editing;

• differentiation of access rights to data;

• use of the same data in different applications;

• the ability of exchanging data between different programs, disciplines, as well as with the faculty database [3; p.79-84].

The ongoing process of forming a unified informational methodological environment of additional education promotes the use of modern digital technologies, educational electronic systems and complexes, means of remote telecommunication access to digital informational funds and educational resources in the subjects studied in the educational process. The informational methodological environment accelerates the process of entry of the educational unit into the Unified Russian Internet space. The use of the informational methodological environment, as experience shows, helps to increase the effectiveness of distance learning for foreign students.

It is obvious that the increasing flow of educational information leads to the emergence of the problem of inconsistency of its sharply increasing volume with the physiological possibilities of informational assimilation by the students, gives rise to the problem of selection and reduction of information, highlighting the main, basic in it. It is known that a young person does not perceive the world as a whole, but as a series of almost unrelated parts, facts, events, “clips” [10; p.189-194]. At the initial level of training, the presentation of material in the form of tables and diagrams

helps. These are kinds of informational blocks in which the minimum of the studied language material is highlighted at this moment at this lesson [8; p.291-299], the fruitful use of which is explained by the peculiarities of the "clip thinking" characteristic of the modern younger generation. Lack of holistic perception, fragmentation, extraction of superficial information, unwillingness to go deeper into the search for causes and effects, establishing connections between events, phenomena, processes, physical quantities that characterize these processes and phenomena are the main features of clip thinking, as a result of which the student becomes incapable and unwilling to analyze, compare, connect, comprehend. There is no unambiguous answer to the question whether clip thinking contributes to the effective assimilation of material by foreign students in the educational process.

So, the use of clip thinking in physics, contributes to the memorization of terms, rules, definitions of physical concepts and formulas, the mathematical expression of the law of the physical phenomenon without a sufficiently deep physical essence understanding of the process and phenomenon. For example, methodological recommendations written in the form of "question - answer" can be useful in preparation for the exam and for independent work [7; p.4-5].

Что такое гармонические колебания? What are harmonic vibrations?	*Гармонические колебания* - это периодические изменения физической величины в зависимости от времени, происходящие по закону синуса или косинуса. *Harmonic vibrations* are periodic changes in a physical quantity depending on time, occurring according to the law of sine or cosine.
Напишите математическое уравнение гармонических колебаний. Write a mathematical equation for harmonic vibrations.	$x = x_0 \sin(\omega t + \varphi_0)$ или $x = x_0 \cos(\omega t + \varphi_0)$

The method of using dosed presentation of verbal, linguistic information presented in the form of slides, tables, photos, short animated pictures, proposed by modern computer technology, contributes to the formation of certain images and memorization of the educational material of the discipline, for example, Russian as a foreign language. The table presented in the manual contributes to the formation of skills in the use of Russian verbs of movement. As practice shows, it is the verbs of movement that are the

most difficult lexical and grammatical group for foreign students to master [11; p.61]. The success of mastering this grammatical material is checked by completing the corresponding tasks.

Conjugationof the verbsofmotion

Present tense	**Past tense**	**Future tense**
Идти – to go	Ходил (а,и)	Пойти – will go
Я иду I go Ты идешь You go Он/она идет He/she goes Мы идем We go Вы идете You go Они идут They go	Он ходил He went Она ходила She went Они ходили They went	Я пойду I will go Ты пойдешь Он (а) пойдет Мы пойдем Вы пойдете Они пойдут
Today, now	***Yesterday, before***	***Tomorrow, then***
Она идет в аптеку. She goes to the pharmacy.	Она ходила в аптеку. She went to the pharmacy.	Она пойдет в аптеку. She will go to the pharmacy.

Задание 1. Закончите предложения. Используйте материал данной таблицы. Употребите в нужной форме глаголы *идти – ходить – пойти.*

1) Куда ты …вчера? Куда ты …сейчас? Куда ты …завтра?

2) Сегодня мы никуда … . Вчера мы никуда … . Завтра мы никуда … .

Task 1. Complete the sentences. Use the verb GO in the correct form.

1) Where did you ... yesterday? Where are you ... now? Where will you ... tomorrow?

2) Today we ... nowhere. Yesterday we ... nowhere. Tomorrow we will ... nowhere [2; p.7].

On the other hand, this method does not allow to comprehend, consciously and adequately assimilate, analyze information, establish connections between phenomena, processes, events, concepts, does not allow to perceive a holistic picture of the surrounding world.

This contradiction can be overcome, in particular, by the approach using contextual learning technology. As it is known, context is a semantic category that provides a level of personal inclusion of a student in the processes of cognition, for example, mastering the basics of a future speciality. Therefore, it is logical that while studying the language of the speciality, students get acquainted with the texts of chemical, biological and medical

orientation. Answers to questions on the named texts, as well as tasks for the transformation of the sentences using the studied lexical and grammatical structures, the description of diagrams and tables also check the students' knowledge of educational material on anatomy, biology, chemistry.

For example, at the Department of Physics, the fulfillment of test tasks of part A in throughout the entire period of continuing training at mechanics with the choice of one correct answer allows, during distance learning, to check the knowledge of students of educational material not only in physics, but also in anatomy.

А 41. Человек находится в воде. Как изменится величина выталкивающей силы, действующей на человека при вдохе и выдохе:

А) уменьшается при вдохе и увеличивается при выдохе

В) увеличивается при вдохе и уменьшается при выдохе

С) не изменяется при вдохе и выдохе

D) в пресной воде увеличивается при вдохе и выдохе, в соленой уменьшается при вдохе и выдохе [1; p.54].

A 41 The man is in the water. How will the magnitude of the buoyancy force acting on a person during inhalation and exhalation change:

A) decreases with inhalation and increases with exhalation

B) increases with inhalation and decreases with exhalation

C) does not change with inhalation and exhalation

D) in fresh water it increases with inhalation and exhalation, in salty water it decreases with inhalation and exhalation.

Overcoming this contradiction allows, in particular, an approach using, for example, contextual learning technology. As you know, the context is a semantic category that provides the level of the student's personal inclusion in the processes of cognition, for example, mastering the basics of the future specialty. Thus, these inter-subjects' relations are realized at the preparatory faculty and kept throughout the entire period of studying at the university.

So, taking into account the individual psychological characteristics of students, it is necessary to structure and compositionally organize educational information in different forms of presentation, using modern technologies which will simulate the interest to a subject and the foreign students' future professional activities [8; c. 291-299].

In our opinion, the current problems under consideration, related to the creation and rapid development of specific digital products, and their implementation in the process of training, contribute to the success of the educational process for teaching foreign students at the preparatory faculty as a link in their continuing education at the medical university in Russia.

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THE ROLE OF SPEECH AUDIOMETRY IN ASSESSING SOCIAL HEARING IN CHILDREN WITH HEARING IMPAIRMENTS

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Abstract. Due to the increasing prevalence of hearing impairments, the problem of hearing loss and deafness in children is of great social importance. The capabilities of Praat computer technology made it possible to carry out a frequency-spectral analysis of Uzbek speech, which formed the basis of speech tables, and to assess the quality of hearing in children of primary and senior school age with various forms of hearing loss. Speech audiometry in the children's native language not only makes it convenient, comfortable for the subject and the audiologist, but also increases the quality and information content of the test, thereby minimizing the likelihood of false results. A qualitative assessment of the hearing in children according to the developed speech audiometry in the Uzbek language showed that the speech intelligibility in children with sensorineural hearing loss is influenced by the gender of the speaker. Thus, when tested with different voices, the achievement of the level of speech intelligibility thresholds depended on the level of increase in the hearing thresholds in the frequency range, as well as the perception of male and female voices.

Keywords: sensorineural hearing loss, modified speech tables, speech audiometry, social hearing.

Speech perception is, first of all, the process of decoding and recognizing the semantic and emotional content of information. Studies of leading experts in the field of phonetics have established that the main parameters of the speech signal depend not only on the person's age, but also on gender [1]. It is undeniable that the main parameters of a speech signal are determined by a person's belonging to a particular language group [2]. The

Uzbek language also has its own specific characteristics. Consequently, in speech audiometry for each language group, its own speech tests should be applied, which would take into account in full the peculiarities of national speech. Diagnostics and rehabilitation of hearing impairments in young children with sensorineural hearing loss and deafness is the most difficult area of pediatric audiology [3]. Despite the successes achieved in the methods of hearing research, the quality of speech intelligibility in children with hearing loss of school age, the effect of the frequency-amplitude characteristics of male and female voices of Uzbek speech on intelligibility in normal conditions and at various degrees of hearing loss have not been sufficiently studied. To study the quality of intelligibility in children, standard speech signals in the Uzbek language, based on the acoustic characteristics of speech, were also not selected, the role of speech audiometry in assessing the state of social hearing was not evaluated.

Purpose of the study. Assessment of the role of speech audiometry in determining the level of speech intelligibility in children with hearing impairments.

Materials of the study: 51 children of school age were examined - from 6 to 15 years old. The inclusion criteria for the study cohort were children with grade 1, 2, 3 sensorineural hearing loss, symmetric or asymmetric hearing loss (according to HAT data), conversational skills and an adequate response to examination. The exclusion criteria were - IV degree of hearing loss, sensorineural hearing loss of central genesis, congenital hearing loss.

The study included: collection of complaints, anamnesis, clinical examination of the upper respiratory tract, tympanometry and reflexometry, speech audiometry in male and female voices using modified speech tables in Uzbek. All the subjects were proficient in the Uzbek language. The degree of hearing loss was determined in accordance with the international classification of hearing (WHO, 1997).

The group of children with normal hearing (control group) included 40 healthy children who had no complaints of hearing loss, a history of middle ear disease, whose hearing thresholds did not exceed 10 dB, according to the data of tone threshold audiometry in the frequency range 125 to 8000 Hz. All children in the control group had 100% speech intelligibility at the level of 30 dB, tympanograms corresponded to type A. All children were divided into 2 age groups.

The first group consisted of 29 (56.9%) children aged 6 to 11 (primary school group), and the second group included 22 (43.1%) children aged 12 to 15 (senior school group). To analyze speech audio signals, the Praat

program developed at the Institute of Phonetic Sciences of the University of Amsterdam was used. This program is constantly being improved by its authors, PaulBoersma and David Weenink. Despite the fact that it is mainly used in practice for phonetic research, this program includes excellent tools for visualizing the parameters of a speech audio signal with the output of their values in the context of the time of its flow, which makes it possible to use it for in-depth analysis of speech signals. Based on the results obtained, we developed speech tables in Uzbek for children 6-11 and 12-15 years old, while we adhered to the following criteria:

- words correspond to the age of children and the level of communication vocabulary and are easily perceived;
- speech tests contain the maximum number of phonemes, one- and two-syllable words, phrases and numbers;
- to reduce the time of examination of hearing in children from 6-11 years old, 3 groups of 6 verbal tests were selected, for children from 12-15 years old - 3 groups consisted of 10 verbal and numeral tests.
- to exclude adaptation of speech tests, a variation of speech tests was carried out.

The table for children 6 - 11 years old consisted of 12 monosyllabic words and 12 dissyllabic ones, also of 24 phrases and 12 numerals. The table for children 12 - 15 years old consists of 20 monosyllables, 40 disyllables, 20 phrases and 20 numerators.

As a result of preliminary approbation of the proposed tests in the corresponding age group of children with normal hearing, the acoustic equivalence of separate groups of words was achieved and the age norms of perception and intelligibility of the sounds of Uzbek speech were established with an increasing and decreasing order of changes in speech signals in school-age children with normal auditory function.

Before each study, we set a reference level for a tone of 1000 Hz previously recorded on a CD, and determined the main intelligibility thresholds - the Threshold level of speech discrimination, 50% and the maximum level of intelligibility. The obtained data in average values were recorded on tonal and speech audiograms in the form of curves of air, bone conduction and speech intelligibility. On a speech audiogram, hearing loss is noted along the horizontal axis (in decibels), and on the vertical axis - speech intelligibility (in percent).

Research results

Complaints upon admission of children of the main group, apart from hearing loss, were a decrease in school performance in 42 (82.4%) cases, speech perception impairments in 48 (94.1%) cases, defective pronuncia-

tion in 28 (54.9%) cases, too high and nasal tone of voice in 27 (52.9%) patients. The etiology of the disease was infectious and inflammatory diseases in 15 (29.4%) cases, traumatic factor in 5 (9.8%) cases, toxic effects of aminoglycosides in 20 (39.2%) cases, in 11 (21.6%) cases, the etiology of the disease remained unclear. In 3 (5.9%) patients the duration of the disease was up to 1 year, in 12 (23.5%) patients the duration of the disease was 1-3 years, and 36 (70.6%) children suffered from hearing loss over 3 years, which allows to say that chronic hearing loss prevailed in the study group.

Analysis of the results of speech audiometry using the modified scales developed by us in children with sensorineural hearing loss showed the following results (tab. 1).

Table 1.

Comparison of Hearing Thresholds with Speech Understanding in Children with Sensorineural Hearing Loss (n=51)

Speech intelligibility thresholds	Hearing impairment					
	I grade		II grade		III grade	
	Male voice	Female voice	Male voice	Female voice	Male voice	Female voice
Children aged 6-11						
Sensitivity threshold	34,2±1,9	34,4±1,9	43,3±1,9	45,2±2,4***	59,4±2,6	64,4±3,9***
Intelligibility threshold 50%	47,5±2,8	57,5±2,7*	60,2±2,4	68,1±3,1*	75,0±1,9	87,5±2,5**
Intelligibility threshold 100%	62,2±3,9	74,4±3,8*	78,5±3,9	80,8±2,5**	87,5±2,5	-
Children aged 12-15						
Sensitivity threshold	32,5±4,3	33,8±3,8	43,8±1,5	53,3±1,7***	62,9±3,3	66,7±3,3***
Intelligibility threshold 50%	47,5±5,9	53,0±8,0	59,6±3,4	71,7±2,1**	82,5±2,5	89,4±2,4*
Intelligibility threshold 100%	62,5±7,5	72,5±7,5	78,8±3,9	88,8±4,8	77,5±2,5	87,5±0,0

Note: reliability of data between male and female voices * - P<0,001; **-P<0,005; ***-P<0,05

Based on the data obtained, it can be seen that the threshold level of speech discrimination in children aged 6-11 years with sensorineural hearing loss, depending on the male and female voices, did not have a significant difference in intensity in degree I hearing impairment and significantly differed in children with sensorineural hearing loss II. (P <0.05) and III (P <0.05) degrees. A significant difference between male and female voices of 50% of the intelligibility threshold in children with sensorineural hearing

loss was observed at I (P <0.001), II (P <0.001), and III (P <0.005) degrees of hearing loss. Significant influence of male and female voices on 100% threshold of intelligibility was observed at I (P <0.001) and II (P <0.005) degrees of hearing loss. With III degree of hearing loss, 100% speech intelligibility threshold was reached only in the male voice, and amounted to 87.5 ± 2.5 dB, while the 100% threshold of intelligibility was not reached in the female voice.

The analysis of speech sensitivity threshold indicators in children aged 12-15 years with sensorineural hearing loss of I degree did not show significant differences between male and female voices, while in II (P <0.05) and III (P <0.05) degrees revealed a significant influence of male and female voices. A similar picture emerged when determining the threshold of 50% speech intelligibility for male and female voices - there were no significant differences in the I degree, and in the II (P <0.05) and III (P <0.001) degrees there were differences in the intensity of perception. There were no significant differences in the threshold of 100% intelligibility for male and female voices in all degrees of hearing loss.

Analysis of the quantitative ratio of children with sensorineural hearing loss who reached 50% and 100% of the threshold level of speech intelligibility, depending on the gender of the speaker, showed that in children of the age category 6-11 years old with the I degree of hearing loss, 100% threshold of speech intelligibility was achieved, both male and female voices in 100% of children. In children of the same age group, with II degree of hearing loss, in 100% of cases, a 50% threshold of speech intelligibility for male and female voices was reached. The 100% threshold of speech intelligibility for a male voice was reached in 100% of the subjects, while this indicator for a female voice was 50%. With III degree of hearing loss, 50% of the threshold for intelligibility of male and female voices was also reached in 100% of cases, 100% of the threshold for intelligibility of a male voice was reached by 50% of the studied, and the maximum threshold for intelligibility of a female voice was not reached in any patient. In patients aged 12-15 years with I degree of hearing loss, 100% of the threshold of speech intelligibility was achieved for both male and female voices in 100% of children. With II degree hearing loss, the threshold of 50% speech intelligibility was reached in 100% of cases, while 100% female voice intelligibility was achieved in 66.7% of the subjects. With the III degree of hearing loss in children of the age group 12-15 years, in 66.7% of cases, the 50% threshold for the intelligibility of the female voice was reached, while the 100% threshold for the intelligibility of the male voice was reached in 16.7% of cases, and the female voice only in 8.3% of cases.

Thus, when analyzing speech intelligibility, we revealed the effect of the speaker's gender on the 50% and 100% intelligibility threshold, both on qualitative and quantitative indicators, regardless of the age of the child with sensorineural hearing loss of varying degrees. In view of the above, there is a tendency for the child to perceive the male voice better than the female one.

Hearing studies in children with sensorineural hearing loss have shown that in patients of this category, the differential ratio between the individual threshold levels and the range of speech intelligibility increases. The curves of the growth of speech intelligibility in this case have a different shape, so if the averaged threshold of perception to pure tones for air and bone conduction in the speech zone does not exceed 40 dB, then 100% speech intelligibility is achieved, which was observed in children with I degree of sensorineural hearing loss. That is, the shape of the growth curve of speech intelligibility has a slightly sloping appearance (fig. 1.).

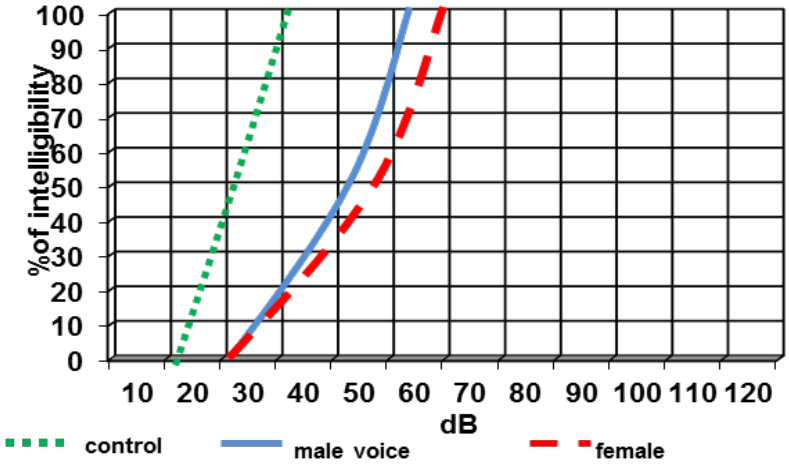

Figure 1. Shape of the curve of increasing speech intelligibility in children with grade I SNHL.

With an increase in the threshold for bone and air conduction in the zone of speech frequencies within 50 dB, regardless of the presence or absence of recruitment, intelligibility is disturbed, but usually maximum intelligibility is achieved at high levels of intensity of speech signals (90-100 dB), which is characteristic of the II degree hearing loss in children. In this case, the shape of the growth curve of intelligibility has a gentle form (fig. 2).

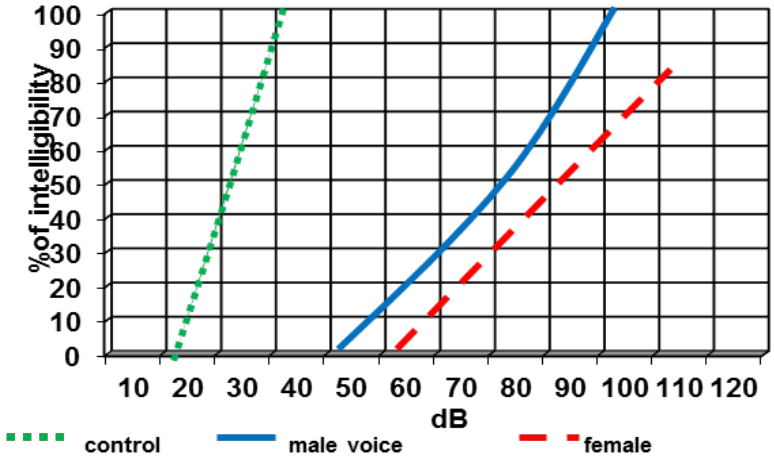

Figure 2. Shape of the speech intelligibility growth curve in children with grade II SNHL

With an increase in the threshold of perception to pure tones with bone and air conduction in the speech zone above 50 dB, the growth curve of intelligibility has a flat shape, 100% speech intelligibility is often absent, despite the increase in the intensity of speech sounds to large numbers (90-100 dB), which occurs in children with grade III hearing loss (fig. 3.).

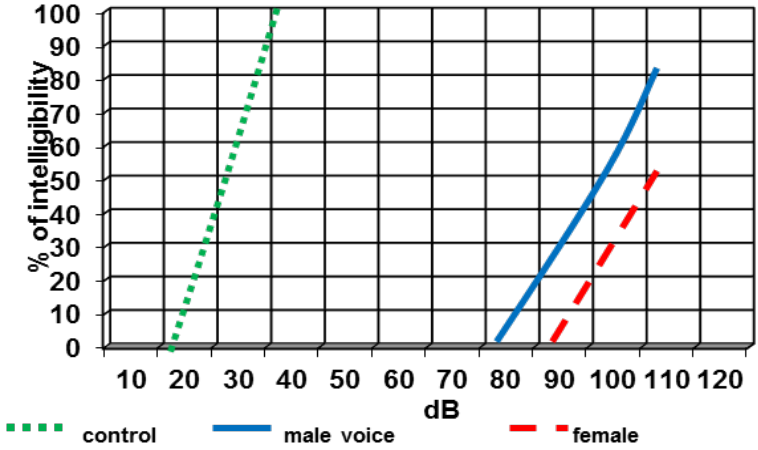

Figure 3. Shape of the speech intelligibility increase curve in children with grade III SNHL

When analyzing the curves of intelligibility depending on the gender of the speaker, it can be seen that with a female voice, the curve has a flatter appearance.

Conclusions

When analyzing speech intelligibility, according to our proposed method, with sensorineural hearing loss, we revealed the influence of the speaker's gender on the 50% and 100% threshold of intelligibility, both on qualitative and quantitative indicators in all age groups with various degrees of its impairment. the tendency for a child to perceive a male voice better than a female.

Speech audiometry using modified speech tables makes it possible to more accurately determine social hearing in children with sensorineural hearing loss and to carry out adequate rehabilitation measures, thereby avoiding significant economic costs.

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INFLUENCE OF THE COURSE OF PREGNANCY WITH A COMBINATION OF INTRAUTERINE INFECTION AND FETAL GROWTH RETARDATION ON PERINATAL OUTCOMES

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Summary.

Purpose of the study. To study the influence of the course of pregnancy and perinatal outcomes in the case of a combination of intrauterine infection (IUI) and fetal growth retardation (FGR).

Materials and methods. The outcomes of childbirth in 157 women who gave birth in the City Clinical Perinatal Center of the city of Omsk were analyzed. All pregnant women with IGR were divided into 2 groups, depending on the presence of signs of intrauterine infection: the main group included 33 pregnant women who gave birth to newborns with a diagnosis of IGR and IUI, the comparison group - 124 women who gave birth to babies with signs of IGR, but without manifestations VUI.

Results. Most often during pregnancy, acute respiratory infections (39.4%), urinary tract infections (15.1%), bacterial vaginitis (45.4%) were observed in the main group, which was significantly more than in the comparison group (19, 3%; $p = 0.003$). The most frequent in the study groups was I degree IGR, at the same time in the comparison group it was found significantly more often (77.4%), III degree IAR was detected only in the main group (9.1%; $p < 0.001$). In the main group, 4 (12.1%) cases of early neonatal mortality were registered (1 - early sepsis of a newborn, 3 observations - congenital pneumonia), in the comparison group, cases of early neonatal mortality were not observed.

Conclusion. In pregnant women with fetal growth retardation syndrome who gave birth to newborns with intrauterine infection, vaginal infections, acute and exacerbation of chronic infections of extragenital localization were significantly more often detected. The presence of infection was characterized by a higher incidence of critical fetal conditions, which led to poor perinatal outcomes.

Keywords: intrauterine infection, fetal growth retardation

Introduction. Intrauterine infections (IUIs) rank third in the structure of newborn morbidity and perinatal mortality after respiratory disorders and congenital malformations. In the last decade, there has been a tendency towards an increase in the incidence of IUI. The problem of fetal growth retardation (FGR) is also urgent. In the population of pregnant women, FGR complicates from 5% to 24% of pregnancies, is considered one of the causes of stillbirth and a high risk factor for perinatal morbidity and mortality. Thus, the study of the mutual influence of these obstetric pathologies (intrauterine infection, fetal growth retardation), which significantly complicate the condition of the newborn at birth, is of great practical importance for predicting them and obtaining favorable perinatal outcomes.

Purpose of the study. To study the influence of the course of pregnancy and perinatal outcomes with a combination of intrauterine infection and fetal growth retardation.

Materials and methods. The outcomes of childbirth were analyzed in 157 women who gave birth at the City Clinical Perinatal Center in Omsk. All pregnant patients with FGR were divided into 2 groups, depending on the presence of signs of intrauterine infection: the main group included 33 pregnant women who gave birth to newborns with a diagnosis of FGR and IUI, the comparison group included 124 women who gave birth to babies with signs of FGR, but without manifestations of IUI. For retrospective analysis, medical records from 2012 to 2019 were used. Height and weight indices of newborns were estimated according to centile tables. Intrauterine growth retardation in newborns was diagnosed when body weight decreased below the 10th percentile for a given gestational age.

All statistical calculations were performed using Microsoft Excel 2010 and Statistica (version 6.0). The arithmetic mean and standard deviation ($M \pm m$) were calculated. Comparison of groups was carried out using the analysis of four-field tables using nonparametric statistical tests. The critical level of significance of statistical hypotheses in this study was taken equal to 0.05.

Results. The average age of women in the main group was 28.6 ± 5.2

years, in the comparison group - 27.9 ± 5.5 years. The proportion of primiparas was 45.5% (15 women) in the main group, of which 21.2% (7 women) are age primiparous; the frequency of multiparous in the same group is 54.5% (18 women). There were 57.3% primiparas in the comparison group (71 women), of which age primiparas accounted for 16.1% (20 women), young primiparas - 2.4% (3 women), and the proportion of multiparous in this group was 42.7 % (53 women).

The average body weight of children was 1843.3 ± 555.2 g in the main group, in the comparison group - 2128.5 ± 579.1 g. The average body length of children was 41.7 ± 5.7 cm in the main group, in the comparison group - 44.7 ± 5.2 cm.

In the main group, 2 (6.1%) women had occupational hazards, 6 (18.2%) smoked, in the comparison group - 8 (6.4%; p = 0.918) and 15 (12.1%; p = 0.362) according to the groups. Medical abortions were in 6 (18.2%) and 29 (23.4%; p = 0.524) in the main group and the comparison group. Non-developing pregnancy and spontaneous miscarriage were observed in 2 (6.1%) and 5 (15.1%) patients in the study group, 15 (12.1%; p = 0.322) and 18 (14.5%; p = 0.927) in the comparison group, respectively.

When studying the past diseases of the genital organs in the study groups, it was found that most often in the history of women there was cervicitis and cervical dysplasia - in 10 (30.3%) and 35 (28.2%; p = 0.659), respectively, in the studied groups ... In the main group, bacterial vaginitis was most often detected in 15 (45.4%), in the comparison group, this pathology was found in 24 (19.3%; p = 0.003), which was significantly less common than in the main group. In total, gynecological pathology occurred significantly more often in the main group - 37 (112.1%), in the comparison group - 90 (72.6%; p <0.001). Uterine fibroids were diagnosed in 12.1% of observations in the main group and in 9.7% in the comparison group, inflammatory diseases of the pelvic organs in 15.1% and 11.3%, respectively, in the groups. 9% of women in the main group and 4% in the comparison group had a history of infertility. In total, gynecological diseases were found in all studied women in the main group and in 72.6% in the comparison group (p <0.001).

Complications of pregnancy (table 1) were observed in all women in the study groups. The most frequent complications of gestation in the main group and in the comparison group were threatening termination in 17 (51.5%) and 39 (31.4%; p = 0.033) patients and placental abnormalities in 18 (54.5%) and 45 (36.3%; p = 0.058) of pregnant women, respectively. In the observed pregnant women with identified fetal FGR and IUI, the most frequent pathology during pregnancy was acute respiratory viral infections

during pregnancy - in 13 (39.4%) and urinary tract infections in 5 (15.1%), which was significantly more than in the comparison group - in 25 (20.2%; p = 0.022) and 5 (4.0%; p = 0.021) patients, respectively.

In the main group, in second place in frequency, anemia was detected - in 25 (25.5%) women, in the third - cardiovascular disorders 22 (22.4%), while arterial hypertension and neurocirculatory dystonia were observed equally often. In the comparison group, anemia was diagnosed in 23 (23.7%; $\chi 2 = 0.016$; p = 0.900) examined, cardiovascular disorders - in 19 (19.6%; $\chi 2 = 0.099$; p = 0.753). In general, in the main group, the course of gestation became complicated in 90 (272.2%) cases, and in the comparison group - in 247 (199.2%).

Table 1 - Distribution of women depending on pregnancy complications
Таблица 1 – Распределение женщин в зависимости от осложнений беременности

Complications of pregnancy	Groups n -%		p
	Main n = 33	Comparisons n = 124	
Acute respiratory viral infections	13 – 39,4	25 – 20,2	**0,022**
Urinary tract infections	5 – 15,1	5 – 4,0	**0,021**
Edema, hypertensive disorders during pregnancy	10 – 30,3	38 – 30,6	0,970
Threatened termination of pregnancy	17 – 51,5	39 – 31,4	**0,033**
Fetal-placental blood flow disorders (placental disorders)	18 – 54,5	45 – 36,3	0,058
Gestational diabetes	9 – 27,3	34 – 27,4	0,987
Polyhydramnios	7 – 21,2	3 – 2,4	**0,001**
Olygohydramnios	2 – 6,1	38 – 30,6	**0,004**
Preeclampsia	7 – 21,2	16 – 12,9	0,231
Placenta previa	-	2 – 1,6	0,463
Intrahepatic cholestasis	2 – 6,1	2 – 1,6	0,150

During ultrasound examination, the presence of intrauterine infection was confirmed by signs of a violation of the amount of amniotic fluid: in the main group, polyhydramnios were more often recorded - 7 (21.2%), in the comparison group - 3 (2.4%; p <0.001), oligohydramnios was observed more often in the comparison group - in 38 (30.6%), in the main group - in 2 (6.1%; p = 0.004).

Delivery on term occurred in 8 (24.2%) pregnant women in the main

group, which is significantly less than in the comparison group - 83 (66.9%; p <0.001). There were no significant differences in the frequency of births through the vaginal birth canal in the study groups: in the main group - 12 (36.4%) pregnant women delivered on their own, in the comparison group - 52 (41.9%; p = 0.563). Caesarean section was performed in 63.6% of observations in the main group and in 58.1% in the comparison group. The main indications for delivery by cesarean section in the main group and the comparison group were: progressive fetal hypoxia in 6 (28.6%) pregnant women and in 29 (40.3%; p = 0.330), respectively, in the studied groups, decompensated placental insufficiency in 4 (19.0%) and 13 (18.0%; p = 0.918) and preeclampsia in 7 (33.3%) and 11 (15.3%; p = 0.066), respectively.

Most often in the studied groups, I degree of FGR was observed, at the same time in the comparison group it was found significantly more often (77.4%) than in the main group (51.5%; p = 0.004; Table 2), II degree was detected with a frequency 39.4% - in the main group and 22.6% - in the comparison group (p = 0.065), grade III was detected only in the main group in 3 (9.1%) newborns (p <0.001). The forms were observed without significant differences in the studied groups: symmetric in 48.5% of cases of the main group and 34.7% of the comparison group; asymmetric at 51.5% and 65.3%, respectively.

Table 2. Forms and degrees of fetal growth retardation

Forms and degrees of FGR	Группы n - %		p
	Main n = 33	Comparisons n =124	
FGR shapes: - symmetrical	16 – 48,5	43 – 34,7	0,146
- asymmetric	17 – 51,5	81 – 65,3	0,146
FGR degrees: - I degree	17 – 51,5	96 - 77,4	**0,004**
- II degree	13 – 39,4	28 – 22,6	0,065
- III degree	3 – 9,1	0	<0,001

With an Apgar score of 8 points and higher, children were born only in the comparison group 10 (8%; p = 0.092). Most often, children were born with moderate asphyxia with an Apgar score of 4-7 points - in the main group there were 27 (81.8%) newborns, in the comparison group - 103 (83.1%; p = 0.778). 6 (18.2%) newborns were born with severe asphyxia with an Apgar score of 0-3 points in the main group, 11 (8.9%; p = 0.127) in the comparison group.

The structure of other concomitant pathology in newborns with fetal growth retardation is presented in Table 3.

Table 3. Structure of concomitant pathology in newborns

Concomitant pathology	Группы n - %		p
	Main n = 33	Comparisons n =124	
Cerebral ischemia	27 - 81,8	73 - 58,9	**0,015**
Congenital malformations	6 – 18,2	13 – 10,5	0,229
Early neonatal jaundice	9 - 27,3	26 - 21,0	0,505
Intraventricular hemorrhage, hemorrhagic syndrome	3 - 9,1	8 – 6,4	0,598
Necrotizing enterocolitis	2 - 6,1	3 - 2,4	0,290
Respiratory distress syndrome	11 - 33,3	20 – 16,1	**0,016**

In the main group, taking into account the severity of the condition of newborns immediately after childbirth, 27 (81.8%) children were hospitalized in the intensive care unit, in the comparison group - 41 (33.1%; p <0.001). Newborns of the main group 18 (54.5%) were more often transferred to the second stage of nursing in the intensive care unit, in the comparison group - 17 (13.7%; p <0.001). Children of the comparison group 24 (19.4%) at the second stage of nursing were more often transferred to the neonatal unit than in the main group - 5 (15.2%; p <0.001). In the main group, 4 (12.1%) cases of early neonatal mortality were registered (1 - early sepsis of a newborn, 3 - congenital pneumonia), in the comparison group, cases of early neonatal mortality were not observed.

Conclusion. In pregnant women with fetal growth retardation syndrome who gave birth to newborns with intrauterine infection, the course of pregnancy was more often complicated by the addition of vaginal infections, acute and exacerbation of chronic infections of extragenital localization, which was often accompanied by threatening termination of pregnancy. Ultrasound examination in the group of pregnant women with fetal growth retardation in combination with intrauterine infection was more often recorded polyhydramnios, in the group of women without infection - oligohydramnios. Cerebral ischemia and respiratory distress syndrome were more often diagnosed in the group of newborns with intrauterine infection. The presence of intrauterine infection was characterized by a higher frequency of critical conditions of the newborn, which led to the presence of cases of perinatal mortality.

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CIRCADIAN RHYTHMS OF THE MINUTE VOLUME OF BLOOD CIRCULATION IN ADULTS WITH BURN TOXEMIA

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Abstract. The MVBC mesor indices on the first day did not differ from the normative data in all patients. The most pronounced deviations in group 1 were expressed in a stable hyperdynamic type of hemodynamics with a burn injury of the skin with an area of 59.4 ± 13.5%, 3 B degree 21.3 ± 13.3%, IF 119.4 ± 38.4 units. Regardless of the time of day, the hourly data of the MVBC indicator of patients in group 1 were significantly higher than the indicator of patients in group 2 by an average of 33% and in group 3 by 22%. The transition of burn toxemia to septicotoxemia at 3 weeks and on the following days of burn disease is associated with a high risk of developing acute heart failure with a total area of 40-60%, the area of a 3B degree burn is more than 20%. During 75% of the period of toxemia in group 2, a shift of the hyperdynamic type of hemodynamics at night is characteristic. At the age of 27.3 ± 5.6 years, a direct dependence of MVBC changes on the level of the body's temperature reaction was revealed.

Keywords: circadian rhythms, minute volume of blood circulation, burn toxemia.

Relevance. Cardiopulmonary disorders in burn disease include a marked decrease in plasma volume, an increase in peripheral vascular resistance, and a decrease in cardiac output. These changes are associated with moderate direct damage to the heart and a slight decrease in lung static compliance. An increase in vascular permeability in tissues immediately adjacent to the burn surface and in tissues remote from the burn contributes to a decrease in vascular volume and subsequent slowdown of blood flow, creating the effect of centralizing blood supply. Protein loss and hemoconcentration lead to decreased blood flow as well as increased vascular permeability. Changes in the membrane potential of cells lead to the sequestration of sodium and water into the interstitial space, where

they become inaccessible in order to affect vascular volume and blood flow. All the factors and changes listed above contribute to a decrease in blood flow, hypotension, shock, acidosis and circulatory disturbance [1, 2].

The weakening of myocardial contractility is essential in the pathogenesis of burn shock. X-ray kymographic studies carried out by I.B. Gurevich in an experiment on animals showed that after 10-30 minutes after a flame burn, the heart diameter increases during diastole, the amplitude of the ventricular teeth decreases markedly and the contraction coefficient decreases. In humans, the minute volume of blood circulation (MVBC) decreases almost 2 times. One of the reasons for the decrease in MVBC is oligemia with a subsequent decrease in the amount of venous return of blood to the right heart. However, it occurs even before a pronounced decrease in the BCC, being in this case the result of a primary weakening of the myocardium. In cardiomyocytes during the period of burn shock, swelling and destruction of mitochondria, focal destruction of myofibrils, the appearance in the cytoplasm of a large number of lysosomes, myelin structures and autophagosomes, depletion of cells in glycogen and accumulation of lipids in them are observed. Later, during the period of septicotoxemia in the myocardium against the background of its dystrophy, embolic abscesses and foci of necrosis occasionally appear. During the period of toxemia, plasma loss stops, with normalization of the BCC, hemoconcentration on the 3-5th day after the injury is replaced by anemia, hematocrit falls, the volume of circulating plasma decreases, leukocytosis and a shift of the leukocyte formula to the left increase. Characteristic are high proteolytic activity of blood serum, pronounced catabolic reactions - negative nitrogen balance, impaired blood aminogram, hypoproteinemia, a sharp decrease in the albumin-globulin coefficient. Disorders of water-electrolyte balance persist, oliguria accompanying burn shock is replaced by polyuria, hypokalemia is found. Burn toxemia lasts an average of 10-15 days and gradually turns into septicotoxemia [3,4]. With a large amount of research results on burn shock, toxemia, septicotoxemia of burn disease, there is not enough information in the literature on the dynamics of circulatory disorders, circadian rhythm of hemodynamics in severe burns, which was the reason for studying the results of monitoring the MVBC indicator during toxemia.

Purpose of the work. To study changes in the circadian rhythm of the minute volume of blood circulation during the period of toxemia of burn disease in adults.

Material and research methods. The results of monitoring the index of minute blood volume of blood circulation (MVBC) of 25 patients admitted

to the Department of Cambustiology of the Republican Scientific Center of Emergency Medicine due to burn injury were studied. After recovery from shock, anti-inflammatory, antibacterial, infusion therapy, correction of protein and water-electrolyte balance disorders, early surgical, delayed necrectomy, additional parenteral nutrition, syndromic, symptomatic therapy were performed. Changes in the circadian rhythm of the minute volume of blood circulation (MVBC) of the heart were studied by monitoring the hourly continuous recording of hemodynamic parameters in patients with severe thermal burns in three age groups - group 1, 12 patients aged 20-40 years, group 2 - 7 patients aged 41-60 years, Group 3, 6 patients - 61-78 years old. The division into groups was dictated by the well-known characteristics inherent in each age group, described in detail in the literature. The calculation of the stroke volume index was carried out according to the formula: MVBC=SV*HR/1000 l/min.

Results and discussion. As can be seen from tab. 1, the age groups were significantly different and averaged 27.3 ± 5.6 years in group 1, 50.7 ± 7.1 years in the second, and 71.3 ± 7.0 years in the third. The total area and area of deep skin burn lesions did not differ significantly between the groups.

Table 1
Patient characteristics (25)

	Age, years	Height, cm	Weight, kg	Total area of the burn,%	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

The highest IF index was revealed in group 1, which determined the longest duration of intensive therapy in ICU conditions in the youngest group. Thus, the most pronounced burns in area and depth were found in patients of group 1.

As shown in Table 2, the MVBC mesor indices on the first day did not differ from the normative data. During the period of toxemia, an increase in the mesor of the circadian rhythm MVBC in group 1 on day 4 by 18% ($p < 0.05$) was revealed, remaining at this level for up to 12 days. In the

next 14-29 days, the MVBC mesor indicator was stably increased by an average of 28% (p <0.05) with a maximum increase on the 22nd day by 45% (p <0.05). Thus, in patients of group 1, a hyperdynamic type of blood circulation was observed throughout the entire period of toxemia. At the same time, in patients of group 2, throughout the observation period, the mesor of the circadian rhythm MVBC did not differ from the indicator on day 1. An increase in the MVBC mesor in group 3 was revealed on day 11 by 30% (p <0.05), followed by a decrease to the initial level. Thus, the most pronounced deviations in group 1 were expressed in the hyperdynamic type of hemodynamics, which, most likely, was due to the extensive burn injury with an area of 59.4 ± 13.5%, 3 B degree 21.3 ± 13.3%, IF 119.4 ± 38.4 units.

Table 3 shows the average data of the MOC circadian rhythm for the period of toxemia by age groups. It was found that, regardless of the time of day, the MVBC index in group 1 was significantly higher than in groups 2 and 3 of patients. In the daytime, the hourly difference between the indicators of the circadian rhythm MVBC of groups 1 and 2 was 33% (p <0.05), in the dark - 34% (p <0.05). In patients of group 3, MVBC was less than in group 1 by 22% during the day (p <0.05), and by 23% at night (p <0.05). Thus, regardless of the time of day, the MVBC index of patients in group 1 was significantly higher than that in patients in groups 2 and 3 (fig. 1).

Table 2

Dynamics of the mesor of the circadian rhythm MVBC

Days	Group 1	Group 2	Group 3
1	4,9±0,2	4,1±0,4	4,3±0,4
2	5,2±0,2	3,4±0,2	4,4±0,3
3	5,0±0,2	3,4±0,1*	4,8±0,3
4	5,8±0,2*	4,1±0,2	4,6±0,3
5	5,6±0,2*	4,2±0,2	4,2±0,4
6	5,7±0,2*	4,2±0,3	4,7±0,3
7	5,8±0,2*	4,4±0,2	5,0±0,2
8	5,9±0,3*	4,1±0,2	4,5±0,2
9	5,7±0,3*	4,4±0,2	4,6±0,4
10	5,9±0,2*	3,7±0,2	4,4±0,4
11	5,8±0,4*	4,0±0,3	5,7±0,5*
12	5,7±0,4*	3,6±0,1	4,8±0,5
13	5,3±0,3		5,1±0,5
14	6,3±0,4*		4,9±0,5
15	5,6±0,3*		4,6±0,6

16	6,3±0,3*		4,2±0,3
17	6,4±0,4*		3,8±0,3
18	6,1±0,4*		4,5±0,3
19	6,2±0,2*		5,1±0,5
20	6,0±0,3*		4,9±0,4
21	6,1±0,4*		4,0±0,4
22	7,1±0,3*		4,4±0,6
23	6,1±0,4*		4,4±0,5
24	6,3±0,4*		5,3±0,7
25	6,0±0,3*		4,4±0,8
26	5,7±0,5		4,6±0,6
27	5,8±0,3*		4,0±0,6
28	6,0±0,4*		3,5±0,5
29	6,3±0,5*		4,4±0,7
30	5,7±0,3*		3,9±0,4

*- reliably relative to the indicator in 1 day

Table 3

Indicators of MVBC mesor in circadian rhythm

Hours	Group 1		Group 2		Group 3	
8	5,8±0,4		3,9±	0,3"	4,3±	0,5"
9	5,8±	0,5	3,9±	0,3"	4,5±	0,5"
10	5,9±	0,5	4,0±	0,5"	4,3±	0,7"
11	5,8±	0,4	3,9±	0,3"	4,5±	0,5"
12	5,8±	0,4	3,9±	0,4"	4,2±	0,5"
13	5,5±	0,5	3,7±	0,3"	4,2±	0,5"
14	5,7±	0,5	3,9±	0,3"	4,4±	0,6"
15	6,0±	0,5	3,9±	0,4"	4,5±	0,5"
16	5,9±	0,4	4,0±	0,4"	4,7±	0,5"
17	6,0±	0,4	4,1±	0,4"	4,5±	0,6"
18	5,8±	0,4	4,0±	0,3"	4,7±	0,6"
19	5,9±	0,4	4,1±	0,4"	4,8±	0,6"
20	5,9±	0,4	3,9±	0,3"	4,5±	0,7"
21	6,0±	0,4	4,1±	0,4"	4,7±	0,7"
22	5,8±	0,4	3,9±	0,3"	4,5±	0,6"
23	5,8±	0,3	4,1±	0,3"	4,7±	0,7"
24	5,8±	0,4	3,9±	0,3"	4,6±	0,6"
1	6,0±	0,5	4,3±	0,4"	4,7±	0,4"
2	6,0±	0,5	4,0±	0,5"	4,5±	0,5"

3	6,1±	0,6	4,0±	0,4"	4,5±	0,6"
4	6,0±	0,5	4,1±	0,5"	4,6±	0,6"
5	6,1±	0,5	4,2±	0,4"	4,6±	0,5"
6	5,9±	0,4	3,9±	0,3"	4,6±	0,5"
7	5,9±	0,5	3,9±	0,3"	4,5±	0,6"

" – reliably relative to the indicator in group 1

The average value of the amplitude of daily fluctuations of MVBC in group 1 during the first 12 days was 0.6 ± 0.1 l/min, in group 2 - 0.7 ± 0.2 l/min, in group 3 - 0.9 ± 0.3 l/min In the next 13-30 days, the average value of the amplitude of the circadian rhythm MVBC in group 1 increased by 0.4 l/min ($p < 0.05$) and amounted to 1 ± 0.2 l/min, in patients of group 3 there was a tendency to an increase in the amplitude daily changes in MVBC up to 1.3 ± 0.3 l/min. Thus, a significant increase in the amplitude of daily MVBC fluctuations in group 1 and a tendency to an increase in the amplitude of daily MVBC fluctuations in the third and more weeks in group 3 were revealed.

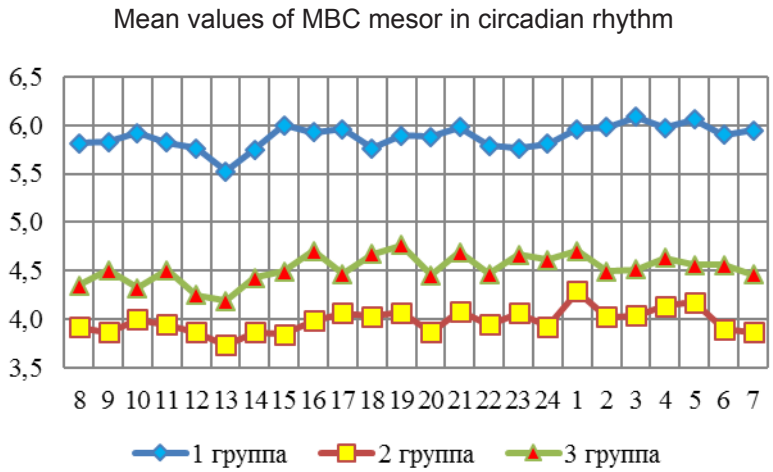

Fig.1

Dynamics of the amplitude of the MBC circadian rhythm

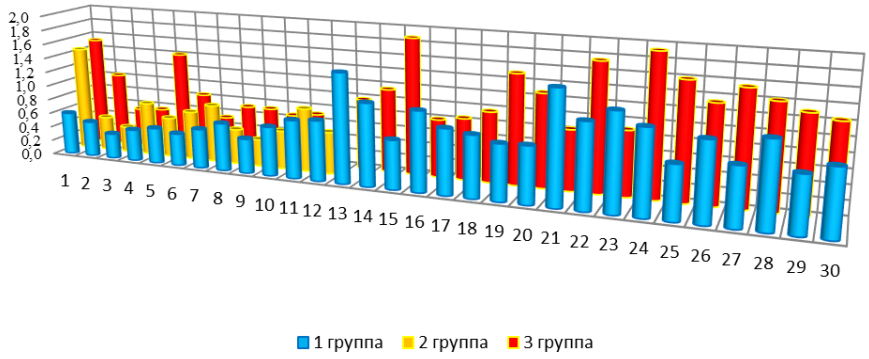

Fig.2

The revealed changes indicate a disposition to destabilization of hemodynamics in the later periods of the period of toxemia, which is caused by high proteolytic activity of blood serum, pronounced catabolic reactions - negative nitrogen balance, impaired blood aminogram, hypoproteinemia, a sharp decrease in the albumin-globulin coefficient. Violations of water-electrolyte balance persist. Thus, the gradual transition of burn toxemia to septicotoxemia is associated with a high risk of developing acute heart failure with an area of a 3B burn of more than 20%, with a total area of 40-60% (fig. 2).

The longest maximum displacement of the acrophase peak at night was found in patients of group 2 (76%), somewhat less in patients of group 1 (50%), and in group 3, the inversion of the circadian rhythm lasted for 41% of the toxemia period (fig. 3).

Thus, in the adaptation of hemodynamics, the shift of the increase in MVBC to night hours with burns with an area of 54%, 3B degree 12% takes a more active and prolonged part. That is, for 75% of the time in group 2, a shift of the hyperdynamic type of hemodynamics at night is characteristic.

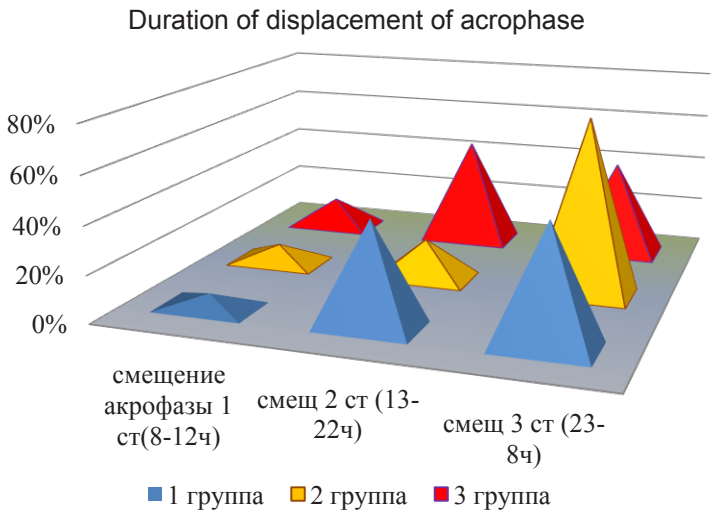

Fig.3

A strong direct correlation was found between MVBC and SV (in group 1 - 0.781, in 2 - 0.825, in 3 - 0.721), a direct relationship between MVBC and PBP in 1 - 0.928, and in 2 - 0.745, which slightly weakened in group 3, making 0.666. A strong direct dependence of the MVBC value on body temperature was observed only at a young age of 27.3 ± 5.6 years, significantly weakening in the older age groups (0.575 and 0.319, respectively). Thus, it was only at a young age that a direct dependence of MVBC changes on the level of the body's temperature reaction was revealed (fig. 4). In the 2 and 3 older age groups, this relationship significantly weakened, amounting to 0.575 and 0.318 (tab. 4).

Table 4

Correlation relationships of the MVBC mesor with other parameters of hemodynamics and body temperature

	MVBC/ SV	MVBC/ AvBP	MVBC/ SBP	MVBC/ DBP	MVBC/ PBP	MVBC/ T°C
Group 1	0,781	0,165	0,577	0,343	0,928	0,758
Group 2	0,825	-0,008	0,378	-0,499	0,745	0,575
Group 3	0,721	-0,250	0,133	-0,414	0,666	0,318

Correlations between the MBC mesor and other parameters of hemodynamics and body temperature

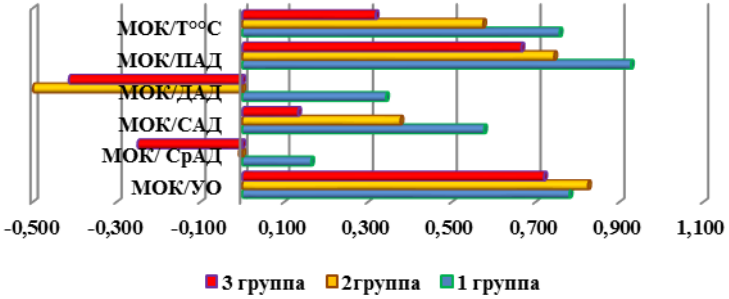

Fig.4

Conclusion. The MVBC mesor indices on the first day did not differ from the normative data in all patients. The most pronounced deviations in group 1 were expressed in a stable hyperdynamic type of hemodynamics with a burn injury of the skin with an area of 59.4 ± 13.5%, 3 B degree 21.3 ± 13.3%, IF 119.4 ± 38.4 units. Regardless of the time of day, the hourly data of the MVBC indicator of patients in group 1 were significantly higher than the indicator of patients in group 2 by an average of 33% and in group 3 by 22%. The transition of burn toxemia to septicotoxemia at 3 weeks and on the following days of burn disease is associated with a high risk of developing acute heart failure with a total area of 40-60%, the area of a 3B degree burn is more than 20%. During 75% of the period of toxemia in group 2, a shift of the hyperdynamic type of hemodynamics at night is characteristic. At the age of 27.3 ± 5.6 years, a direct dependence of MVBC changes on the level of the body's temperature reaction was revealed.

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CIRCADIAN RHYTHM OF TOTAL PERIPHERAL VASCULAR RESISTANCE IN ADULTS WITH BURN TOXEMIA

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Abstract

Conclusions. On the first day, significantly higher TPVC values were found in groups 2 and 3. From the first day of toxemia in group 1, the hyperdynamic type of hemodynamics was associated with the formation of a compensatory increase in cardiac output with a corresponding decrease in TPVC. In contrast to young patients, persons over 41 years of age did not have a compensatory decrease in the mesor of the circadian rhythm TPVC in response to an increase in cardiac output, which indicates a failure of vasodilator mechanisms to increase perfusion blood flow in response to an acutely increased cell oxygen demand. In groups 2 and 3, a strong negative correlation between MCV, SV and TPVC turned out to be an indicator of the compensatory mechanism of hemodynamic adaptation, when TPVC decreased in response to an increase in cardiac output.

Keywords: Circadian rhythm, total peripheral vascular resistance, adult burn toxemia

Relevance. Distinguished are - hyperkinetic: minute circulatory volume (MCV) is increased, TPVC tendency to decrease; normokinetic: MCV-norm, TPVC-norm; and hypokinetic type of blood circulation - MCV is decreased, TPVC is increased. Hyperkinetic variant - a pathological variant of blood circulation is dangerous by a decrease in the blood flow rate, especially against the background of hypercoagulation (DIC syndrome), when massive generalized microthrombosis develops, blocking microcirculation in all organs and leading to irreversible multiple organ failure. Also, due to a decrease in blood flow velocity, oxygen delivery to tissues decreases, metabolic acidosis progresses, which further disrupts the regulation of vascular tone. Ultimately, due to the blockage of microcirculation and an increase in total peripheral vascular resistance (TPVC), hypercirculation is replaced by hypocirculation, foreshadowing a sad outcome. [1-

4]. However, in the literature it was not possible to find information on the change in the circadian rhythm and the peculiarities of the rearrangement of hemodynamics during the period of toxemia in adults.

Goal of the work. To study the circadian rhythm of the total peripheral vascular resistance during the period of toxemia of burn disease in adults.

Material and research methods. The results of monitoring the index of total peripheral vascular resistance (TPVC), body temperature, infusion therapy of 25 patients admitted to the Department of Cambustiology of the Republican Scientific Center for Emergency Medicine due to burn injury were studied. After excretion from the cheek, anti-inflammatory, antibacterial, infusion therapy, correction of protein and water-electrolyte balance disorders, early surgical, delayed necrectomy, additional parenteral nutrition, syndromic, symptomatic therapy were carried out. The systemic inflammatory response was studied by monitoring the hourly continuous recording of body temperature TPVC 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.

Table 1
Patient characteristics (25)

	Age, years	Height, cm	Weight, kg	Total area of the burn,%	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. Thus, the most pronounced burns in terms of area and depth were found in patients in group 1.

Results and discussion.

Table 2.

Dynamics of the mesor of the circadian rhythm of the total peripheral vascular resistance, (dyn.s.cm $^{-5}$)

Days	Group 1	Group 2	Group 3
1	1008±62	1546±136≈	1583±143≈
2	936±48	1853±59≈	1584±167 ≈
3	1022±40	1859±106 ≈	1394±83 ≈
4	937±36	1581±107 ≈	1415±82 ≈
5	861±34	1530±55 ≈	1639±181 ≈
6	898±32	1542±104 ≈	1388±141 ≈
7	945±42	1436±94 ≈	1343±81 ≈
8	883±45	1547±106 ≈	1395±62 ≈
9	973±95	1441±89 ≈	1360±86 ≈
10	849±41	1632±89 ≈	1415±104 ≈
11	838±74	1524±173 ≈	1095±129
12	863±65	1650±60 ≈	1237±195 ≈
13	995±75		1222±149 ≈
14	792±71*		1292±122 ≈
15	891±50		1535±396 ≈
16	660±58*		1386±130 ≈
17	831±61*		1537±122 ≈
18	854±61*		1320±108 ≈
19	865±50*		1213±131 ≈
20	1006±49		1280±108 ≈
21	910±59		1526±158 ≈
22	789±64*		1452±178 ≈
23	806±67*		1337±129 ≈
24	754±56*		1233±206 ≈
25	846±58*		1430±443 ≈
26	1026±82		1460±405 ≈
27	862±48		1704±316 ≈
28	956±58		1775±237 ≈
29	893±75		1437±337 ≈
30	842±51*		1669±150 ≈

*- deviation is reliable relative to the indicator in 1 day

≈- reliable relative to the indicator in group 1 of patients

On the first day (tab. 2), significantly higher TPVC values were found in groups 2 and 3. So, in patients of the 2nd group, the mesor of the circadian rhythm TPVC on day 1 was more than in 1 - by 53% ($p < 0.05$), in 3 - by 57% ($p < 0.05$). Over the entire observation period, starting from 14 days in group 1, a decrease in the level of TPVC mesor was found relative to the indicator on day 1 by 14 - 21%, 16 - 34%, 17 - 17%, 18 - 15%, 19 - 14%, 22 -25 - from 12 to 15%, 30 days by 16% ($p < 0.05$, respectively) day. That is, from the first day of toxemia in group 1, the hyperdynamic type of hemodynamics was associated with the formation of a compensatory increase in cardiac output with a corresponding decrease in TPVC. However, the most pronounced decrease in TPVC over the entire period of toxemia was found on day 16 with a stable MCV of 6.3 ± 0.3 l/min. That is, on the verge of the exhausted possibilities of myocardial contractility, there was an even greater decrease in the mesor of the circadian rhythm TPVC on the 16th day to the minimum for the entire period of toxemia - up to 660 ± 58 dyn.s.cm^{-5} of a compensatory nature. In contrast to young patients, persons over 41 years of age did not have a compensatory decrease in TPVC in response to an increase in cardiac output, which indicates a lack of compensatory resources that provide a decrease in vascular tone under stress conditions, causing an insufficient vasodilator effect to increase perfusion blood flow in response to acute increased requirements of cells for oxygen, nutrient energy substrates. The latter leads to acute oxygen starvation of organs and tissues, including the myocardium with a corresponding violation of the functional activity of the heart, which in turn aggravates the consequences of already developed hypoxia, ischemia, causing further deterioration of trophism up to structural damage and, in the absence of timely corrective effects, ultimately causing the development of necrosis. Against the background of the ongoing routine intensive therapy, no signs of acute infarction were found in the examined patients, however, the revealed deviations of functional activity with signs of coronary insufficiency indicated insufficient effectiveness of correction and prevention of coronary insufficiency, which, according to the results of our studies, should be carried out more actively with the addition of drugs of coronary active, metabolic action. more actively in the third week and subsequent days in order to increase the compensatory capabilities of hemodynamics during the adaptation period in conditions of severe burn disease with a burn area of more than 30%.

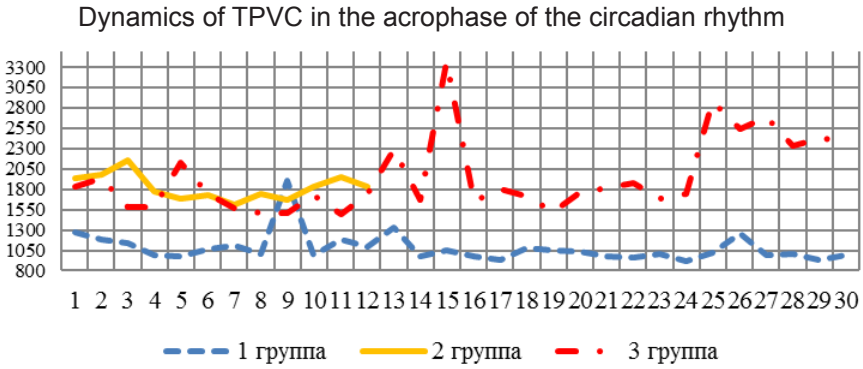

Fig.1

Attention was drawn (fig. 1) to a significantly higher level of dynamics of the acrophase of the circadian rhythm TPVC in groups 2 and 3, and the oldest patients showed a tendency towards an increase in the acrophase of TPVC on days 13, 15, 25 to maximum values (2300 dyn.s.cm $^{-}$5, 3300 dyn.s.cm^{-}5, 2800 dyn.s.cm^{-}5 at MCV 6.1 l/min; 6.5 l/min; 6 l/min, respectively). That is, the acrophase of the circadian rhythm of TPVC increased sharply with relatively normal values of the acrophase of the circadian rhythm of cardiac output. It should be assumed that these days were the most unfavorable, significantly increasing the risk of developing acute heart failure, when the cause of acute cardiac dysfunction is an acute significant increase in TPVC. In this situation, the primary is the deterioration of peripheral blood circulation, which may be caused not so much by vasospasm (taking into account age-related changes in the morphology of the vascular wall), but by a violation of the rheological properties of blood, hypercoagulation, and the consequences of deteriorating perfusion of parenchymal and other organs.

Dynamics of TPVC in the bathyphase of the circadian rhythm

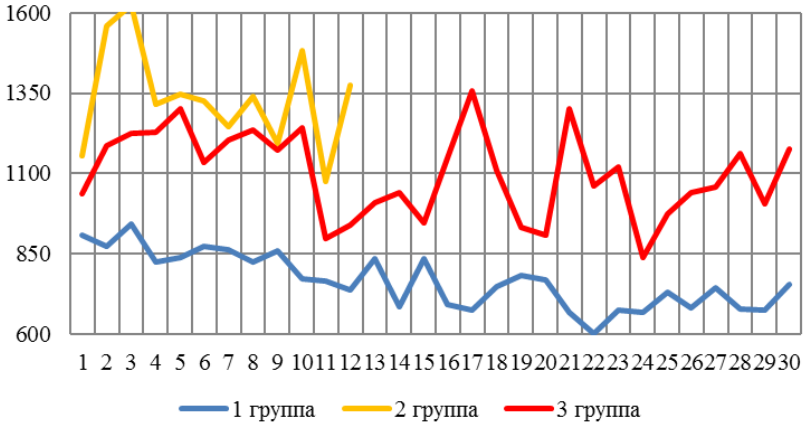

Fig.2

The diagram of TPVC changes in the bathyphase of the circadian rhythm was especially interesting. It was revealed that the highest values were in the middle age group (1100-1600 dyn.s.cm¯5 with a maximum on the 3rd day). Oscillations of TPVC at night occurred at a minimum level (600-900 dyn.s.cm¯5) in group 1. In group 3 patients, TPVC in bathiphase during toxemia ranged from 900 to 1350 dyn.s.cm¯5.

Correlation of the TPVC mesor with other hemodynamic parameters and body temperature

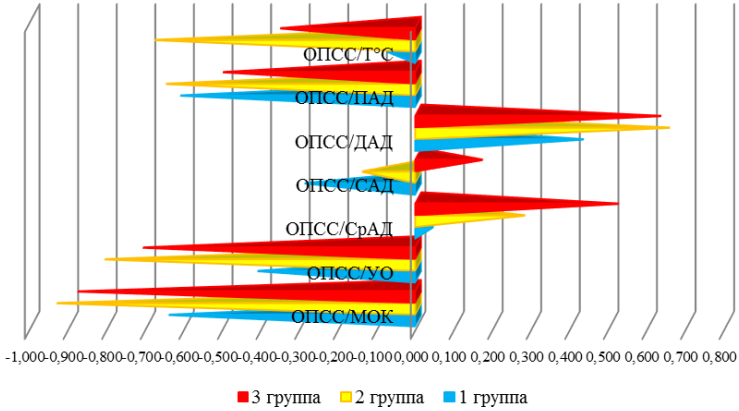

Fig.3

Table 3

Correlation of the TPVC mesor with other hemodynamic parameters and body temperature

	TPVC/ MCV	TPVC/ SV	TPVC/ AvBP	TPVC/ SBP	TPVC/ DBP	TPVC/ PBP	TPVC/ T°C
Group 1	-0,646	-0,415	0,040	-0,294	0,430	-0,616	-0,080
Group 2	-0,936	-0,812	0,278	-0,145	0,653	-0,653	-0,683
Group 3	-0,882	-0,713	0,521	0,168	0,631	-0,506	-0,357

As shown in tab. 3, a reliably significant inverse correlation was found in patients of groups 2 and 3 between the circadian rhythm mesor TPVC and MCV (-0.936; -0.882) and TPVC and the SV circadian rhythm mesor (-0.812; -0.713, respectively). That is, in persons over 41 years of age with burn disease, the compensatory mechanism of hemodynamic adaptation is still working, when in response to an increase in cardiac output, TPVC decreases, which is a protective mechanism aimed at maintaining the contractile function of the myocardium in conditions of a burn injury of the skin surface with a total area of 54.3 ± 16.5%, grade 3B 11.9 ± 8.9%, IF - 92.5 ± 20.8 units, in group 2, as well as with an area of 40.8 ± 5.8%, grade 3B - 21.7 ± 6.7%, IF - 86.7 ± 12.8 units over the age of 61 (fig. 3).

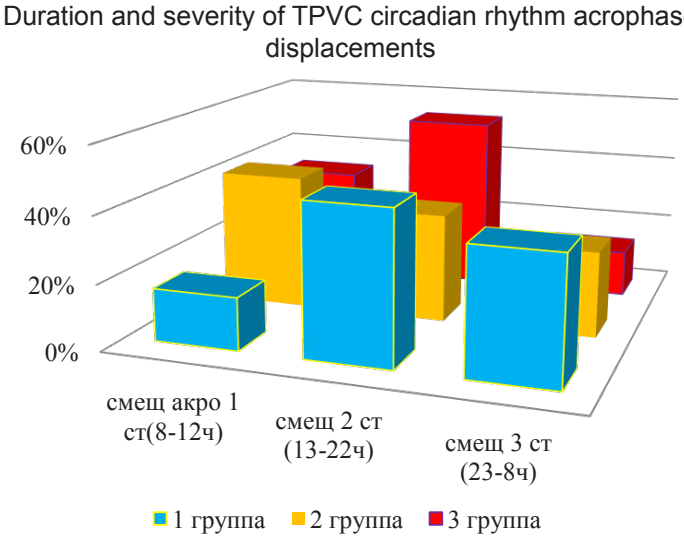

Fig.4

The most prolonged and moderate (within the daytime) and pronounced (shift to nighttime) migration of acrophase (highest values) TPVC were found in patients of group 1 with toxemia (tab. 4, fig. 4). In group 2, insignificant and moderate displacement was 41% and 33%, while in group 3, the duration of acrophase migration during the daytime was 53%. Only at the age of 27 years, the inversion of the TPVC circadian rhythm, which occurred over 38% of the toxemia duration, indicated a relatively greater compensatory value of the shift of the maximum TPVC at night hours, which was most likely due to the insufficient adequacy of stress-limiting therapy in the conditions of the burn surface 59.4 ± 13.5%, 3B degree 21.3 ± 13.3%, IF - 119.4 ± 38.4 units. This is confirmed by the data of compensatory hemodynamic hyperdynamics throughout the observation period in patients of group 1.

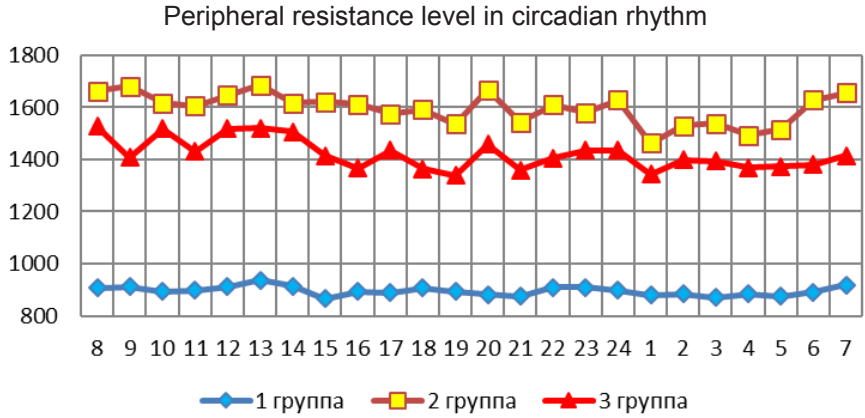

Fig.5

The average level of total peripheral resistance for the period of toxemia in patients of group 1 remained significantly less than the indicator in groups 2 and 3 of patients (fig. 5) and in the daytime and at night.

Conclusions. On the first day, significantly higher TPVC values were found in groups 2 and 3. From the first day of toxemia in group 1, the hyperdynamic type of hemodynamics was associated with the formation of a compensatory increase in cardiac output with a corresponding decrease in TPVC. Against the background of the exhausted possibilities of myocardial contractility, an even greater decrease in the mesor of the circadian rhythm TPVC took place on the 16th day to the minimum for the entire period of toxemia - up to 660 ± 58 dyn.s.cm^{-5}. In contrast to young patients, per-

sons over 41 years of age did not have a compensatory decrease in the mesor of the circadian rhythm TPVC in response to an increase in cardiac output, which indicates a failure of vasodilator mechanisms to increase perfusion blood flow in response to an acutely increased cell oxygen demand. In groups 2 and 3, a strong negative correlation between MCV, SV and TPVC turned out to be an indicator of the compensatory mechanism of hemodynamic adaptation, when TPVC decreased in response to an increase in cardiac output.

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CIRCADIAN RHYTHM OF MYOCARDIAL OXYGEN DEMAND DURING BURN TOXEMIA IN ADULTS

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Abstract. For patients aged 27.3 ± 5.6 years, the period of burn toxemia is characterized by a significant increase in myocardial oxygen demand (MOD) against the background of the developed hyperdynamic type of hemodynamics. Revealed at the age of 71.3 ± 7.0 years, a reliably significant low level relative to the indicator of the mesor of the circadian rhythm MOD of patients of group 1, a moderate displacement of the acrophase of the circadian rhythm MOD within the light time of day for 50% of the time of the age group mitochondrial insufficiency. The highest amplitude of daily fluctuations in myocardial oxygen demand at the age of 71.3 ± 7.0 years also characterized the most pronounced instability of mitochondrial metabolism.

Relevance. Since myocardial oxygen consumption reflects the level of mitochondrial metabolism and ATP synthesis, any increase in the demand for ATP will lead to an increase in oxygen consumption. At the same time, the need for ATP is determined not only by external work. The occurrence of wall stress increases oxygen consumption even when no external work is performed. The larger the left ventricular (LV) cavity, the larger its radius and, accordingly, the greater the wall stress. Consequently, the ejection of a similar volume of blood from a dilated LV at a similar arterial pressure will produce a similar amount of external work as the ejection of the same volume of blood by a normal-sized ventricle, but in the case of a larger ventricle, the wall tension will be significantly greater. Thus, the oxygen demand will also be significantly higher. From a clinical point of view, heart size is an important determinant of myocardial oxygen consumption. In a patient

with angina pectoris and a large LV cavity, therapy is adequate, which contributes to a reduction in the LV cavity, which will lead to a decrease in myocardial oxygen demand [1,2,3].

The general concept of stress includes afterload because an increase in afterload leads to an increase in systolic wall stress. Wall tension also depends on preload, which generates diastolic wall tension. The wall stress increases in proportion to the degree of pressure increase and the radius of the LV cavity, factors that are, respectively, responsible for the increase in post- and preload. Wall tension allows energy to be consumed to generate muscle contraction that does not result in external work. Moreover, states of increased contractility are accompanied by increased wall stress. Thus, the concept of wall stress provides a comprehensive approach to the problem of myocardial oxygen consumption. In addition to the metabolic component, the role of which is usually insignificant, but can significantly increase under certain circumstances, for example, pathologically high levels of circulating free fatty acids, changes in HR and wall tension also determine most of the clinically significant changes in myocardial oxygen consumption.

Thus, myocardial oxygen consumption (MO_2) is determined by the muscle tension of the heart wall, its contractile ability and heart rate. Accurate MO_2 measurement requires cardiac catheterization. During exercise, MO_2 can be measured by the product of the achieved HR and the systolic BP, which is called the double product (DP). The authors usually divide the obtained value by 100. There is a linear relationship between MO_2 and coronary circulation [3,4,5].

The most important principle of exercise physiology is that oxygen consumption (VO_2) and myocardial oxygen demand (MO_2) have clear determinants and methods of measurement and evaluation. Although they are closely interrelated, this ratio can change during exercise, as well as due to medication (eg, β-blockers) [1].

The most important factor determining myocardial oxygen demand is heart function (HR), while in a noncontractile heart, oxygen consumption is only 15-20 normal resting conditions.

The factors that affect metabolic processes in the myocardium are constantly changing. Myocardial oxygen demand almost doubles with atrial pacing, when the heart rate doubles. The uptake of oxygen by the myocardium nearly doubles as soon as the pressure in the aorta rises from 75 to 175 mm Hg. at constant HR and stroke volume (SV). Myocardial oxygen consumption increases by about 20% when SV increases by 60% with a constant pulse-pressure product. During physical exertion, coronary

circulation increases fivefold compared to its value at rest. Persons with stenosing coronary artery disease often cannot maintain the required coronary blood flow in accordance with the degree of increase in metabolic requirements of the myocardium during exercise and, as a consequence, the development of myocardial ischemia occurs [1-4]. Due to the lack of information on the effect of burn disease on the circadian rhythm of myocardial oxygen demand (MOD), the goal of long-term monitoring of the indicator is to assess the features of changes in MOD during the period of burn disease toxemia.

Purpose of the work - to study the circadian rhythm of myocardial oxygen demand during the period of burn toxemia in adults.

Material and research methods. The results of monitoring the MOD indicator, body temperature, infusion therapy of 25 patients admitted to the department of cambustiology of the republican scientific center of emergency medicine due to burn injury were studied. After recovery from shock, anti-inflammatory, antibacterial, infusion therapy, correction of protein and water-electrolyte balance disorders, early surgical, delayed necrectomy, additional parenteral nutrition, syndromic, symptomatic therapy were performed. The systemic inflammatory response was studied by monitoring the hourly continuous recording of body temperature, MOD 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.

Table 1
Patient characteristics

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

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. Thus, the most pronounced burns in terms of area and depth were found in patients in group 1.

Table 2

Dynamics of the mesor of the circadian rhythm of myocardial oxygen demand during burn toxemia in adults

	Group 1	Group 2	Group 3
1	119±4	124±11	108±6
2	119±3	106±2* ‴	114±3
3	121±3	106±3*‴	112±5
4	132±2*	122±3 ‴	111±4 ‴
5	130±3*	125±4	113±6 ‴
6	133±3*	127±5	111±4 ‴
7	142±4*	121±3‴	114±5 ‴
8	141±5*	118±4‴	109±4 ‴
9	141±4*	117±2 ‴	117±7 ‴
10	137±4*	112±2 ‴	115±7 ‴
11	130±4*	111±5 ‴	123±7
12	133±5*	106±3 ‴	110±9 ‴
13	131±5*		112±10 ‴
14	139±5*		120±7 ‴
15	142±4*		111±12 ‴
16	139±4*		97±3 ‴
17	142±4*		97±5 ‴
18	144±4*		102±5 ‴
19	143±2*		110±7 ‴
20	141±4*		108±9 ‴
21	143±5*		93±3 ‴
22	145±3*		105±9 ‴
23	139±3*		101±6 ‴
24	140±5*		137±16
25	144±4*		90±9 ‴
26	138±6*		101±6 ‴
27	138±4*		117±11 ‴
28	135±2*		96±8 ‴
29	137±6*		104±7 ‴
30	137±3*		115±9 ‴

*- - reliable relative to the indicator in 1 day

‴ - reliable relative to the indicator of the same name in group 1

The level of the mesor of the circadian rhythm MOD on day 1 of burn toxemia did not differ significantly from the normative indicators. Group 1 showed an increase in MOD by 13% on days 4-6 ($p < 0.05$), increasing by another 10% on days 7-9. During the period of toxemia in patients of group 1, MOD exceeded the physiological level by 30-44% ($p < 0.05$), remaining stable at this level for up to 30 days. Thus, for group 1 of patients, the period of burn toxemia is characterized by a significant increase in MOD against the background of the formed hyperdynamic type of hemodynamics (fig. 1).

In group 2, on day 2.3, there was a short-term decrease in MOD to normal ($p < 0.05$), on the following days, the mesor of the circadian rhythm of MOD was at the level of the indicator on day 1, but on days 2-4.7-12, the mesor of the circadian rhythm of MOD in group 2 remained less than the indicator in group 1 by 13% (day 2), by 21-27% (day 7-12). The oldest group 3 was distinguished by the absence of significant deviations of the mesor of the circadian rhythm of MOD from physiological values throughout the entire observation period. However, a significant difference from the mesor indicator of the circadian rhythm MOD was found in patients of group 1, starting from 4 days until the end of observation with a short-term increase on days 11 and 24 by 23% and 37% relative to the norm (fig. 1). The revealed features of changes in the mesor of the circadian rhythm MOD in group 3 are most likely due to mitochondrial insufficiency characteristic of this age group, since oxygen consumption by the myocardium reflects the level of mitochondrial metabolism and ATP synthesis.

Dynamics of the mesor of the circadian rhythm of myocardial oxygen demand,%

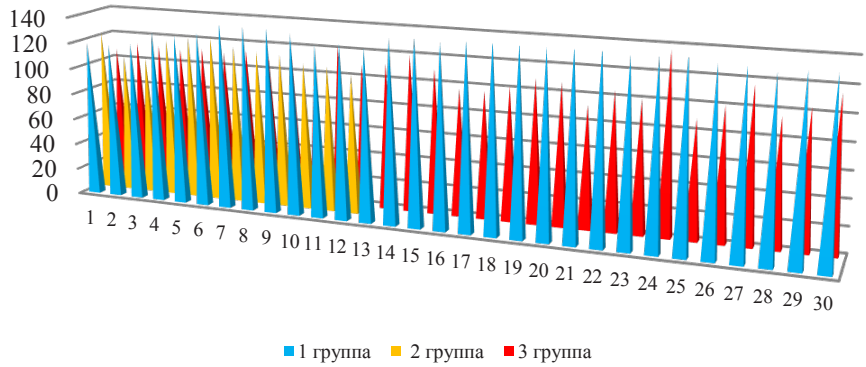

Fig.1

The highest indicators in the circadian rhythm (fig. 2) of the average MOD in the circadian rhythm were found for 24 hours a day in patients of group 1, the lowest MOD indicators were noted in patients of the oldest group. Thus, the MOD indicator in the morning hours of 10-11 am in group 1 was increased by 36%, in group 2 by 15-19%, and in group 3 by 9-6%, practically not differing from the norm (tab. 3).

Average for the period of toxemia indicator of myocardial oxygen demand in the circadian rhythm

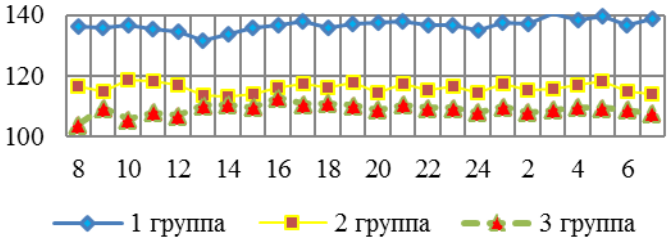

Fig.2

Table 3.

Average myocardial oxygen demand in the circadian rhythm during the period of toxemia

Hours	Group 1	Group 2	Group 3
8	136±7	117±5 ‴	104±8 ‴
9	136±7	115±6 ‴	109±10 ‴
10	137±6	119±9 ‴	106±9 ‴
11	136±5	118±8 ‴	108±8 ‴
12	135±6	117±9 ‴	107±8 ‴
13	132±8	114±5 ‴	110±8 ‴
14	134±6	113±5 ‴	111±8 ‴
15	136±7	114±5 ‴	110±9 ‴
16	137±6	116±7 ‴	113±12 ‴
17	138±6	118±7 ‴	111±10 ‴
18	136±6	116±8 ‴	111±10 ‴
19	137±7	118±9‴	110±11 ‴
20	137±6	115±7 ‴	109±13 ‴
21	138±7	118±8 ‴	111±12 ‴
22	137±7	115±7 ‴	110±11 ‴
23	137±6	117±6 ‴	110±9 ‴

24	135±6	114±6 ‴	108±8 ‴
1	138±7	117±8 ‴	110±11 ‴
2	137±7	115±10 ‴	108±11 ‴
3	141±9	116±8 ‴	109±10 ‴
4	138±7	117±7 ‴	110±11 ‴
5	140±7	118±8 ‴	110±12 ‴
6	136±6	115±6 ‴	109±11 ‴
7	139±8	114±8 ‴	108±9 ‴

‴ - the difference is significant relative to the indicator in group 1

Dynamics of the amplitude of the circadian rhythm of myocardial oxygen demand in%

Fig.3

The most significant daily variations in MOD in group 3 characterized a more pronounced instability of mitochondrial metabolism and ATP synthesis in the older age group. MOD changes were wavy in nature with a period of fluctuations of 5-6 days in all age groups. Thus, the greatest amplitude of daily fluctuations in myocardial oxygen demand was characteristic of persons aged 71.3 ± 7.0 years (fig. 3).

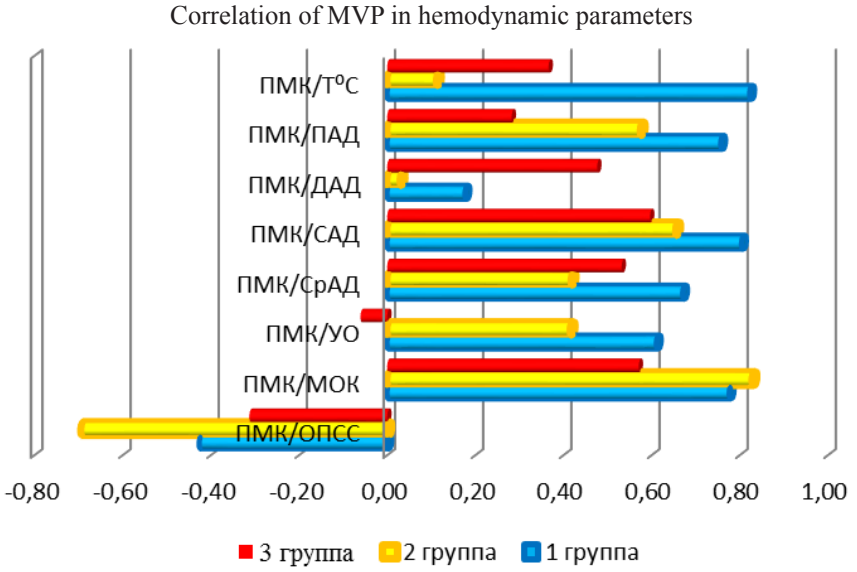

Fig.4

A direct strong correlation was found between MOD and MVC, SV, AvgBP, SBP, PBP and T°C in group 1, while in group 2 all these correlations became less significant, with the exception of MVC. These correlations decreased even more in group 3. It was revealed that the severity of compensatory mechanisms was most active in the youngest patients and significantly weakened in the older age groups. Thus, the severity of compensatory hemodynamic reactions during the period of burn toxemia depended on the age of the patients.

As shown in fig. 5, the duration and severity of displacements of the acrophase of the circadian rhythm of the OPSS varied as follows. So, in groups 1 and 2 of patients, the prevalence of duration (64% and 68% of the duration of toxemia) and the severity of the acrophase shift (inversion) was revealed. While in group 3, the duration of the moderate displacement of the acrophase of the circadian rhythm MOD within the daylight hours prevailed (50%). The latter was most likely due to a lower level of mitochondrial metabolism and ATP synthesis characteristic of older age.

The duration and severity of displacements of the acrophase of the circadian rhythm of the OPSS

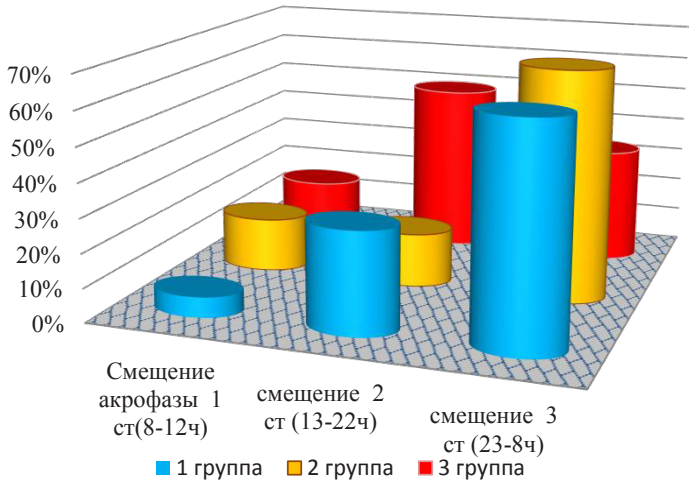

Fig.5

Conclusion. For group 1 of patients, the period of burn toxemia is characterized by a significant increase in MOD against the background of the formed hyperdynamic type of hemodynamics. The reliably significant low level of the MOD mesoor in group 3, revealed in group 3, relative to the indicator of the circadian rhythm mesoor MOD of patients in group 1, moderate displacement of the acrophase of the circadian rhythm MOD within daylight hours, is most likely due to mitochondrial insufficiency characteristic of this age group. The greatest amplitude of daily fluctuations in myocardial oxygen demand characterized the most pronounced instability of mitochondrial metabolism at the age of 71.3 ± 7.0 years.

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TISSUE REACTION AFTER INTRA-ABDOMINAL IMPLANTATION OF A COMBINED HERNIOPROSTHESIS IN EXPERIMENT

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Aim. To study the peculiarities of integration of a combined endoprosthesis made of biological and synthetic material with the tissues of the anterior abdominal wall of rats in intra-abdominal implantation. To compare the short-term results of intra-abdominal implantation of a combined endoprosthesis (CE) and a composite polyester mesh with single-sided adhesion (POC) in rats.

Materials and Methods. The experiment was performed on 20 laboratory male rats of Vistar line. The animals were divided into two groups: the first group included ten rats with implantation of a combined hernioprosthesis. The second group included ten rats with implantation of a composite polyester mesh. The activity of adhesion process in the abdominal cavity was visually evaluated by the area of the formed adhesions, their type and strength according M.P. Diamond et al. (1992).

Results. Immediate results and short-term complications of the performed operation were noted: in 20% of cases fistulas of the anterior abdominal wall were formed. Adhesion process in the abdominal cavity was most pronounced in animals with fistulas. In the course of study, a macroscopic evaluation of peculiarities of integration of endoprosthesis with the tissues of the anterior abdominal wall was performed, the best result was noted 6 months after the implantation.

Conclusion. Zones of formation of adhesions were identified, which were the places of ligatures and the edges of the hernioprosthesis. In a comparative evaluation of the results of intraabdominal implantation of a combined endoprosthesis on the basis of a modified xenopericardium

and of a composite mesh with one-sided adhesion by the methods of parametric statistics, comparable results were obtained. Formation of adhesion was most active at the edge of the endoprosthesis and at the sites of ligatures. In this connection, a more thorough treatment of the edges of the hernioprosthesis is required during implantation.

Keywords: combined prothesis, pericardium, mesh, morphological reaction.

Synthetic hernioprostheses have become firmly established in surgical practice and have proven their reliability [2, 4]. The danger of the development of adhesions in the abdominal cavity does not allow their use for intra-abdominal implantation. The solution to this problem lies in the creation of combined hernioprostheses, which can be used for both laparoscopic and open hernioplasty. There are composite hernioprostheses, which are a synthetic mesh with collagen coating. Literature data indicate good results of intra-abdominal implantation of a composite mesh with unilateral adhesion [1].

Existing developments are represented by a combination of biological tissues (for example, xenopericardium or collagen plate) and synthetic meshes [5, 6]. Nevertheless, the search for the optimal combination of components for creating endoprostheses continues.

Purpose

To study the specialties of integration of combined endoprosthesis made of biological and synthetic material with the tissues of the anterior abdominal wall of rats at the intraabdominal implantation.

Materials and methods

Twenty laboratory male Vistar rats weighing 180-200 grams underwent intra-abdominal implantation of hernioprostheses. The animals were divided into two groups: ten rats of the first group underwent implantation of a combined hernioprosthesis based on a modified xenopericardium (manufactured by OOO Kardioplant, Russia, Penza TU 9398-003-99509105-2014) so that the smooth side of the xenopericardium was facing to the abdominal organs. Ten rats of the second group received the composite polyester mesh (PCO, manufactured by Covidien, France), placing with an anti-adhesive coating to the abdominal organs. The animals were taken out of the experiment at 1, 4 and 6 months after the operation. The activity of the adhesive process was assessed visually at autopsy by the scale of M.R. Diamond et al. (1992) [7].

Results

The results were studied in 19 surviving animals. One rat died within 1 month after the surgery. Pneumonia was morphologically diagnosed. A complication of the performed operation was the formation of suture fistulas on the anterior abdominal wall in two rats of the first group (20%) and in two rats of the second group (20%). The sizes of the fistulas were from 3 to 10 mm. In two cases the mesh prolapsed through the fistulous opening (Fig. 1, 2).

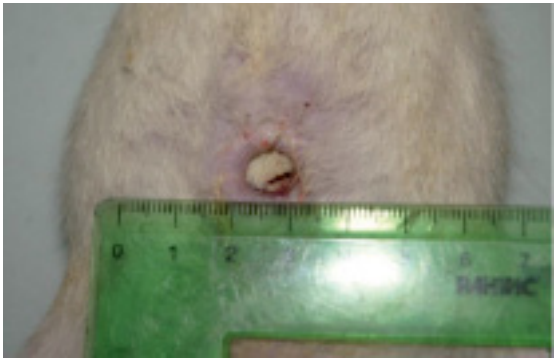

Figure: 1. Suture fistula orifice on the anterior abdominal wall d = 8 mm. Combined endoprosthesis, 6 months after implantation

Figure: 2. Fistula orifice on the anterior abdominal wall d = 10 mm. Polyester mesh with one side adhesion, 1 month after implantation

Determining the activity of the adhesion process the area of the formed adhesions was assessed in percent, their type - density and presence of vessels, and strength. Each characteristic (table 1) was assigned scores from zero to four or from zero to three in accordance with the table for evaluating the adhesion process proposed by M. R. Diamond et al. [7]. The sum of points for the three assessed criteria was considered an indicator of the severity of the adhesion process.

Table 1. Assessment of the severity of the adhesive process

Characteristics of postoperative adhesions	Scores
Prevalence% no adhesions adhesion area less than 25 adhesion area up to 50 adhesion area up to 75 adhesion area more than 75	 0 1 2 3 4
Type no adhesions thin, transparent, avascular adhesions translucent, opaque, avascular adhesions opaque with multiple small visualized vessels adhesions opaque with multiple large (coarse) visualized vessels adhesions	 0 1 2 3 4
Density no adhesions adhesions lysed without tension adhesions lysed under tension lysis of adhesions is performed by dissection	 0 1 2 3 4

The average score in the group of animals implanted with a combined endoprosthesis was 8.4 ± 1.7, and in the group of rats, which were implanted with a composite mesh with unilateral adhesion, 9.2 ± 1.5 ($p = 0.439$). The most pronounced adhesive process in the abdominal cavity was observed in animals with a fistula. The implantation zone of the prosthesis was a conglomerate consisting of a prosthesis, loops of the small and large intestines soldered to it, there were also adhesions with the liver, stomach, and spleen (Fig. 3, 4).

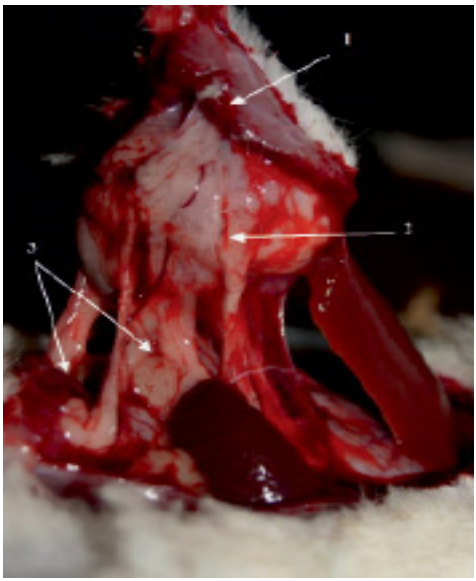

Figure: 3. The inner surface of the anterior abdominal wall of the rat, combined endoprosthesis, 6 months after surgery: 1 - the anterior abdominal wall of the rat; 2 - conglomerate containing an endoprosthesis; 3 - dense adhesions with large vessels

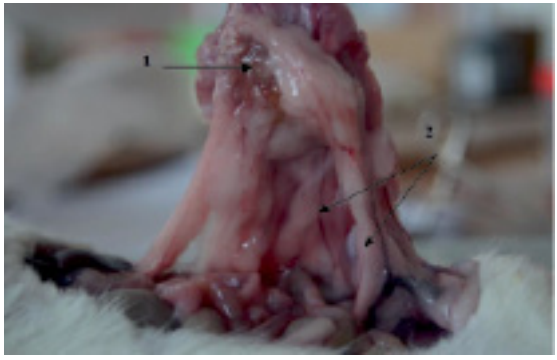

Figure: 4. Inner surface of the anterior abdominal wall of a rat, polyester mesh with one-sided adhesion, 6 months after surgery: 1 - conglomerate containing an endoprosthesis; 2 - dense adhesions with large vessels

The zone of the most active adhesion formation was the sites of ligatures, as well as the edge of the composite polyester mesh, and the edge of the combined endoprosthesis at the border of the xenopericardium and mesh. The best result was observed within 6 months after the operation in the group of animals that received the combined endoprosthesis. The smooth surface of the xenopericardium was covered with a newly formed peritoneum, with many small vessels, along the edge of the endoprosthesis there were thin adhesions with small vessels, adhesions were easily destroyed (Fig. 5, 6.).

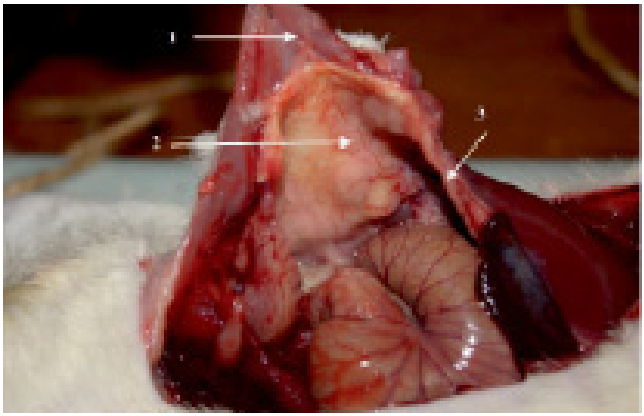

Figure: 5. Inner surface of the anterior abdominal wall of a rat, combined endoprosthesis, 6 months after surgery: 1 - anterior abdominal wall; 2 - "smooth" surface of the endoprosthesis, covered with a newly formed peritoneum; 3 - thin adhesions on the periphery of the endoprosthesis

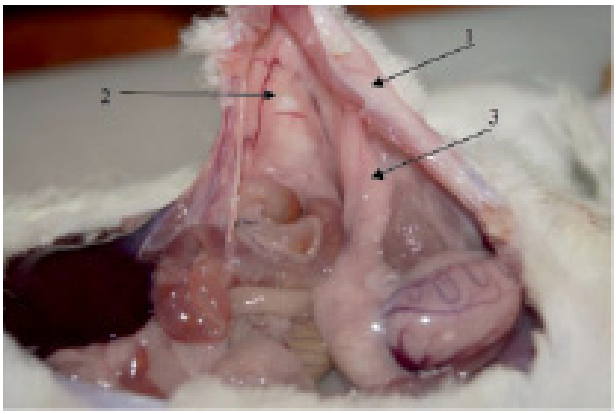

Figure: 6. Inner surface of the anterior abdominal wall of a rat, polyester mesh with one-sided adhesion, 6 months after surgery: 1 - anterior abdominal wall; 2 - the inner side of the mesh, with a newly formed peritoneum; 3 - adhesions

Conclusions

The immediate results of intra-abdominal implantation of a combined endoprosthesis made of biological and synthetic material and a polyester mesh with unilateral adhesion in laboratory animals are comparable. The formation of fistulas was a complication of intra-abdominal implantation of hernioprostheses. Adhesion occurs most actively at the edge of the endoprosthesis and in the places of ligatures. In this regard, it is necessary to more thoroughly process the edges of the hernioprosthesis during implantation. The development, improvement and implementation into practice of methods that prevent the development of adhesions is a perspective direction in modern surgery of hernial disease.

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THE THIRD LAW OF THERMODYNAMICS FROM THE POINT OF VIEW OF QUANTUM CHEMISTRY

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Abstract. The purpose of this study is to demonstrate the inconsistency of the third law of thermodynamics from the point of view of quantum chemistry, which asserted that there is no state of matter when the kinetic energy of its particles is zero.

Method. Study, analysis and comparison of educational and scientific data, the area of which is described in the literature on physical chemistry and quantum chemistry.

Results. As a result of solving the Schrödinger equation for a one-dimensional or three-dimensional potential box and the result that the energy of a particle can indicate only a strictly defined quantity, which is characterized by the principal (principal) quantum number n. On the other hand, it follows from the solution of the Schrödinger equation that the product energy t can be zero even at absolute zero temperature: the minimum energy (zero energy) is observed at n = 1.

Conclusion. The third law of thermodynamics of quantum chemistry is inconsistent, because atoms and other particles, even at temperatures close to absolute zero, have zero energy associated with zero-point vibrations.

Keywords: quantum mechanics and quantum chemistry, the law of thermodynamics, one-dimensional or three-dimensional potential box, quantum number.

Introduction

In connection with the emergence of a new scientific discipline in natural science as quantum mechanics, and after it, quantum chemistry in 1926-1927, it became necessary to revise some concepts and theorems of physical chemistry (chemical thermodynamics) and classical provisions of general chemistry. In this work, in particular, we are talking about the third

law of thermodynamics and about some difficulties of Rutherford's theory that arose in connection with the prediction of the properties of atoms (in particular, the position of stability of an atom as a structural chemical unit).

I consider it my professional and pedagogical duty to inform the younger generation of students and young chemists about the information that inevitably occurs in the natural sciences in connection with the emergence of new scientific achievements in theoretical (in particular, quantum) chemistry.

1. Materials and their discussion. Inconsistency of the third law of thermodynamics from the point of view of the achievements of quantum chemistry (and conclusions from the solution of the Schrödinger equation).

First, we will give an exposition of the third law of thermodynamics, as it is given in the classical textbooks for higher education in the specialty "physical chemistry" [1, 2].

It is generally known from the course of physical chemistry, in particular from the section on chemical thermodynamics, that the entropy S is a measure of the disorder of the system, and with decreasing temperature, the entropy of the system also decreases. According to Boltzmann, entropy, taking into account its statistical interpretation, is related to the thermodynamic probability of the existence of the system W by the Boltzmann relation

$$S = k \, Ln \, W, \qquad (1)$$

where k is the Boltzmann constant. As for the thermodynamic probability W, it is understood as the number of microstates with the help of which a given macrostate of the system is realized. The fact is that one and the same thermodynamic state of a given system can correspond to different energy distributions between individual molecules (particles), that is, a given macrostate of the system can be realized by a large number of different microstates. Let us explain the above with the following example.

If in some system there are N particles, and N 1 of them is of the 1st kind, N 2 is of the second kind, then the thermodynamic probability of the system W will be equal to

$$W = N \, ! \, / \, N1 \, !. \, N2 \, !, \qquad (2)$$

Where N ! - factorial N equal to 1, 2, 3 … N (and N = N1 + N2).
The Boltzmann equation (1), taking into account relation (2), takes the form

$$S = k/ \, Ln \, [\, N \, ! \, / \, (N1 \, !/N2!) \,] \qquad (3)$$

In other words, the thermodynamic probability of the existence of a system W is equal to the number of distinguishable permutations in a system of N particles [3].

Since N is usually a large number, for calculations according to equation (3) We apply the approximate Stirling formula for the factorial

$$\text{Ln } N ! = N \text{ Ln } N - N \quad (4)$$

Boltzmann's equation (1) underlies statistical thermodynamics, which makes it possible to calculate the entropy of various substances based on data on the internal structure. In this case, entropy is considered as the sum of components related to various forms of particle motion. The following components of entropy are distinguished: entropy of translational motion of molecules S (transl), entropy of rotational motion of molecules S (rot), entropy of rotational motion of atoms and atomic groups contained in a molecule, entropy of internal rotation S (int. rot), entropy of vibrational motion of atoms and atomic groups contained in a molecule S (vibr), and the entropy of motion of electrons S (elect). Thus, entropy can be represented as the sum of the following components

$$S = S \text{ (transl)} + S \text{ (rot)} + S \text{ (int. rot)} + S \text{ (vibr)} + S \text{ (elect)} \quad (5)$$

As follows from the Boltzmann equation (1), as the thermodynamic probability (i.e., the number of microstates) increases, the entropy of the system S also increases. The maximum value of W also corresponds to the maximum value of the entropy S, which corresponds to the state of equilibrium. What has been described in this article so far is true both from the point of view of classical thermodynamics and the point of view of the achievements of quantum chemistry, as well as the Schrödinger equation. The divergence begins at this point when classical thermodynamics and its third law reason as follows. At absolute zero temperature, the motion of atoms and molecules stops and the thermodynamic probability of the existence of the system will be equal to unity. With this assumption, the crystal becomes, as it were, ideal without any defects with a thermodynamic probability equal to unity (W = 1). And since Ln1 = 0, it is natural to assume that the value of the entropy of an ideal crystal at absolute zero temperature will also be zero. This assumption is the essence of the third law (or principle) of thermodynamics. It is precisely this main assumption of classical thermodynamics and its third law that is erroneous from the point of view of quantum mechanics and the quantum chemistry created on its basis. From the point of view of the third law of thermodynamics, it is mistakenly believed that in an ideal crystal all possible movements and vibrations (as well as the processes of rotation of atoms, atomic groups and the movement of electrons) completely cease and the crystal at a tem-

perature of absolute zero becomes ideal and perfect. And matter or substance exists without movement. But matter without motion can possibly exist, because motion is the root property of matter (an attribute of matter), which is confirmed by dialectical materialism since the time of the classic of materialism Hegel [4]. In full agreement with Hegel, quantum mechanics, and after it quantum chemistry, in full agreement with the solutions of the Schrödinger equation, assert that the localization of an electron in a certain region of space causes the appearance of a certain momentum in it and, consequently, kinetic energy, which is the more, the more the motion of the electron is limited. The same can be said about any other microparticle (including the atoms and molecules of the crystal). Quantum mechanics and quantum chemistry assert that there is no such state of matter in which the kinetic energy of its particles would be equal to zero. Even at a temperature of absolute zero, not only electrons, but atoms as a whole will be in continuous motion, oscillating around the equilibrium position.

Zero vibrations of atoms affect many properties of substances, including the value of entropy in accordance with equation (5). The reality of zero-point vibrations of atoms is confirmed by the study of X-ray diffraction by crystals. These studies show the existence, even at temperatures close to absolute zero, of some disorder in the arrangement of atoms, due to their zero-point vibrations. Everything that has been said here casts a shadow of doubt on the assertion of the third law of thermodynamics, which allows the idea that at absolute zero temperature the motion of atoms and molecules stops and the entropy of the crystal becomes equal to zero. Therefore, we declare with a very high degree of probability and confidence in our statement that this provision of the third law of thermodynamics from the point of view of the achievements of quantum chemistry based on the solution of the Schrödinger equation can be considered untenable.

However, one of the consequences of the third law of thermodynamics, namely the second consequence, which is called Planck's postulate, still remains of great importance for chemical thermodynamics. This consequence can be formulated as follows: the temperature of absolute zero is unattainable. This corollary makes sense in the sense that the absolute value of the entropy of the system cannot be calculated, which is quite consistent with the thermodynamic position, namely, it is only possible to calculate the change in entropy during the transition of the system from state one to state two, and not the absolute value of entropy. This position is akin to the position that it is impossible to reach the speed of light with the help of devices created by human intelligence, no matter how fast the electron accelerators in nuclear reactors are.

Materials and discussion

2. Why Rutherford's theory could not explain the real fact of the stability of the atom

Rutherford's "planetary model" of the atomic structure, despite certain successes, contradicted some well-established experimental facts. For example, Rutherford's model could not explain the stability of the atom as a structural chemical unit. An electron revolving around a positively charged nucleus should emit electromagnetic energy in the form of light waves. But by emitting light, the electron loses some of its energy. Over time, the electron, having exhausted its energy, must fall on the nucleus, and then the atom will cease to exist. This conclusion contradicts the real properties of the atom, which are stable formations and can exist for an extremely long time.

A correct and completely scientific explanation of the reason for the stability of the atom is given by quantum chemistry, namely, the answer follows from the results of solving the Schrödinger equation for a one-dimensional and three-dimensional potential box. According to the solution of the Schrödinger equation, the total energy of a particle E (in this case, an electron in a potential box) is determined by the relation

$$E = n2\ h\ 2 \mid 8\ m\ a2 \qquad (6),$$

where n = 1, 2, 3 …;(principal quantum number); h - Planck constant; m – particle mass; a – size of one-dimensional potential box.

Since in expression (6) for the energy of a particle in a potential box n /= 0, then the energy E cannot be equal to zero; the minimum energy (zero energy of a particle, i.e., an electron) corresponds to n = 1 and is calculated by relation (6) with the value of the principal quantum number equal to unity. Under these conditions, it is natural to assume that the electron should not fall on the nucleus, and the atom should maintain its usual stable position

Thus, quantum chemistry and one of the founders of this science, Schrödinger, again came to the aid of Schrödinger.

Results and conclusions

1. If we take into account the results of the achievements of quantum chemistry and the conclusions from the solutions of the Schrödinger equation as applied to the third law of thermodynamics, then the main postulate of this law, namely the zero value of entropy at the temperature of absolute zero, can be considered inconsistent.

2. As for the stability of the atom, the main reason for it, according to quantum chemistry, is also the presence of the minimum zero energy for the electron, corresponding to the value of the principal quantum number equal to one.

Conclusion

The author of this article is ready to listen to the well-grounded point of view of other scientists on the issues discussed in the article and will be very grateful to them.

All the editorial staff of our beloved magazine "Bulletin of DSPU; series natural and exact sciences" I sincerely wish you a Happy New Year! May the New Year bring only health, luck and prosperity to all of you!

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INFLUENCE OF LASER RADIATION ON STRUCTURE AND PROPERTIES OF MULTI-ELEMENT COATINGS

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Introduction

Laser radiation, when exposed to the surface of the material being processed, allows fast and dosed transfer of large energy. The possibility of such an intensive supply of energy to the material determines the locality of thermal and other physical processes associated with them. The modification of the properties of materials by laser radiation is physically reduced to local thermal effects. Therefore, it is determined by the thermophysical parameters of the material, the power density and the time of exposure to radiation, in general, the amount of specific energy absorbed by the material, and the rate of its dissipation. The structure of the layer hardened by laser radiation is characterized by high hardness, reduced chemical activity, mechanical properties, heat resistance, magnitude and nature of the distribution of residual stresses change [1-5]. Recently began to practice laser alloying of coatings [6-10].

In [11], we showed that the diffusion process in a thin solid layer depends on its surface energy. In this work, we will focus on the effect of laser radiation on laser alloying of coatings and the surface energy of deposited coatings in accordance with our work [12]. Experimental technique. We used laser alloying of finished nanocrystalline coatings. The coatings were applied to steel 12Kh18N10T by sputtering $AlFe_{0.43}$ cathodes by the

ion-plasma method. A neodymium-doped yttrium-aluminum garnet laser ($\lambda = 1064$ íì) was used as a source of laser radiation. The duration of the flash of the laser pumping lamps operating in the free-running mode was 2 10^{-3} s. The laser pulse energy was 1 J, and the laser pulse repetition rate was adjusted from 0.1 to 35 Hz. Electron microscopic examination was carried out on a TESCAN MIRA 3 scanning electron microscope. The X-ray energy dispersive microanalysis system (Oxford Instruments) allows the local determination of the elemental composition on the sample surface. The surface energy was measured by the method [12]. A 3D image of $AlFe_{0.43}$ coatings was obtained on an AFM NT-206, microhardness - on an HVS-1000 device. Experiment Results. Figure 1 shows a 3D image of $AlFe_{0.43}$ coatings obtained with the NT-206, and Figure 2 shows an SEM image.

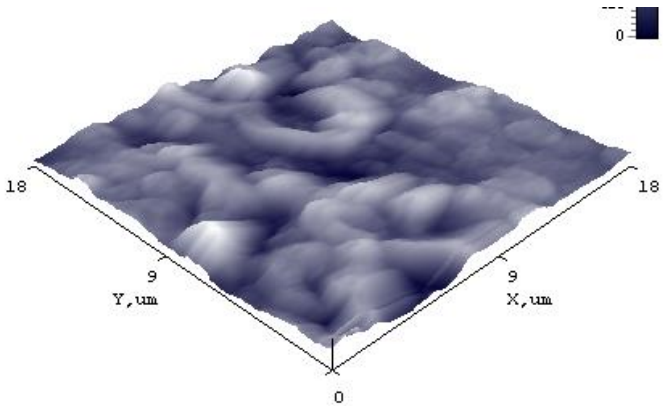
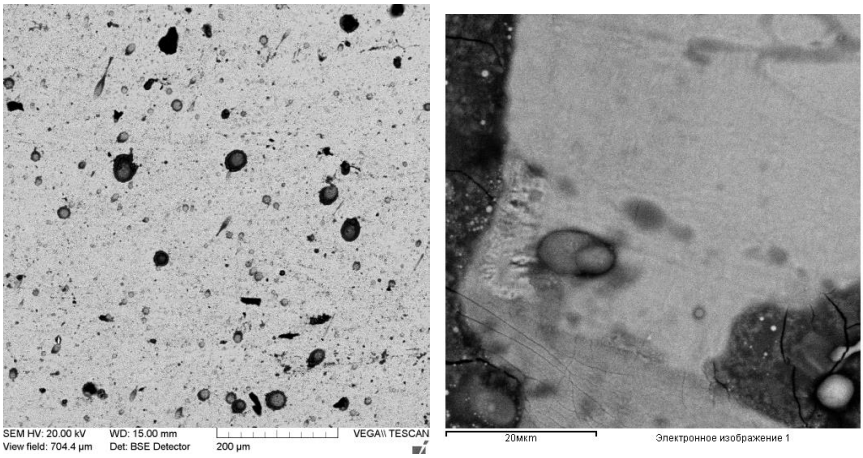


Figure 1 - 3D - image of $AlFe_{0.43}$ coating



a) b)

before laser irradiation (a) and after laser irradiation (b)
Figure 2 - Electron microscopic image of the coating $AlFe_{0.43}$

The elemental composition of the $AlFe_{0.43}$ coating before and after irradiation is presented in Tables 1 and 2.

Table 1 - Elemental composition of $AlFe_{0.43}$ coating before irradiation

Element	Weight%
C K	7.30
O K	5.46
Al K	12.35
Mn K	0.36
Fe K	74.53
Total	100.00

Table 2 - Elemental composition of AlFe0.43 coating after irradiation

Element	Weight%
O K	11.05
Al K	14.10
Ti K	30.06
Cr K	15.48
Mn K	11.37
Fe K	18.95
Total	100.00

Table 3 shows the friction coefficients of $AlFe_{0.43}$ samples paired with aluminum and copper in an argon atmosphere without laser treatment and after laser treatment. Table 4 shows the values of Vickers microhardness (HV) of $AlFe_{0.43}$ l samples in an argon atmosphere before and after laser treatment.

Table 3 - Coefficients of friction AlFe0.43, obtained in argon

Sample	Friction coefficient	
	aluminum	copper
AlFe0,43 before laser processing	0,327	0,282
AlFe0,43 after laser processing	0,142	0,148

Table 4 - Microhardness of AlFe0.43 obtained in argon mediumна

Sample	Test load, kg	Microhardness, HV
$AlFe_{0,43}$ before laser processing	0,025	196,8
$AlFe_{0,43}$ after laser processing	0,025	453,2

Table 5 shows the surface energy before and after laser treatment

Sample	Surface energy, J/m²
$AlFe_{0,43}$ before laser processing	0,944
$AlFe_{0,43}$ after laser processing	1,034

Discussion of the experimental results. During the primary laser melting of the coated surface, the homogeneity of the layer is rather low (Fig. 2b). Repeated laser irradiation under milder conditions provides high-quality doped layers and makes it possible to reduce the structural inhomogeneity. In this case, the strengthening particles consist of globular precipitates, which should not cause cracks to appear during operation. Compared to the base metal, the layer is etched very poorly, which indicates its high corrosion resistance. Comparison of the elemental composition before and after laser irradiation (Tables 1 and 2) shows that the composition of the coating has changed significantly due to mixing with the particles of the metal base. This is evidenced by the change in the surface energy (Table 5). This is due, first of all, to the dependence of the diffusion coefficient on the surface energy of the metal base according to [12]. The resulting alloy is a high-entropy compound (Table 2), which contains at least 5 elements, and the amount of each of them is not more than 35 at.% And not less than 5 at.%. Such compounds are characterized by a large

value of the entropy of mixing and surface tension. In [13], high-entropy alloys were synthesized for the first time, their name was proposed, and it was shown that they can have a number of unique properties. In [14], the criteria for the formation of disordered substitutional solid solutions in high-entropy alloys were analyzed. It is shown that not a single criterion or their definite combination allows one to accurately predict the formation of solid solutions or intermetallic phases in high-entropy alloys. Table 3 shows that the coefficient of friction is reduced by more than 2 times. This is due to a decrease in roughness during laser melting of the coating. Microhardness increases almost 3 times (Table 4), that is, the performance characteristics of the coatings become much better. In [14], four main effects of high-entropy alloys are summarized, namely:

(1) Thermodynamics: high entropy effect;

(2) Kinetics: sluggish diffusion;

(3) Structure: strong lattice distortion;

(4) Properties: cocktail effect.

(1) The condition for the thermodynamic stability of the phase is the minimum of its free energy. Since G=U+H-TS, high entropy leads to a decrease in the Gibbs energy and stabilization of the solid solution.

(2) The effect of sluggish diffusion follows from equation (3) and is related to the logarithmic term. This effect is usually used to explain the formation of nanoscale precipitates, since in materials in which diffusion is difficult, nuclei form more easily, but grow slowly.

(3) Since the sizes of atoms can be very different, the crystal lattice is strongly distorted, which leads to high elastic stresses and deceleration of dislocations. This effect is confirmed by the ultra-high strength of bcc high-entropy alloys.

(4) For metal alloys, the cocktail effect indicates that unexpected properties can be obtained by mixing many elements that cannot be obtained from any single independent metal. The cocktail effect shows that alloy properties can be significantly altered by varying composition and alloying. A common method for producing high-entropy alloys is arc melting. Arc melting temperatures can be very high (> 3000 ° C). The technology of plasma spraying and laser or electron-beam surfacing is also used [14, 15]. Mechanical alloying is also used - this is destruction in a ball mill and re-welding of powder particles. This method can be used to synthesize equilibrium and non-equilibrium alloys, both by mixing elementary substances and by dispersing pre-prepared alloys [15]. The method is used to obtain precipitation-hardened nickel-based or iron-based alloys for the aerospace industry.

Conclusions and further research prospects. The method of laser alloying proposed in this work differs from the works cited above [14, 15] in simplicity of execution. This method has other advantages as well:

5) high wear resistance;
6) good anti-friction characteristics;
7) high resistance to corrosion;
8) efficiency of coatings.

It is also shown in the work that the structure of the surface layer and its surface energy play a significant role in the formation of high-entropy coatings. It should be noted that the properties of the surface layer, that is, the structure and characteristics obtained by it as a result of processing the part, depend primarily on the forming technology and technology, which gives the surface special physicochemical and mechanical properties. In our case, this is laser treatment of the surface layer. The properties of the surface layer are also affected by the high oxygen content in the coating (Table 2). The rate of adsorption, as a rule, increases with time and the faster the higher the temperature. High temperatures occur with laser irradiation. Further research prospects are as follows: - it is necessary to continue laser alloying on coatings of various types and with bases of other metals; - it is necessary to come up with a mechanism for laser alloying, taking into account the thickness of the surface layer.

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FIRST RESULTS OF SOLVING THE DIRICHLET PROBLEM FOR A GYROTROPIC ELLIPTICAL WAVEGUIDE

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Abstract. The dispersion equations that are solutions of the Dirichlet problem for the Helmholtz equations of hybrid electromagnetic waves propagating in a gyrotropic elliptical waveguide under longitudinal magnetization are solved. According to the first results of solutions of the dispersion equations, the dependences of the propagation constants on the strength of the magnetizing field for various magnetizations of ferrite are investigated. The phase incursions for longitudinally magnetized gyrotropic elliptical waveguides are compared and it is shown that with an increase in the magnetization of ferrite by ≈3.7 times, the angle of rotation of the polarization plane increases by ≈5.4 times.

Keywords: dispersion equations, Helmholtz equations, gyrotropy, elliptic waveguide, electromagnetic wave, magnetization, propagation.

Introduction

To study the structure of the electromagnetic field of gyrotropic elliptic waveguides under longitudinal magnetization and various characteristics of electromagnetic waves propagating in such waveguides, it is necessary to solve the Dirichlet problem for the corresponding Helmholtz equations [1]. In [2], such a Dirichlet problem was posed and solved, but not brought to practical application, due to the difficulty of calculating the eigenvalues and corresponding roots of ordinary and modified Mathieu functions [3, 4] included in the dispersion equations.

The aim of this paper is to solve the above-mentioned dispersion equations [2] and to analyze some characteristics of hybrid electromagnetic waves propagating in a gyrotropic elliptical waveguide under longitudinal magnetization.

1. The Dirichlet Problem

For the Helmholtz equations corresponding to a longitudinally magnetized gyrotropic elliptic waveguide [1], the Dirichlet problem for *EH*- and *HE*-waves is as follows [2]

$$\begin{cases} \dfrac{\partial^2 E_Z}{\partial \xi^2} + \dfrac{\partial^2 E_Z}{\partial \varphi^2} + e^2 d^2 \left(\omega^2 \varepsilon \mu_\perp - \gamma^2\right) E_Z - je^2 d^2 \gamma \omega \mu_\parallel \dfrac{k}{\mu} H_Z = 0, \\ \dfrac{\partial^2 H_Z}{\partial \xi^2} + \dfrac{\partial^2 H_Z}{\partial \varphi^2} + e^2 d^2 \left(\omega^2 \varepsilon \mu_\parallel - \dfrac{\mu_\parallel}{\mu} \gamma^2 \right) H_Z + je^2 d^2 \gamma \omega \varepsilon \dfrac{k}{\mu} E_Z = 0, \end{cases} \quad (1)$$

under the Dirichlet condition for an electric field at the boundary of an infinitely conducting longitudinally magnetized elliptic waveguide

$$E_Z \mid_{\xi=\xi_0} = E_\varphi \mid_{\xi=\xi_0} = 0 . . \quad (2)$$

In equations (ξ, φ, z) – the coordinates of the elliptical system, E_φ and E_z – the components of the electric field, H_z – the longitudinal component of the magnetic field, e – focal length of the ellipse, $d = \sqrt{ch^2\xi - \cos^2\varphi} = \sqrt{0{,}5\left(ch2\xi - \cos 2\varphi\right)}$ – the geometrical parameter, ω – the cyclic frequency, ε – the absolute permittivity of the ferrite, γ – the distribution constant, j – the imaginary unit, $k = \mu_0 \dfrac{\omega \omega_m}{\omega^2 - \omega_0^2}$ and $\mu = \mu_0 - \mu_0 \dfrac{\omega_0 \omega_m}{\omega^2 - \omega_0^2}$ – the magnetic permeability tensors of ferrite, $\mu_\perp = \dfrac{\mu^2 - k^2}{\mu}$, $\mu_0 = 4\pi \cdot 10^{-7}$ *H/m* – the magnetic permeability tensor of ferrite, $\mu_\parallel \approx \mu_0$, $\omega_0 = \mu_0 Y H_0$ – the frequency of ferromagnetic resonance, $Y = 1.76 \cdot 10^{11}$ *C/kg* – the gyromagnetic ratio, H_0 – the tension of a constant magnetic field, $\omega_m = \mu_0 Y M_0$, M_0 – the saturation magnetization of the ferrite.

Note that the system of differential equations (1) describes the propagation of hybrid electromagnetic waves arising from the gyrotropy of the propagation region [5 - 7].

The solution of the Dirichlet problem (1) and (2) obtained in [2] is the dispersion equation for even waves

$$\left[-\left(k_\perp^2 - \gamma^2 - \frac{4q_1}{e^2} \right) \frac{4q_2}{e^2} \frac{Ce_m'(\xi_0, q_1)}{Ce_m(\xi_0, q_1)} + \left(k_\perp^2 - \gamma^2 - \frac{4q_2}{e^2} \right) \frac{4q_1}{e^2} \frac{Ce_m'(\xi_0, q_2)}{Ce_m(\xi_0, q_2)} \right] +$$

$$+ j\left[\frac{a^2}{\omega^2 \varepsilon k}\left(k_\perp^2 - \gamma^2 - \frac{4q_1}{e^2}\right)\left(k_\perp^2 - \gamma^2 - \frac{4q_2}{e^2}\right)\left\{\frac{ce_m'(\varphi,q_2)}{ce_m(\varphi,q_2)} - \frac{ce_m'(\varphi,q_1)}{ce_m(\varphi,q_1)}\right\} + \right. \quad (3)$$

$$\left. + \frac{\gamma^2}{\mu}\left\{\frac{ce_m'(\varphi,q_1)}{ce_m(\varphi,q_1)}\left(k_\perp^2 - \gamma^2 - \frac{4q_1}{e^2}\right) - \frac{ce_m'(\varphi,q_2)}{ce_m(\varphi,q_2)}\left(k_\perp^2 - \gamma^2 - \frac{4q_2}{e^2}\right)\right\}\right] = 0.$$

In equation $Ce(\xi_0, q_{1,2})$, $Ce'(\xi_0, q_{1,2})$ – the attached (modified) Mathieu functions of the 1st kind (with integer index) and their derivatives, $ce(\varphi, q_{1,2})$, $ce'(\varphi, q_{1,2})$ – the ordinary Mathieu functions of the 1st kind of an integer order *m* and their derivatives.

After performing the following replacement in (3)

$$\begin{cases} Ce(\xi_0, q_{1,2}) \to Se(\xi_0, q_{1,2}), Ce'(\xi_0, q_{1,2}) \to Se'(\xi_0, q_{1,2}); \\ ce(\varphi, q_{1,2}) \to se(\varphi, q_{1,2}), ce'(\varphi, q_{1,2}) \to se'(\varphi, q_{1,2}), \end{cases}$$

we obtain the dispersion equation for odd waves

$$\left[-\left(k_\perp^2 - \gamma^2 - \frac{4q_1}{e^2}\right)\frac{4q_2}{e^2}\frac{Se_m'(\xi_0,q_1)}{Se_m(\xi_0,q_1)} + \left(k_\perp^2 - \gamma^2 - \frac{4q_2}{e^2}\right)\frac{4q_1}{e^2}\frac{Se_m'(\xi_0,q_2)}{Se_m(\xi_0,q_2)}\right] +$$

$$+ j\left[\frac{a^2}{\omega^2 \varepsilon k}\left(k_\perp^2 - \gamma^2 - \frac{4q_1}{e^2}\right)\left(k_\perp^2 - \gamma^2 - \frac{4q_2}{e^2}\right)\left\{\frac{se_m'(\varphi,q_2)}{se_m(\varphi,q_2)} - \frac{se_m'(\varphi,q_1)}{se_m(\varphi,q_1)}\right\} + \right. \quad (4)$$

$$\left. + \frac{\gamma^2}{\mu}\left\{\frac{se_m'(\varphi,q_1)}{se_m(\varphi,q_1)}\left(k_\perp^2 - \gamma^2 - \frac{4q_1}{e^2}\right) - \frac{se_m'(\varphi,q_2)}{se_m(\varphi,q_2)}\left(k_\perp^2 - \gamma^2 - \frac{4q_2}{e^2}\right)\right\}\right] = 0,$$

where $Se(\xi_0, q_{1,2})$ and $Se'(\xi_0, q_{1,2})$ – odd adjoint (modified) Mathieu functions of the 1-st kind (with integer index) and their derivatives, $se(\varphi, q_{1,2})$ and $se'(\varphi, q_{1,2})$ – odd ordinary Mathieu functions of the 1-st kind of an integer order *m* and their derivatives.

2. Solution of dispersion equations

To study the characteristics of hybrid electromagnetic waves propagating in a longitudinally magnetized gyrotropic elliptic waveguide and the spatial structure of the electromagnetic field, it is necessary to obtain solutions to the dispersion equations (3) and (4), which consist in determining the eigenvalues and their corresponding roots, ordinary and modified Mathieu functions included in the dispersion equations. Note that certain difficulties are encountered in calculating the eigenvalues and corresponding roots of Mathieu functions by numerical methods. To overcome these difficulties, a program for the refined calculation of all roots of ordinary and modified Mathieu functions on a given interval was developed on the basis of the standard Maple software package [9].

The obtained solutions of the dispersion equations (3) and (4) allow us to construct graphs of dependencies $\gamma = f(l,\ k,\ \mu,\ H_0,\ M_0)$, where *l* – the geometric parameters of the guide system (*e* and *d*); *k, μ* – components of the magnetic permeability tensor of ferrite; M_0 – magnetization of ferrite; H_0 – strength of the external magnetizing magnetic field.

Usually, when analyzing dispersion equations, the dispersion characteristics of the guide system are numerically obtained for various geometric parameters of the waveguide, the strength of the magnetizing field, the magnetization of the ferrite filling, and the cut-off frequency (in this case, $\gamma = 0$), the most efficient modes (harmonics) are determined, which allows us to plot the distribution of fields inside the waveguide.

The paper presents the first results of solving the dispersion equations (3) and (4) for a constant eccentricity of an ellipse with different saturation magnetization of ferrite. The appearance of wave types (modes) depends on the eccentricity of the ellipse, which is a feature of elliptical waveguides [10], and which makes it possible to choose the mode of operation of the waveguide. In this case, the size of the guide system is chosen so that in the absence of an external magnetic field, several types of waves can propagate in the guide system.

Fig. 1–4 show the results of solving the dispersion equations (3), (4) at $\varphi = 45°$ and $\omega = 6.28 \cdot 10^{10}$ *Hz*. The graphs in Fig. 1–4 show the dependence of the propagation constant of hybrid waves on the strength of the magnetizing field at a constant eccentricity of the ellipse *E* and for different frequencies ω_m associated with the magnetization of the ferrite.

On all graphs, the magnetization of the external constant magnetic field ω_0/ω is plotted along the *X*-axis, and the normalized propagation constant γ_z/k_z is plotted along the *Y*-axis. Here γ_z – the propagation constant (calculated numerically from the dispersion equations), k_Z – the wave number in a boundless non-magnetized ferrite medium.

From the graphs in Fig. 1–4, it follows that any electromagnetic wave propagating in a gyrotropic elliptical waveguide along a constant magnetic field decays into two independent waves with different propagation constants, for example, the wave ${}_cHE_{11}$ decays into waves ${}_cHE^{+}_{11}$ and ${}_cHE^{-}_{11}$. The index "+" indicates the wave of the right rotation, and "-" – the left rotation. As these waves propagate, there will be a phase shift equal to [6]

$$\varphi = \left(\frac{\gamma_Z^+ - \gamma_Z^-}{2} \right) Z, \qquad (5)$$

γ_Z^+, γ_Z^-, – the constants wave propagation with right and left rotations, respectively, *Z* – the distance.

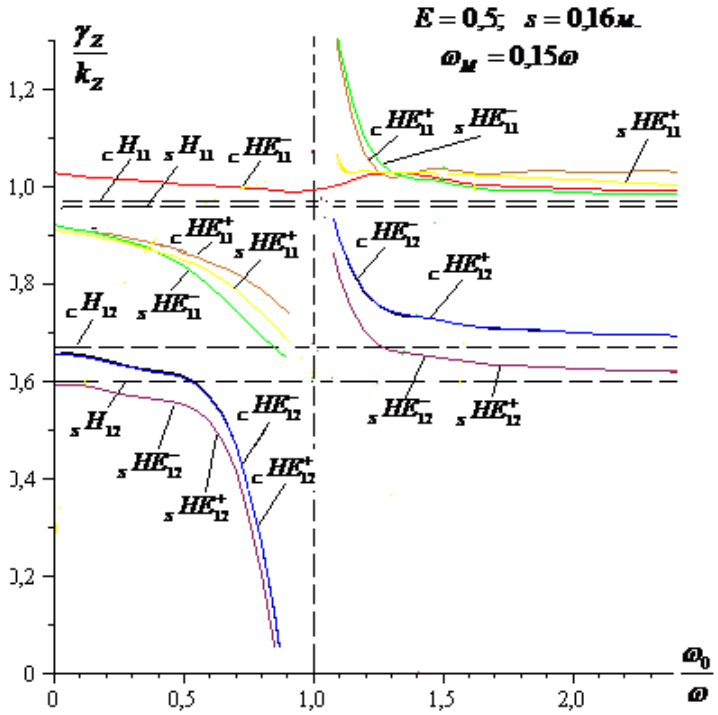

Fig. 1. Dependence of the propagation constant of HE-waves on the strength of the magnetizing field at E = 0.5 and ω_m=0.15ω. Horizontal dotted lines show modes in the absence of a magnetic field: ${}_cH_{11}$, ${}_sH_{11}$, ${}_cH_{12}$, ${}_sH_{12}$, where the subscripts "c", "s" mean even and odd modes. The vertical dotted line corresponds to the ferromagnetic resonance.

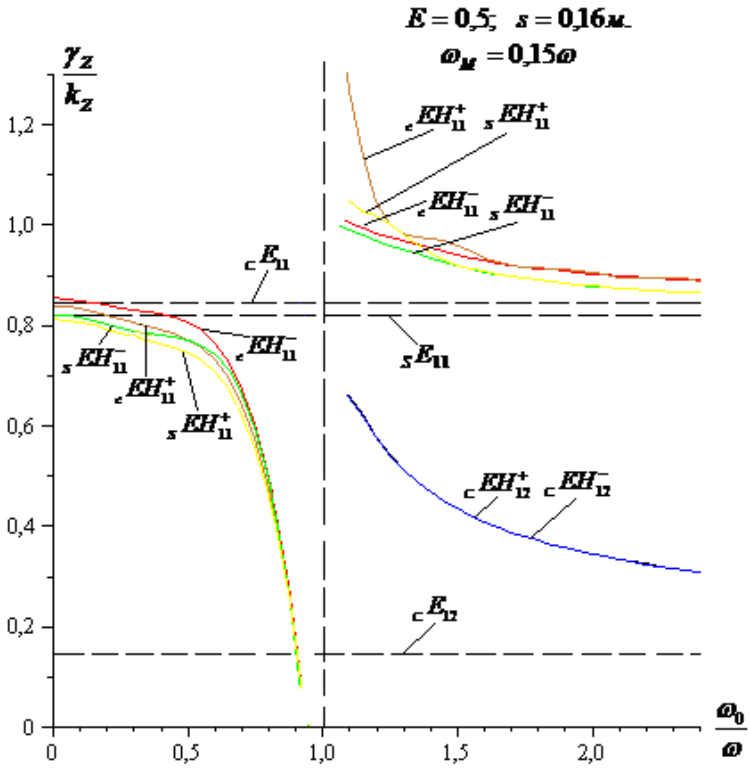

Fig. 2. Dependence of the propagation constant of EH-waves on the strength of the magnetizing field at E = 0.5 and ω_m = 0.15ω. Horizontal dotted lines show modes in the absence of a magnetic field: ${}_cE_{11}$, ${}_sE_{11}$, ${}_cE_{12}$.

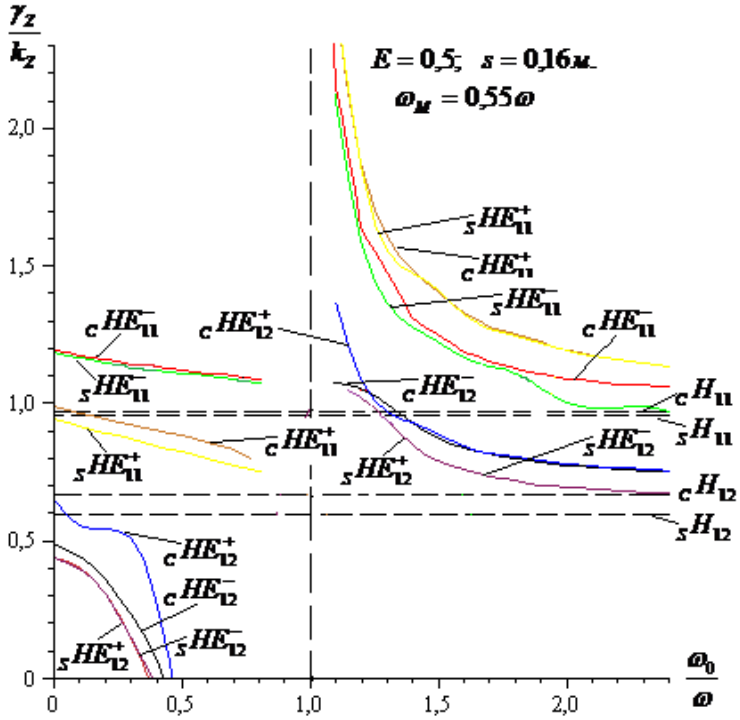

Fig. 3. Dependence of the propagation constant of HE-waves on the strength of the magnetizing field at E = 0.5 and ω_m = 0.55ω Horizontal dotted lines show modes in the absence of a magnetic field: $_cH_{11}$, $_sH_{11}$, $_cH_{12}$, $_sH_{12}$.

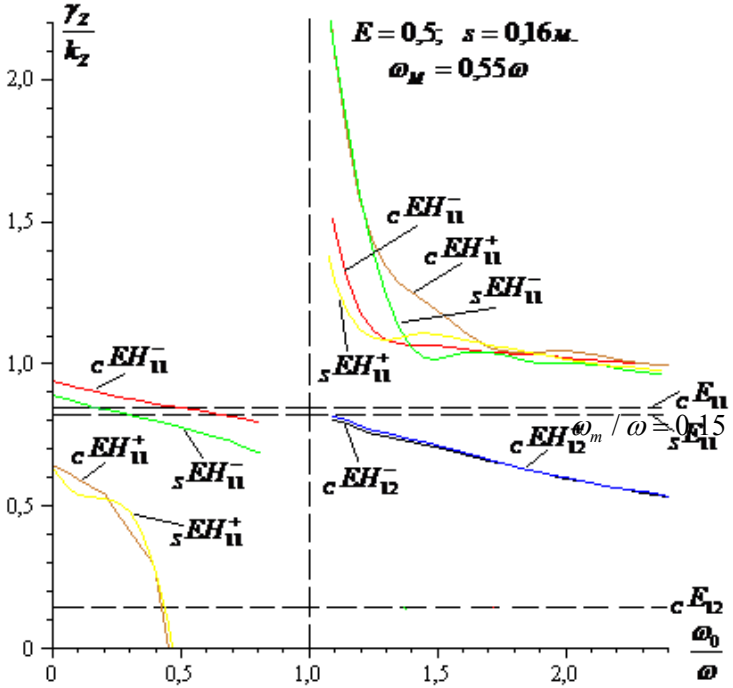

Fig. 4. Dependence of the propagation constant of EH-waves on the strength of the magnetizing field at E = 0.5 and ω_m = 0.55ω. Horizontal dotted lines show modes in the absence of a magnetic field: ${}_cE_{11}$, ${}_sE_{11}$, ${}_cE_{12}$

By deliberately changing the magnitude of the external longitudinal magnetic field, the phase shifts of the left and right rotation waves can be adjusted.

From the results obtained in Fig. 1–4, it follows that the appearance of modes depends on the magnitude of the magnetization of the ferrite ω_m. In practice, the frequency ω is selected in such a way that in the absence of a magnetizing field, the desired number of modes exists. Quite often, such a frequency is chosen so that only the main mode exists in the guide system, which exists at the lowest frequency. Having fixed the frequency ω, the intensity of the magnetizing field H_0 is changed within reasonable limits according to a predetermined algorithm. At a certain strength of the longitudinal external constant magnetizing magnetic field H_0, a ferromagnetic resonance occurs, which consists in the resonant absorption of the energy

of the electromagnetic field by the ferrite (gyrotropic medium).

It is known that this phenomenon occurs at $\omega = \omega_o$. At very high values of the external magnetizing field strength H_0, the propagation constants of different types of waves (modes) tend to the propagation constants of the corresponding wave types for the isotropic case [6].

Analysis of the graphs in Fig. 1–4 shows that with increasing magnetization of ferrite, the phase difference for modes with left and right rotation increase (for example, for modes ${}_cHE^{+}{}_{11}$ and ${}_cHE^{-}{}_{11}$) at the same magnetization value of the constant external magnetic field H_0. This is especially noticeable in the region of weak external fields H_0 corresponding to the condition $\omega_0/\omega<1$, i.e. in the region of frequency change preceding the resonance. This is an important practical advantage of gyrotropic elliptical guide systems over circular ones, since with the same geometric parameters of the guide system, it is possible to obtain more significant phase incursions, therefore, to develop more efficient phase shifters.

For example, we calculate the rotation angle of the polarization plane for every 1 *cm* for an elliptical waveguide with a half-axis length of 1.6 *cm* and E_1 = 0.5. The characteristics of ferrite and electromagnetic wave are as follows: frequency $\omega = 2\pi\cdot 10^{10}$ *Hz*, magnetization of ferrite $\omega_m/\omega = 0.15$, relative permittivity of ferrite $\varepsilon_r = 5$, magnetization of external constant magnetic field $\omega_0/\omega = 0.2$.

The angle of rotation of the polarization plane is calculated by the well-known formula (5). Since one usually tends to the single-mode regime, consider the mode ${}_cHE_{11}$, we consider the mode using, for all cases $k_Z = \omega\sqrt{\varepsilon_0\varepsilon_r\mu_0} = 468{,}178m^{-1}$. Further, from these graphs in Fig. 1 and Fig. 2, we obtain the angle of rotation of the polarization plane $\varphi_1 = 0.2667\ rad = 15.29°$ for every 1 *cm* (Z = 0.01 *m*) for an elliptical waveguide with an eccentricity of E = 0.5.

For the same waveguide with the magnetization of ferrite $\omega_m/\omega = 0.55$, using the data in the graphs in Fig. 3 and Fig. 4, we obtain the angle of rotation of the polarization plane $\varphi_2 = 1.4396\ rad = 82.5°$ for every 1 *cm* (Z = 0.01 *m*).

From the results obtained, it can be seen that with an increase in the magnetization of ferrite ≈3.7 times, the angle of rotation of the polarization plane increases by ≈5.4 times.

Conclusion

The main conclusions are as follows:

- Solutions of the dispersion equations (3) and (4), which are solutions of the Dirichlet problem for the Helmholtz equations of hybrid waves propagating in a longitudinally magnetized gyrotropic elliptic waveguide, are obtained;

• Graphs of the dependences of the propagation constants on the strength of a constant magnetizing longitudinal field at a constant eccentricity of the ellipse and various magnetizations of ferrite are constructed;

• Phase incursions for longitudinally magnetized gyrotropic elliptical waveguides are compared and it is shown that with an increase in the magnetization of ferrite by ≈3.7 times, the angle of rotation of the polarization plane increases by ≈5.4 times.

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ON STRENGTH CALCULATION OF THIN-WALLED SHELLS

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Abstract. Based on Pascal's analysis and the hydraulic engineering paradox applied to vertical cylindrical reservoirs based on the hypothesis of flat sections according to the momentless theory of thin shells, the following proposal is made:

- the pressure on the wall, according to the hypothesis of flat sections, is produced not by the entire mass of the liquid, limited by its height and area, but only by the ring, balanced by the internal column of the liquid. Based on this, it is assumed in the formula for calculating the strength of the tank wall to introduce a correction factor of 0.29.

Keywords: Hypothesis of flat sections, momentless theory of thin shells, wall strength of a cylindrical shell, Pascal's law and hydrotechnical paradox, internal and external fluid volume, correction factors, decrease in wall thickness.

In industry, reservoir structures for storing oil, oil products, liquefied gases and other explosive and fire hazardous substances have become widespread. As a rule, they are stored in vertical surface cylindrical tanks. Consider the strength calculation of the walls of such tanks.

Calculation of vertical cylindrical tanks is based on the hypothesis of flat sections (Bernoulli hypothesis) [1] according to the momentless theory of thin shells [2] (fig. 1).

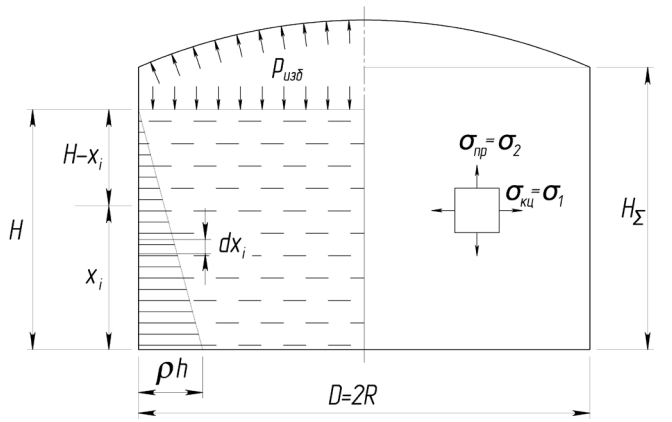

Figure 1

Laplace's equation [2] for calculating the strength of the tank wall:

$$\frac{N_1}{R_1}+\frac{N_2}{R_2}=P \quad (1)$$

where N_1 and N_2 – annular and meridian forces, respectively;

R_1 and R_2 – radii of curvature in the annular and meridian direction;

P – external forces acting on the tank wall, determined by the formula.

$$P=\rho g\,(H-x_i) \quad (2)$$

where ρ – product density (kg/m^3);

g – acceleration of gravity (9.81 m/s^2);

H – tank height, m;

x_i – distance to the investigated section, m

Bending radii for VST:

$$R_1=R,\ R_2\rightarrow\infty$$

Therefore, equation (1) takes the form

$$\frac{N_1}{R}=P \quad (3)$$

According to the hypothesis of flat sections (fig. 2)

$$PDdx_i=2\,\sigma_{hs}dx_it, \quad (4)$$

where t – shell thickness,

D – tank diameter,

σ_{hs} - hoop stresses in the wall $\sigma_{hs}=\sigma_1$ (fig 1, 2)

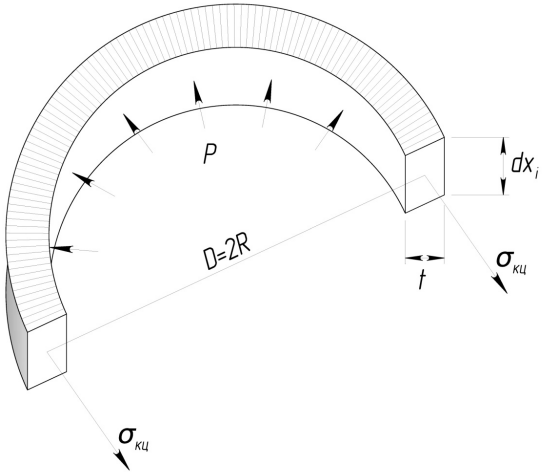

Figure 2

Then the hoop stresses in the wall σ_{hs} are determined by the formula:

$$\text{P2R}dx_i = \sigma_{\text{hs}} 2dx_i t \tag{5}$$

$$\sigma_{\text{hs}} = \frac{\text{PR}}{\text{t}}; \tag{6}$$

$$\text{t} = \frac{\text{PR}}{\sigma_{max}}, \qquad \text{where } \sigma_{max} = \text{Ry} \tag{7}$$

where σ_{max} - rated voltage;

Ry – rated material resistance

Substituting formula (2) into formula (6), we obtain

$$\sigma_{\text{hs}} = \frac{\rho g(\text{H} - x_i)\text{R}}{\text{t}} < \sigma_{max} = R_y \tag{8}$$

therefore, the wall thickness t in the section x_i can be determined by the formula

$$t_i = \frac{\rho g(\text{H} - x_i)\text{R}}{\sigma_{max}} \tag{9}$$

Taking into account the excess pressure of gas vapors in the reservoir (fig. 1) and introducing the corresponding coefficients into formula (9), we obtain

$$t_i = \mathrm{C_R}\,\frac{[\rho g(H - \mathrm{x}_i)C_1 + T_{exc}C_2]R}{C_w R_y} \qquad (10)$$

where

C_R – reliability coefficient for the responsibility of the structure;

C_1 - overload coefficient from hydrostatic pressure;

C_2 - safety factor for load from excess gas pressure;

x_i – distance from the bottom to the lower edge of the i-th belt;

T_{exc} – excess gas pressure in the space under the tank roof;

t_i – thickness of the i-th belt of the wall;

C_w – working condition coefficient: for product storage mode

As follows from formula (10), the wall thickness in the considered section depends and is proportional only to the pressure created by the mass of the liquid, limited by the height above the given section H and by the area of the liquid in this section S, limited by its radius R. As follows from Pascal's law, the pressure exerted on liquid, transferred to any point without changing in all directions.

At the same time, according to the hydrostatic paradox (Pascal's paradox), the force of weight pressure of the liquid poured into the vessel at the bottom of the vessel may differ from the weight of the poured liquid. In vessels with an upwardly increasing cross section, the force of pressure on the bottom of the vessel is less than the weight of the liquid, and in vessels with an upwardly decreasing cross section, the force of pressure on the bottom of the vessel is greater than the weight of the liquid (fig. 3, a, b).

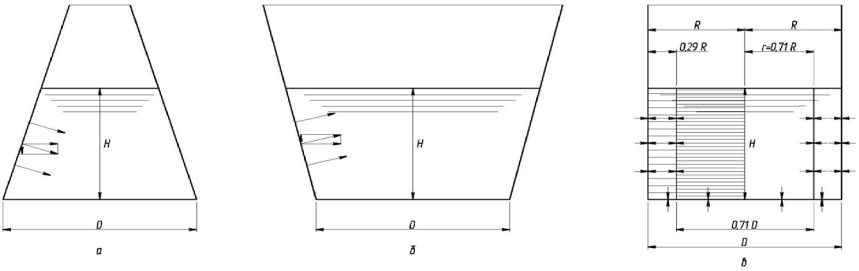

Figure 3

The mathematical explanation of the paradox, given by Simon Stevin, is that, according to Pascal's law, the liquid presses not only on the bottom, but also on the walls of the vessel. If the walls of the vessel are vertical, then the forces of pressure of the liquid on its walls are directed horizon-

tally and have no vertical component (fig. 3 c). In this case, the force of pressure of the liquid on the bottom of the vessel is equal to the weight of the liquid in the vessel (fig. 3c). If the vessel has inclined walls, the fluid pressure on them has a vertical component (fig. 3a, c). In a vessel expanding upward, it is directed upward (fig. 3b), and in a vessel narrowing upward, it is directed downward (fig. 3 a). And since the weight of the liquid in the vessel is equal to the sum of the vertical components of the pressure of the liquid over the entire vertical area of the vessels, therefore it differs from the pressure on the bottom.

Since the liquid inside a cylindrical vessel is in equilibrium, we assume that this equilibrium is realized between the same masses of liquid, which for one "flat section" depends only on its area S. That is, we assume that only the wall part of this volume presses on the wall. And the inner column of the liquid is balanced with it (Figure 3, c, 4). In the general case, the inner circle (S_{cir}) and the ring surrounding it (S_{hs}) have such equal volumes. In our case, as can be seen from fig. (4.3), this is a semicircle (S_{sci}) aand a semiring (S_{sri}).

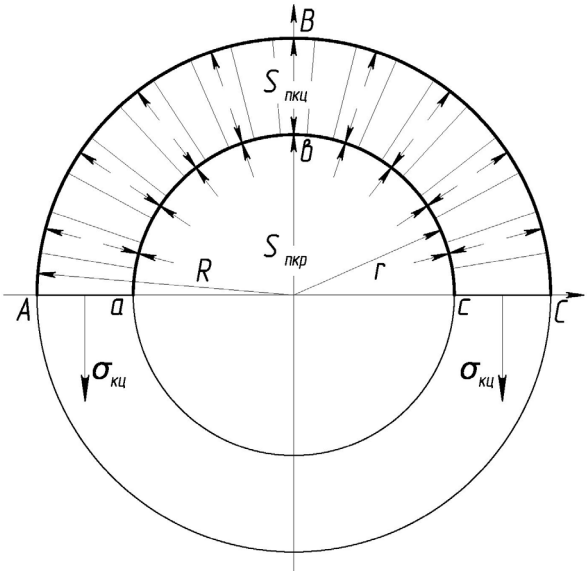

Figure 4

Thus,

$S_{sri} = S_{sci,}$

where S_{sri} - area of a semi-ring with radius R,

S_{sci} – area of a semicircle with radius r

Then

$$S_{sci} = \frac{\pi R^2}{2} - \frac{\pi r^2}{2} = \frac{\pi r^2}{2};\ \frac{\pi R^2}{2} = \pi r^2 \quad (11)$$

$$r = \frac{R}{\sqrt{2}} = 0{,}71\ R \quad (12)$$

So the thickness of the half-ring S_{sri}, pressing on the tank wall will be equal to

$$R - r = R - 0{,}71R = 0{,}29R, \quad (13)$$

Thus, formula (6) takes the form:

$$\sigma_{hs} = 0{,}29\frac{PR}{t} \quad (14)$$

and the wall thickness for $\sigma_{hs} = \sigma_{max}$ accordingly will be equal

$$t = 0{,}29\frac{PR}{\sigma_{max}} \quad (15)$$

Thus, formula (14) and (15) have a general form and when using the appropriate coefficients reflecting the specificity of the storage product, design features, working conditions and external influences, formula (10) with a coefficient of 0.29 can be used to calculate the wall strength a vertical cylindrical tank made of any construction materials.

This proposal needs experimental verification.

The confirmation of our proposal can have a significant economic effect, especially in tank structures with an increase in tonnage, as well as when using more expensive high-strength and stainless steels.

In subsequent publications, this proposal will be applied to conical shell structures (fig. 3), as well as spherical tanks.

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COMPREHENSIVE ANALYSIS OF MODERN TECHNOLOGIES FOR THE CONSTRUCTION OF PREFABRICATED BUILDING

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Abstract. In this article, the author gives the results of a comprehensive analysis of modern building systems of prefabricated buildings and touches on topical problems associated with modern construction of prefabricated buildings and structures. In addition, the article presents the results of a comparison of the most common building technologies for the construction of buildings with a fundamentally new single-element flat building system for high-speed assembly of prefabricated buildings. The developed system has no analogues in modern construction, which adds relevance and novelty to this article. The practical value lies in comparing current systems for the construction of prefabricated buildings with fundamentally new developments. Research results show that the use of new technologies for the construction of prefabricated buildings increases productivity. The main provisions of this research can form the basis for further theoretical and practical developments.

Keywords: panel-frame system, large-panel system, volume-block system, large-panel system, frame-monolithic system, energy efficient construction, prefabricated buildings, high-speed installation, glass, metal structures, facade systems, enclosing structures.

The main construction systems of prefabricated buildings include panel-frame system, large-block construction system, volume-block construction system, large-panel construction system, frame-monolithic construction system.

The most famous representatives of the panel-frame system are the KUB-2.5 system. The KUB-2.5 building system is a universal structural system based on vertical columns that serve as the building frame and flat panel floors that act as crossbars. Such a system is widely used in the construction of residential buildings up to 25 floors and ground multi-level parking lots. The main features of this system are:

• Possibility of designing buildings with different span spacing from 3 to 18 meters, the column spacing can vary from 3 to 6 meters, and the floor height can be provided from 2.8 to 4.2 meters;

• Design of free planning solutions due to a small number of vertical frame elements;

• The range of building construction varies from 1 to 25 floors;

• Facade solutions can be used different depending on the climatic conditions of construction and architectural solutions;

• Production of all building elements in a factory;

• Reduced costs and construction costs due to reduced consumption of steel and cement per 1 square meter.

The author identified a number of shortcomings of this building system:

• Due to the complete prefabrication of building elements, there is a problem with the design and construction of flights of stairs in accordance with fire and building regulations;

• Difficulties with the design and construction of the machine rooms of the elevator shafts;

• Imperfection of the junction of columns and panels, installation of this unit in the conditions of a construction site is a rather laborious process that requires high quality work;

• Taking into account the inaccuracies of prefabrication and errors during installation on the construction site, a serious deviation of prefabricated building elements from the design position occurs, which violates the design loads;

• When laying communications and hidden electrical wiring, it is necessary to create technological holes and grooves in the floors, which leads to a decrease in the bearing capacity of structures.

The technical and economic indicators of the system are presented in Table 1.

Table 1

Technical and economic indicators	Панельно-каркасная система	
	KUB-2.5 system	Base system
Manufacturing labor costs,%	50	45
Labor costs for the manufacture of 1 m3, man-days	0,55	0,89
Reduction of construction time, times	2	2
Construction costs,%	50	55
Reducing labor intensity at a construction site, times	0,75	0,55
Labor costs for installation 1 m3, man-days	0,50	0,55

House frame weight, kg / m2	900	1100
Specific concrete capacity coefficient, m3 / m2	0,29	0,38
Steel consumption, kg / m2	12,3	14

The construction of residential and public buildings according to the KUB-2.5 construction system in our country is quite common, which indicates its competitiveness in the construction market.

The author analyzed a large-block building system. This system is used for the construction of residential buildings up to 22 floors. The mass of building elements of a building system reaches a mass of 3 to 5 tons. The main principle of the construction of a large-block building system is the installation of stone walls in horizontal rows with mutual dressing of the seams. Buildings up to 5 floors can be erected without an additional frame, high-rise buildings require an additional frame in the form of longitudinal columns.

The advantages of this building system are:

• Easy installation of the system due to the self-stability of the building blocks;

• Extensive use of the construction system in conditions of various raw materials and climatic conditions;

• Flexibility of the building block system, it becomes possible to build various types of residential buildings with a limited number of standard sizes;

The main disadvantages include:

• Labor intensity of production, transportation and installation of building blocks due to the large size of the elements and high weight;

• Low thermal performance of the erected buildings;

• High cost of production and construction of system elements;

The technical and economic indicators of the system are presented in Table 2.

Table 2

Technical and economic indicators	Large block system
Manufacturing labor costs,%	35
Labor costs for the manufacture of 1 m3, man-days	0,75
Reduction of construction time, times	0,20
Construction costs,%	70
Reducing labor intensity at a construction site, times	0,1
Labor costs for installation 1 m3, man-days	0,65
House frame weight, kg / m2	1500

The construction of residential buildings using this building system is not so widespread now, the system requires significant improvements and updating for the modern construction market.

The author analyzed the volume-block building system. This system is based on the construction of buildings from large volumetric-spatial reinforced concrete elements weighing up to 25 tons. Each such volumetric-spatial unit contains a certain fragment of the building: living rooms, utility rooms, sanitary rooms, etc. Such blocks are installed on top of each other, as a rule, without bandaging the seams. Buildings based on this system can be erected up to 16 floors in normal and difficult ground conditions. The most famous representatives of this system are: BKR-2, OKPM, OBD series, APSK.

The advantages of this system are:

• Manufacturing of a building element is carried out 100% in the factory;

• Installation of buildings based on a volume-block system is carried out in a short time with a small amount of labor;

• The volumetric block is supplied with practically all communications in the conditions of the plant;

• Possibility to erect small collapsible buildings and structures.

The main disadvantages of this system include the following:

• During installation, it is necessary to use powerful specialized cranes due to the significant weight of the building elements;

• During the installation process, there is a high probability of skewing of the building block due to unequally rigid connection;

• On the construction site, it is necessary to arrange expensive high-quality roads and access roads.

The technical and economic indicators of the system are presented in Table 3.

Table 3

Technical and economic indicators	Volume-block system
Manufacturing labor costs,%	65 (80)
Labor costs for the manufacture of 1 m3, man-days	1,2
Reduction of construction time, times	3–4
Construction costs,%	35
Reducing labor intensity at a construction site, times	2,5–2,8
Labor costs for installation 1 m3, man-days	0,15
House frame weight, kg / m2	1300
Specific concrete capacity coefficient, m3 / m2	0,67
Steel consumption, kg / m2	28,5

The disadvantages of this building system prevail over the advantages, which makes the use of a volume-block building system irrelevant in our time in the current situation in the construction market.

For comparison with the widespread construction systems of prefabricated buildings, the author analyzed a one-element flat construction system consisting of typical large-sized building elements, which in turn consist of prefabricated 1x1 meter elements. The small element consists of a steel frame and a translucent cover. At the construction site, wall panels, floor panels and columns are assembled from small factory elements. This system is shown in Figure 1.

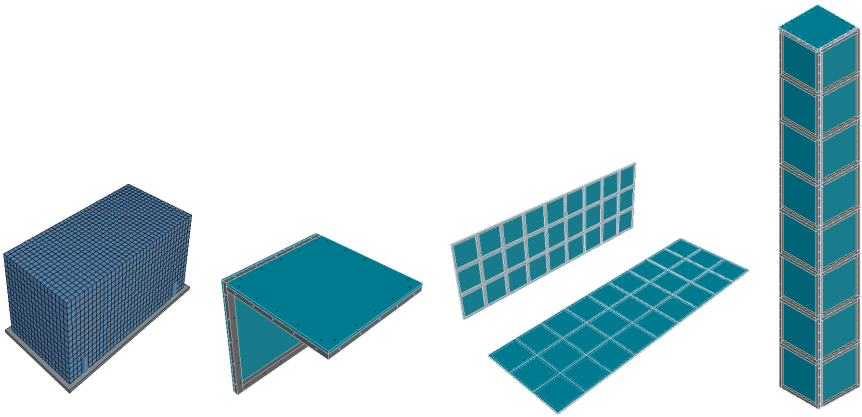

Fig. 1. Single piece flat building system for prefabricated building construction.

The building element consists of a steel frame, glazing, elements for fastening the glazing to the steel frame. The steel frame is equipped with bolt holes for connecting elements to each other using high-strength bolts and strips. The building elements are equipped with fasteners for assembly. To protect the metal structures of the glazing elements, a method is used using fire retardant paints. Fire retardant paint for metal structures is a special paint that provides increased fire retardant characteristics of metal structures when exposed to an open flame. The application of fire-retardant paint to the previously cleaned and primed metal creates an additional decorative layer on its surface and significantly increases its fire-fighting properties. Technical and economic indicators are presented in table 4.

Table 4

Технико-экономические показатели	Single piece flat building system
Manufacturing labor costs,%	40
Labor costs for the manufacture of 1 m3, man-days	0,52
Reduction of construction time, times	2
Construction costs,%	60
Reducing labor intensity at a construction site, times	0,8
Labor costs for installation 1 m3, man-days	0,50
House frame weight, kg / m2	850
Specific concrete capacity coefficient, m3 / m2	-
Steel consumption, kg / m2	15,4

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CLAAS TYPE COMBINE HARVESTER USED FOR HARVESTING, PRESERVING FORAGE AND FEEDS FOR ANIMALS

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Annotation. Nowadays, modern farming requires continuous production of gains and faster working speed, as a result, it becomes necessary to simplify or create new working machines or methods to achieve these results. One of these methods is the fact that there was a need to develop various technical means to improve the design of a combine harvester. Modern combine harvesters are fully equipped with automation systems, which are ergonomically assembled in the cab of the combine harvester.

Keywords: continuous growth of production, increase of working speed, creation of new working machines, automation system.

Introduction

CLAAS is a world renowned German manufacturer of agricultural machinery. Its main production link was and it's still combine harvesters, which have won trust not only in European continent, but also far beyond its borders. The history of CLAAS combines began with the Dominator range, some of which are still used today. Subsequent technical developments took this brand to a completely new level and consolidated its credibility among customers. Grain preparation equipment from the CLAAS brand numbers several dozen models, which are grouped in a series: Dominator - machines with a capacity of up to 300 hectares, from which the history of the company began. Became prototypes for subsequent versions; Mega - devices with hydrostatic drive, which cultivate up to 1.5 hectares of territory per season. They are subdivided into 200 and 300 models, distinguished by the type of power plant (in the first case - from Mercedes-Benz, in the second - Daimler Chrysler) and its power; Tucano - grain harvesting is carried out on fields with an area of up to 2 thousand hectares. The list of suitable crops includes not only grains, but also rice, corn, rapeseed,

peas, soybeans; Lexion - the most productive among grain harvesters, the presentation of which fell on 2013. Due to the combination of wheel and caterpillar tracks, there are no impassable areas for them; Jaguar - corn harvesters. They are equipped with the Jaguar Green Eye cob ram and the legendary Corn-Cracker re-chopper. Despite the age and modification of this or that version of Class combine harvesters, they all differ in the following advantageous characteristics: High harvesting speed, which is achieved due to powerful power units and a wide threshing drum; High-quality grain cleaning; Minimal grain loss on lodged crops; Comfortable operator's cabin; Intuitive control; Minimum wear and tear on equipment, regardless of the load. All equipment is reliable. It has a large resource, so it will serve for many years without failures. The company's specialists are constantly working on improving old models and releasing new ones. All combine harvesters have powerful engines; they demonstrate high productivity and working speed. The patented threshing system enables efficient harvesting of grains and other crops. The cabins have good visibility; the operator is comfortable to work thanks to the climate control. The systems are controlled by an on-board computer. The company stands out for its high quality service. Consumers can replace parts requiring repair, order the delivery of new units even to hard-to-reach regions. In the LEXION 770/750 Claas combines, the designers applied the latest developments that allow real-time control of the operation of all mechanisms. The sensor system automatically monitors the process parameters. Based on these data, control actions are generated automatically or in a mode previously set by the operator. The threshing system of the LEXION combine, developed by the company's design office specifically for these machines, combines two efficient technologies - tangential APS and ROTO PLUS separation. The developers named it APS HYBRID SYSTEM.

Combine model LEXION 770/750

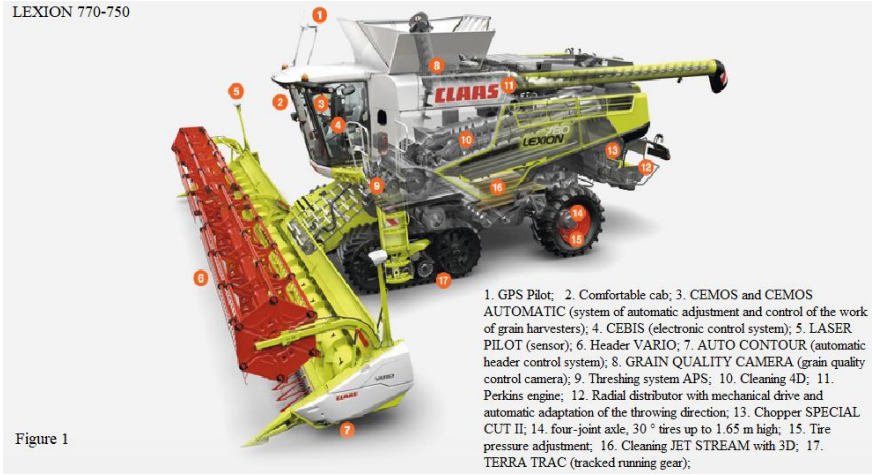

Figure 1

1. GPS Pilot;
2. Comfortable cab;
3. CEMOS and CEMOS AUTOMATIC (system of automatic adjustment and control of the work of grain harvesters);
4. CEBIS (electronic control system);
5. LASER PILOT (sensor);
6. Header VARIO;
7. AUTO CONTOUR (automatic header control system);
8. GRAIN QUALITY CAMERA (grain quality control camera);
9. Threshing system APS;
10. Cleaning 4D;
11. Perkins engine;
12. Radial distributor with mechanical drive and automatic adaptation of the throwing direction; 13. Chopper SPECIAL CUT II;
14. four-joint axle, 30 ° tires up to 1.65 m high;
15. Tire pressure adjustment;
16. Cleaning JET STREAM with 3D;
17. TERRA TRAC (tracked running gear);

Key technical data for the LEXION 670/650:

device for automatic compensation of crosswind for automatic determination of the direction of discarding the crushed mass; a set of interchangeable headers with built-in shields; adjustable table length; steering "automatic"; automatic tire inflation for gentle driving on soft soil; maximum engine power - 419 hp from.

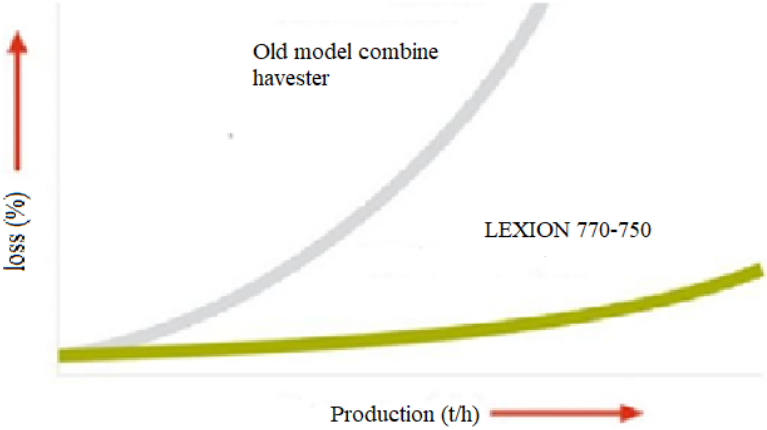

Figure 2

To ensure adequate nutrition for farm animals, it is imperative to harvest such succulent forage as silage. The JAGUAR 850 forage harvester is manufactured by the German company Claas. This model is distinguished by the highest level of technical performance and is designed for a very long service life. Not surprisingly, the Jaguar-850 is the best-selling forage harvester in the world today. It is intended for mowing grasses and tall-stemmed crops of varying degrees of maturity, as well as picking up rolls of dried and natural grasses with subsequent grinding into silage mass

Combine model JAGUAR 850

Technical characteristics of the JAGUAR 850 forage harvester:

Dimensions:

Length (without header) - 6495 mm;

Transporting height - 3897 mm;

Capture width (total) - 3030 mm;

Working height (with a silo extension) - 5450 mm;

Wheelbase - 2890 mm;

Ground clearance (models 2000s / 2010s of release) - 350/450 mm

Model weight without header is 11550 kg.

The maximum transport speed of the combine is 40 km / h, the working speed is 16 m / h.

Wheel dimension: drive axle - 650/75 R 32, 710/75 R 32 or 800/65 R 32; steering axle - 540/65 R 24 or 600 / 55-26.5.

Advantages and disadvantages.

The harvester has the following advantages:

Powerful roller drive mechanism Stone detector The on-board computer displays all the necessary information about the harvesting of crops and the state of the machine systems is Reliable and powerful Mercedes Benz engine has low fuel consumption compared to domestic counterparts. The only drawback of this harvester is its high cost.

Conclusion

The main machine for harvesting forage from grasses and silage crops with shredding is a forage harvester, which provides mowing with shredding and simultaneous loading into a vehicle, as well as selection of wilted grass from rolls with shredding and loading into the body of a car or trailer. A forage harvester must not only efficiently grind the forage crop, but also harvest it within a strictly regulated agro technical terms, which is ensured by the efficiency of its grinding apparatus.

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CONSUMER AWARENESS AS A PREREQUISITE FOR THE OPTIMAL CHOICE OF FUNCTIONAL FOOD

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Abstract. In two groups of respondents, contrasting with the level of awareness in the field of specialized and functional food products, consumer choice was determined in the opposite way. In the absence of sufficient information, the determining selection criteria are the convenience of packaging and the properties declared by the manufacturer. The information on the packaging does not motivate the consumer either to make an informed choice or to verify the statements provided. The presence of basic knowledge in the field of specialized and functional food products allows the consumer to provide a conscious choice of nutrients as the most physiological factor in managing their own health. If there is sufficient information, the determining criteria for the choice of nutrients are their component composition and functional properties. The gross and assortment expansion of the market for specialized food products is a necessary but insufficient condition for counteracting food imbalances. The effectiveness of the use of specialized and functional food products is inextricably linked with consumer literacy and the desire to improve it.

Keywords: specialized foods, functional food, smart food, informed consumer, consumer choice.

Theories of balanced and functional nutrition have arisen for a long time and do not lose their relevance. The concepts of A.A. Pokrovsky, A.M. Ugoleva, I.I. Brekhman are developing actively; a new direction of individualized dietetics arose (MN Volgarev, VA Tutelyan) [1]. Currently, these theories have gained increased relevance, since the list of unfavorable environmental factors is constantly expanding. To such traditional stressors

as environmental pollution, social tension, physical inactivity, desynchronization of biorhythms, dependence on gadgets, regime restrictions are added in connection with the COVID pandemic and many others. The forced restriction of social mobility leads to an increase in the role of fast food enterprises (for example, KFC restaurants, Burger King, McDonald's) and an increase in consumer motivation to choose innovative food products.

Despite the advances in nutritional science, nutritional imbalances remain one of the main causes of health problems, as their occurrence is the result of many biological, medical, social and economic factors [2]. The main direction of nutrition optimization in modern conditions is the development of high-tech functional nutrients [3]. At the same time, according to Murphy's Law, every solution creates new problems. Indeed, the expansion of the range of food products complicates consumer choice and creates a demand for an informed consumer who is able to manage his preferences. This requires complete and verified information about the product, the positioning of which under the brand "#smart food" does not guarantee the consumer an unambiguous positive effect and does not cancel the obligation to make a conscious and responsible choice.

One of the new objects of balanced nutrition is a product from NL International (CIS) [4]. Since 2003, the company has been promoting specialized products in the form of dry mixes for making soups and cocktails. The products quickly gained popularity in Russia. In January 2019, the Energy Smart Diet (#smartfood) line of protein shakes was launched on the food market [5]. Dry mixtures are provided in a portioned version (sachet weighing 30 g); they contain a balanced ratio of a number of basic nutrients - proteins, dietary fiber, vegetable lecithin, as well as mineral, vitamin and polyphenolic complexes [6]. A feature of this product is its focus on the fitness effect through the regulation of metabolic processes in the human body. In the design of protein cocktails from NL International, the target functions are set on the basis of two principles: low calorie content of an integral product and the presence of natural biologically active complexes with high catabolic activity in its composition.

It can be assumed that specialized knowledge is essential when using these products. They are necessary not only to recognize functional compounds in the list of ingredients, but also to provide informed choices made taking into account the functional state of the body of a particular consumer. To avoid mistakes leading to unplanned physiological experiments on your body, you need to focus not only on manufacturer's declarations and inviting brands, but also on basic knowledge of food quality and safety. To test this assumption, it seemed necessary to compare value

judgments about the product in target groups that differ in contrast in the level of initial awareness.

The purpose of this study was to identify the dependence of consumer preferences on the degree of consumer awareness.

Research methods. The work used the methods of online and offline questionnaires conducted in two focus groups with a total of 117 people, differing in the level of initial awareness of the theory and practice of dietetics.

The first group (A, resident site) included consumers of Energy Diet Smart products who submitted their reviews on the company's website (otzovik.com [7]). The sample size consisted of 87 people (69 women, 18 men, 18–44 years old) of various professional backgrounds without special nutritional knowledge.

The second focus group (B, students) included 30 students of the Institute of Food Production of the Krasnoyarsk State Agrarian University of the Institute of Food Production (age 18-24 years, 20 women, 10 men), with special knowledge of the production, composition and properties of food, including the number of specialized types.

A questionnaire, which included two blocks of questions, served as a stimulus material. The first block was aimed at a generalized assessment of the attractiveness of products, for which it was proposed to evaluate the following indicators on a five-point scale: 1) effect; 2) convenience; 3) quality; 4) safety.

The second block of the questionnaire contained more detailed open and closed questions.

1. Are you a consumer of Energy Diet Smart products?

2. For what purpose did you use (are using) Energy Diet Smart products - as a regular food product or as a component of a fitness diet?

3. What, in your opinion, are the advantages and disadvantages of Energy Diet Smart?

4. Do you think that Energy Diet Smart products are of natural origin or contain synthetic compounds?

Statistical processing of the results was carried out by conventional methods of variation statistics. The significance of inter-sample differences was assessed using the nonparametric Wilcoxon-Mann-Whitney U-test for unrelated samples, the significance of differences was taken into account when the criterion condition $U_{emp} \leq U_{cr}(0.05)$ was met.

Results and discussion. The results of the analysis of consumer preferences of group A are shown in fig. 1, which reflects the assessments of satisfaction with the product as a whole, expressed in points, as well as the rating of the main consumer qualities of the product. Figure 1a shows that

in the overwhelming share of the sample (62%), the products received the maximum assessment, with ease of use being the dominant criterion (fig. 1b). Indeed, the sachet is a practical way of packaging, while the respondents could hardly evaluate the effect, quality and safety of this product in the absence of proper information.

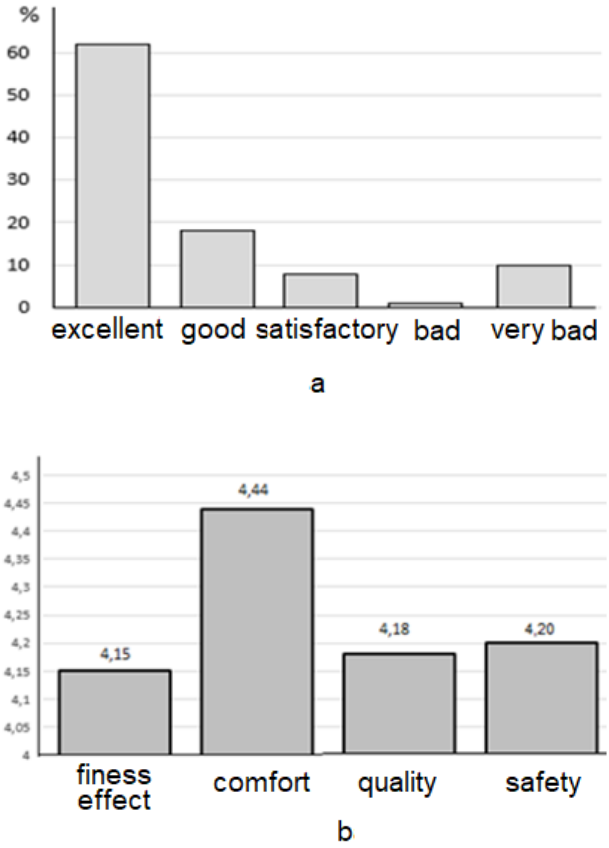

Fig. 1. Overall rating (a) and rating of product indicators (b) in group A

In the course of summarizing the detailed answers in group A to the second block of the questionnaire, it was found that the site-residents use this product exclusively for fitness purposes, since its taste is not so high to use the cocktail in their daily diet.

Were analyzed judgments about the advantages and disadvantages of Energy Diet Smart products. The opinion that the product is undoubtedly beneficial for health prevailed in the group (60%) and was argued by the presence of a rich vitamin and mineral complex in its composition, in connection with which these respondents characterized the product as “completely natural”. At the same time, 16% of respondents, on the contrary, expressed the opinion that the product is not natural, although information about its composition is posted on the company's website and partially on the packaging. At the same time, the text on the packaging indicates that the product of the Energy Diet trademark does not contain artificial and synthetic compounds. However, judging by the information published on the site, one can see that the composition contains additives obtained by chemical modification (for example: cellulose gum, container gum), as well as chemical preservative compounds (potassium citrate, etc.). There is a contradiction, calculated on the low awareness of the consumer, his educational inertia and lack of desire to expand the consumer horizons.

In the overwhelming majority of reviews (80%), product consumers and resident websites recommend Energy Diet Smart products for use, noting the following advantages: ease of use (mainly), as well as (in descending order) fitness efficiency, taste, and overall health benefits. They were opposed by the remaining 20% of respondents, who did not recommend the product to their followers and indicated that the product is "not natural", expensive, tasteless and its use does not guarantee fitness results.

The results of comparison of the obtained data with the answers of group B (informed consumers, students of the Institute of Food Production) are shown in fig. 2. The results for both groups are presented in percentage terms, each respondent could choose several answer options, so the sum naturally exceeds 100%.

Fig. 2 shows that for five of the eight points of the survey, the opinions of the groups differed in the opposite way.

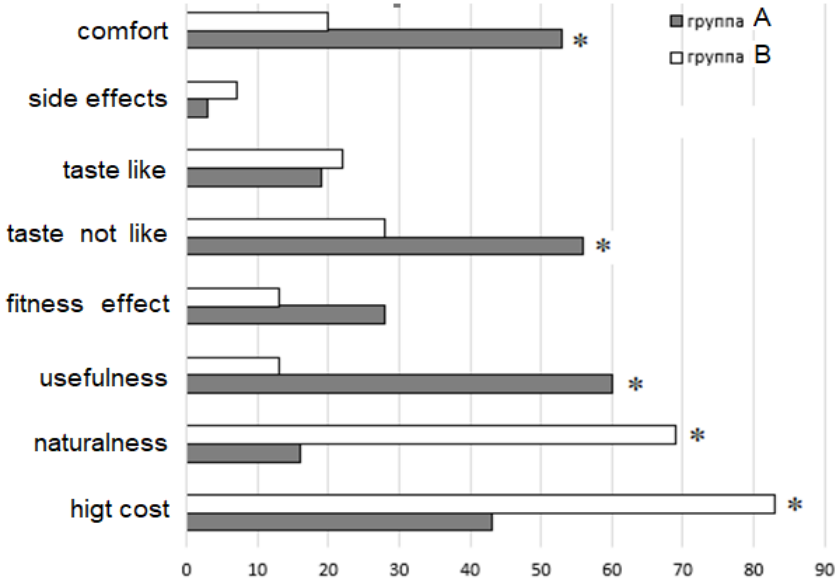

Fig. 2. Distribution of ratings for choosing an Energy Diet Smart product in the groups of uninformed (A) and informed (B) consumers

*** $U_{emp} \leq U_{cr}(0,05)$**

The most obvious and expected was the discrepancy on the issue of the price of the product, while the contrasting distribution of answers on the rest of the items can with a high degree of confidence be associated with the different level of awareness of the respondents.

Group A (resident site) highly appreciated the naturalness and usefulness of the product, as well as its taste. In contrast, Group B (students) expressed the opposite view, easily matching the advertising slogans "natural", "no chemicals" and "no preservatives" with the current list of ingredients and making sure that artificial compounds were present in the cocktail. Familiarization with the product was not limited to reading the labels, and 6.5% of the students reported having side effects (diarrhea, poisoning, abdominal pain) from consuming the product. A product, before using which it is advisable to consult a doctor, is unlikely to be included in the daily diet of an informed consumer, even if its economic availability and convenience increase due to changes in the packaging volume. Indeed, the manufacturer replaced the previous large package (500 g) with compact sachets

[8]. A 30 g portion allows you to more accurately record the calorie content of the portion consumed (provided that the product is diluted with water, not milk). This advantage mattered to a group of site respondents, but not students, who focused on the quality of the product itself.

As for fitness efficiency, the respondents of the more solvent group A tested this product to a greater extent, however, only 13% of consumers recorded significant changes, and the rest reported a slight change in body weight. In the group of students, the fitness effect was recorded by 27% of the participants. Intergroup differences were not statistically significant.

Conclusions

1. In the group of respondents with contrasting differences in the level of awareness in the field of specialized and functional food products, consumer choice was determined in the opposite way.

2. In the absence of sufficient information, the determining criteria for selection are the convenience of packaging and the properties declared by the manufacturer. The information on the packaging does not motivate the consumer either to make an informed choice or to verify the statements provided.

3. The presence of basic knowledge in the field of specialized and functional food products allows the consumer to provide a conscious choice of nutrients as the most physiological factor in managing their own health.

In the presence of sufficient information, the determining criteria for the choice of nutrients are their component composition and functional properties.

4. The gross and assortment expansion of the market for specialized food products is a necessary but insufficient condition for counteracting food imbalances. The effectiveness of the use of specialized and functional food products is inextricably linked with consumer literacy and the desire to improve it.

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INFLUENCE OF THE MAIN FACTORS ON THE BEARING CAPACITY OF BENT REINFORCED CONCRETE ELEMENTS IN INCLINED SECTIONS OBTAINED ON THE BASIS OF EXPERIMENTAL STUDIES

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Abstract. From 1973 to the present, the author of the article has tested more than 500 bent and eccentrically compressed reinforced concrete elements, including models of 48 bent reinforced concrete beams of bridge structures weighing up to 0.5 tons, with one-, two- and, for the first time in the world tested at triaxial prestressing [1].

The purpose of the experimental research was to improve the methodology for calculating the strength of bending reinforced concrete elements along inclined sections, taking into account the correspondence of the influence of all the main factors adopted in the design model under the action of the load to the experimental results.

Keywords: bearing capacity, inclined sections, bending elements.

To improve the design model for calculating the strength of bending reinforced concrete elements of rectangular and T-profile along inclined sections, it is necessary to experimentally establish the share of the influence of each of the above factors on the bearing capacity of the studied elements.

1. Influence of the shear span length on the bearing capacity along inclined sections of bent reinforced concrete elements (fig 1, tab 1).

The influence of the shear span on the bearing capacity of bent reinforced concrete elements along inclined sections is nothing more than the influence of bending moments and shear forces from external loads, i.e., $c = M/Q$. In tab 1 (constructed in accordance with fig. 1), the effect of the shear span length is expressed through the ratio of the bearing capacity of beams with small shear spans ($c=1,5h_0$) to the bearing capacity of similar beams with medium and large shear spans ($c=3h_0$ and $c=4h_0$) with different amounts of transverse reinforcement and different geometric characteristics of beams. The geometric characteristics of the studied beams are shown in fig. 1 and in tab. 1 and 2.

At the same time, in the previously valid normative documents [2], as well as documents currently in force [3 and 4] in Russia and some other countries, when determining the value of the length of the shear span with the influence of the bending moment from external loads, it is not taken into account at all. However, in experimental studies it was found that in rectangular beams with an increase in the length of the shear span c, the bearing capacity along inclined sections decreases much more intensively compared to similar T-beams (see tab. 1). Therefore, the use of T-profile beams in structures subjected to the action of moving temporary loads with a continuous change in the values of the cut-through length (bridge beams, crane beams of industrial buildings, etc.) is a significant advantage over rectangular beams. This factor is not reflected in regulatory documents both in Russia and in the norms of many other countries.

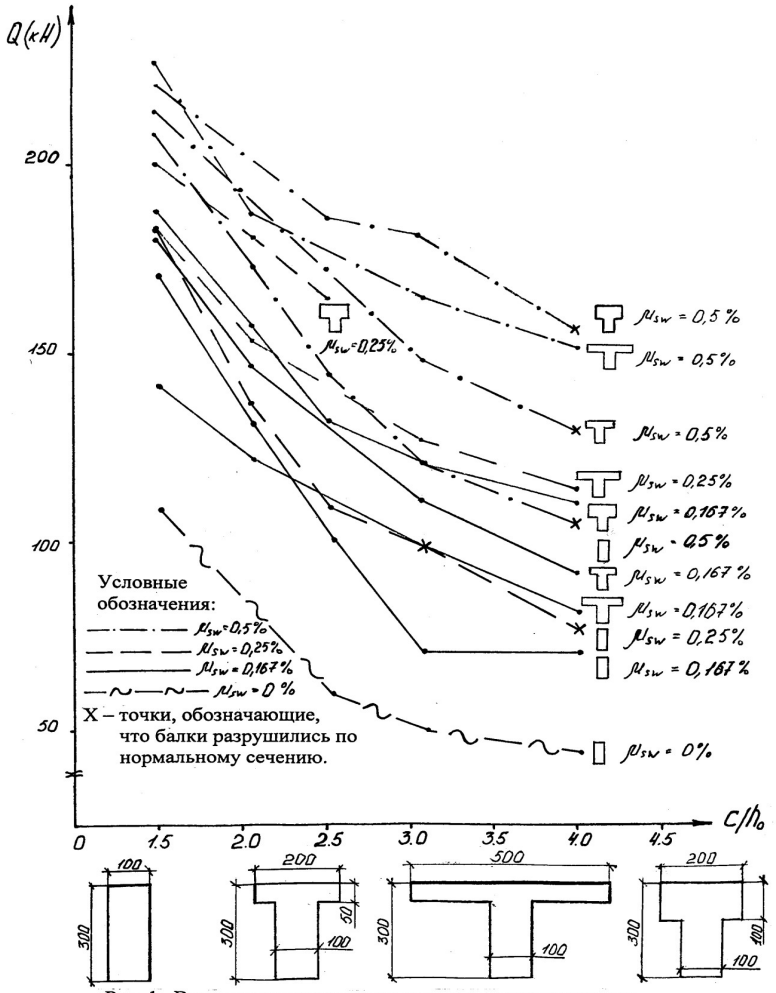

Рис. 1 Влияние относительного пролета среза на несущую способность по наклонным сечениям в зависимости от поперечного армирования и от размера свесов сжатых полок

On the basis of experimental studies, it was found that with an increase in the number of transverse reinforcement in T-profile beams subject to the action of movable temporary loads, a decrease in the effect of the length of the cut span on their bearing capacity along inclined sections depends on the size of the relative width of the overhangs of compressed flanges to their thickness b_{cb}/h'_f.

Tab. 1. Influence of the relative distance from the support to the line of action of the load (shear span) on the bearing capacity of bent reinforced concrete beams along inclined sections, depending on the percentage of transverse reinforcement (horizontally) and the shape of the cross section (vertically).

№ схем попе-речного сечения балок	Схемы поперечного сечения балок	Коэффициенты опытных отношений поперечных сил при $c = 1{,}5h_0$ к поперечным силам при $c = 3h_0$ $(Q^{on}_{c=1,5h_0})/(Q^{on}_{c=3h_0})$				Коэффициенты опытных отношений поперечных сил при $c = 1{,}5h_0$ к поперечным силам при $c = 4h_0$ $(Q^{on}_{c=1,5h_0})/(Q^{on}_{c=4h_0})$			
		Количество поперечной арматуры μ_{sw}, %							
		0	0,167	0,25	0,5	0	0,167	0,25	0,5
1	2	3	4	5	6	7	8	9	10
1		$\frac{110}{50}=2{,}2$	$\frac{167{,}5}{70}=2{,}39$	$\frac{182{,}5}{97{,}5*}=1{,}87$	$\frac{207{,}5}{125}=1{,}66$	$\frac{110}{45}=2{,}44$	$\frac{167{,}5}{70}=2{,}39$	$\frac{182{,}5}{75*}=2{,}43$	$\frac{207{,}5}{102{,}5*}=2{,}0$
2			$\frac{180}{110}=1{,}64$		$\frac{212}{147{,}5}=1{,}44$		$\frac{180}{90}=2{,}0$		$\frac{212}{130*}=1{,}63$
3			$\frac{140}{97{,}5}=1{,}44$	$\frac{182{,}5}{127{,}5}=1{,}43$	$\frac{227}{163}=1{,}39$		$\frac{140}{80}=1{,}75$	$\frac{182{,}5}{112{,}5}=1{,}62$	$\frac{227}{150{,}5}=1{,}51$
4			$\frac{187{,}5}{120}=1{,}56$		$\frac{220}{180}=1{,}22$		$\frac{187{,}5}{108{,}5}=1{,}73$	$\frac{205}{127{,}5}=1{,}61$	$\frac{220}{155*}=1{,}42$

Note: numbers marked with (*) denote that the beam collapsed along normal sections; shear forces are given in kilonewtons (kN)

So, in T-profile beams, with an increase in the width of the overhangs of compressed flanges b_{cb} at their constant thickness h'_f (in the experiments given in tab. 1, the ratio b_{cb}/h'_f is taken within the limits up to b_{cb}/h'_f=20cm/5cm=4) an increase in the amount of transverse reinforcement from μ_{SW} = 0,167% to μ_{SW} =0,5% reduces the effect of the length of the shear span on the bearing capacity of beams along inclined sections insignificantly - only 1.036 times (1.44/1.39 - see tab. 1, cross-sectional diagram 3, columns 4 and 6). However, with a further increase in the length of the shear span, the transverse reinforcement reduces its effect on the bearing capacity of beams along inclined sections more significantly - by 1.16 times (1.75/1.51 - see tab. 1, cross-sectional diagram 3, column 8 and 10).

In T-profile beams, with an increase in the thickness of the overhangs of compressed flanges with their constant width, an increase in the amount of transverse reinforcement reduces the effect of the shear span on the bearing capacity along inclined sections most significantly (see tab. 1 - comparison of beams according to cross-sectional schemes 4 and 2, where in beams with thick overhangs of compressed flanges (cross-sectional diagram 4), an increase in the amount of transverse reinforcement in the

range from μ_{sw}=0,167% to μ_{sw}=0,5% reduces the influence of the length of the shear span on their bearing capacity along inclined sections by 1.28 times (1.56/1.22), and in similar beams with a smaller value of the thickness of the overhangs of compressed flanges (cross-sectional diagram 2), a decrease in the influence of the length of the cut span on the bearing capacity along inclined sections occurred by 1.14 times (1.64/1.44).

2. Influence of the dimensions of the overhangs of compressed shelves on the bearing capacity along inclined sections of bending reinforced concrete T-profile elements (tab. 2).

Experimental studies have shown that in bent reinforced concrete T-profile beams without prestressing longitudinal reinforcement, as well as in prestressed beams, the effect of the dimensions of the overhangs of compressed flanges on their bearing capacity along inclined sections depends on many factors, including: on the amount of transverse reinforcement, on the length of the cut span, on the rib thickness in the cross section of the beams (see tab. 2 - where the T-profile beams have the usual relative rib thickness *b/h* =10cm/30cm=0.33 in comparison with tab. 3, where the beams have a small relative rib thickness *b/h* = 6cm/31cm=0,19).

The influence of the dimensions of the overhangs of compressed flanges on the bearing capacity of beams along inclined sections is expressed through the ratio of the bearing capacity of T-profile beams to the bearing capacity of similar rectangular beams.

According to tab. 2, it can be seen that the smallest influence of the overhangs of compressed flanges on the bearing capacity along inclined sections occurs in T-profile beams with small shear spans ($c=1,5h_0$).

At the same time, in some T-profile beams with wide overhangs of compressed shelves (b_{cb}/h'_f =20cm/5cm=4) with small shear spans (c=1,5h_0 and c=2h_0 – which is absent in this article due to data reduction in tab. 2), as well as with a small amount of transverse reinforcement (μ_{sw} =0.167%), the bearing capacity along inclined sections turned out to be less than the bearing capacity of similar rectangular beams (see tab. 2 - cross-sectional diagram 3).

In T-profile beams, with an increase in the length of the shear span c, their total bearing capacity along inclined sections decreased, but the effect of the overhangs of compressed flanges on the bearing capacity of these beams significantly increases (see tab.2, cross-sectional diagrams 2, 3 and 4).

This is due to the fact that in T-profile beams, the effect of the shear span on the bearing capacity along inclined sections is much less than in the case of rectangular beams.

With an increase in the thickness of the overhangs of compressed shelves with their constant width, the bearing capacity of the beams along inclined sections increases.

Tab. 2. Influence of overhangs of compressed flanges on the bearing capacity of bent reinforced concrete beams along inclined sections (vertically), depending on the size of the cut span and the percentage of transverse reinforcement (horizontally).

№ схем попе-речного сечения балок	Схемы поперечного сечения балок	Отношение несущей способности балок таврового профиля по схемам 2, 3, 4 ($Q^{on}_{схема,n}$) к несущей способности балок прямоугольного профиля по схеме 1 ($Q^{on}_{схема,1}$) ($Q^{on}_{схема,n}$)/($Q^{on}_{схема,1}$)											
		Расстояние от опоры до линии действия нагрузки (пролет среза)											
		$c = 1{,}5h_0$				$c = 3h_0$				$c = 4h_0$			
		Количество поперечной арматуры μ_{sw}, %											
		0	0,167	0,25	0,5	0	0,167	0,25	0,5	0	0,167	0,25	0,5
1		110	167,5	182,5	207,5	50	70	97,5*	125	45	70	75*	102,5*
2			180 / 167,5 = =1,07		212 / 207,5 = =1,02		110 / 70 = =1,57		147,5 / 125 = =1,18		90 / 70 = =1,29	102 / 75* = =1,36	130* / 102,5* = =1,27
3			140 / 167,5 = =0,84	182,5 / 182,5 = =1,0	227 / 207,5 = =1,09		97,5 / 70 = =1,39	127,5 / 97,5* = =1,31	163 / 125 = =1,30		80 / 70 = =1,14	112,5 / 75* = =1,5	150 / 102,5* = =1,47
4			187,5 / 167,5 = =1,12	205 / 182,5 = =1,12	220 / 207,5 = =1,06		120 / 70 = =1,71		180 / 125 = =1,44		108,5 / 70 = =1,55	127,5 / 75* = =1,7	155* / 102,5* = =1,51

Notes. 1. Numbers marked with (*) denote that the beam collapsed along normal sections. 2. The shear forces are given in kilonewtons (kN).

So in a beam with small shear spans (c=1,5h$_0$) and the amount of transverse reinforcement μ_{SW} = 0.167% with a ratio h'_f / b_{cb} =5cm/5cm=1, the overhangs of compressed shelves increased the bearing capacity of the T-profile beam by 1.07 times more than with a similar rectangular beam (see tab. 2 - cross-sectional diagram 2).

With an increase in the thickness of the overhangs of the compressed flanges h' to the ratio h'_f / b_{cb} =10cm/5cm=2, the bearing capacity of the T-profile beam, as indicated above, turned out to be 1.12 times greater than that of a similar rectangular beam (see tab. 2 - cross-sectional diagram 4).

With an increase in the length of the span of the cut, the effect of overhangs of compressed flanges on the bearing capacity of beams along inclined sections increases.

So, in a T-profile beam with a shear span c=3h$_0$ and the amount of transverse reinforcement μ_{SW} = 0.167%, with small overhangs of compressed flanges (h'_f / b_{cb} = 5 cm/5cm=1) the bearing capacity along inclined sections was 1.57 times higher, in comparison with a rectangular beam (see

tab. 2 - cross-sectional diagram 2). In a similar T-profile beam with a small value of the shear span c=1,5h_o, the overhangs of compressed flanges increased its bearing capacity along inclined sections, as noted above, only 1.07 times the size of a rectangular beam.

Table 3. Influence of overhangs of compressed flanges, the amount of transverse reinforcement as well as the magnitude of prestress in longitudinal reinforcement on the bearing capacity of bent reinforced concrete beams along inclined sections

Номера балок	Схема поперечного сечения балок	Величина предваритель-ного напряжения в продольной арматуре	Наличие поперечной арматуры	Разрушающая нагрузка кН	Отношение опытной разрушающей нагрузки балок таврового профиля к разрушающей нагрузке аналогичных балок прямоугольного профиля (влияние свесов сжатых полок на несущую способность балок по наклонным сечениям)	Отношение опытной разрушающей нагрузки балок с поперечной арматурой к разрушающей нагрузке аналогичных балок без поперечной арматуры (влияние количества поперечной арматуры на несущую способность балок по наклонным сечениям)	Отношение опытной разрушающей нагрузки предварительно напряженных балок к разрушающей нагрузке аналогичных балок без предварительного напряжения(влияние величины предварительного напряжения продольной арматуры на несущую способность балок по наклонным сечениям)
1	2	3	4	5	6	7	8
Б-1		Без предварительного напряжения	Балки без поперечной арматуры	90			
Б-2				100,6	100,6/90=1,118		
Б-3				119	119/90=1,322		
Б-4		Среднее предварительное напряжение		95,8			95,8/90=1,064
Б-5				132	132/95,8=1,378		132/100,6=1,312
Б-6				154,9	154,9/95,8=1,617		154,9/119=1,302
Б-7		Сильное предварительное напряжение		87			87/90=0,9666
Б-8				113,5	113,5/87=1,304		113,5/100,6=1,128
Б-9				121	121/87=1,39		121/119=1,017
Б-10		Без предварительного напряжения	Балки с поперечной арматурой 2ф5В -I; S = 5 см; μ_{sw} = 1,3 %	132,5		132,5/90=1,472	
Б-11				245,8	245,8/132,5=1,855	245,8/100,6=2,44	
Б-12				267,5	267,5/132,5=2,019	267,5/119=2,248	
Б-13		Среднее предварительное напряжение		178,3		178,3/95,8=1,861	178,3/132,5=1,3457
Б-14				329	329/178,3=1,845	329/132=2,492	329/245,5=1,338
Б-15				288,1	288,1/178,3=1,616	288,1/154,9=1,86	288,1/267,5=1,077
Б-16		Сильное предварительное напряжение		150		150/87=1,724	150/132,5=1,132
Б-17				203	203/150=1,353	203/113,5=1,788	203/245,8=0,825
Б-18				207,1	207,1/150=1,38	207,1/121=1,712	207,1/267,5=0,774
Б-19		Без предварительного напряжения	Балки с поперечной арматурой 2ф6А -III; S = 5 см; μ_{sw} = 1,9 %	137,1		137,1/90=1,523	
Б-20				260	260/137,1=1,896	260/100,6=2,584	
Б-21				237,3	237,3/137,1=1,730	237,3/119=1,994	
Б-22		Среднее предварительное напряжение		140		140/95,8=1,461	140/137,1=1,021
Б-23				230,8	230,8/140=1,649	230,8/132=1,748	230,8/260=0,887
Б-24				260	260/140=1,857	260/154,9=1,678	260/237,3=1,095
Б-25		Сильное предварительное напряжение		150		150/87=1,724	150/137,1=1,094
Б-26				200	200/150=1,333	200/113,5=1,762	200/260=0,7692
Б-27				278	278/150=1,853	278/121=2,297	278/237,3=1,1715

In a T-profile beam with a shear span c=3h_o and the amount of transverse reinforcement μ_{SW}=0,167%, thick short overhangs of compressed

flanges (h'_f / b_{cb} =10cm/5cm=2) increased its bearing capacity along inclined sections by 1.71 times more than a rectangular beam. In a similar T-profile beam with a small value of the shear span c=1,5h_o, the overhangs of compressed flanges increased the bearing capacity along inclined sections, as noted above, only 1.12 times more than in a rectangular beam.

Thus, the most significant increase in the bearing capacity of T-profile beams along inclined sections, due to the work of the overhangs of compressed flanges, occurs in beams with short thick overhangs (see tab. 2 - cross-sectional diagram 4).

Note: *The results of the experiments given in tab. 1 and tab. 2 for beams with a shear span of c=4h_o cannot be taken for some conclusions or remarks as reliable, since most of the indicated beams (marked in the tables with asterisks) did not collapse. along inclined, and along normal sections.*

The author of the article has carried out experimental studies of a large number of independently manufactured and tested beams of rectangular and T-profile with thin ribs in cross-section, which are most often used in the construction of spans of bridge structures in Russia, some of which are given in tab. 3. Rectangular and T-profile beams with a cross-sectional height *h* =310mm and with a thin rib width *b* =60mm (0.19 *h*) had widening in the lower zone intended for the location of longitudinal stress (and in some beams, non-stress) reinforcement, as well as to ensure their stability in testing process (scale models of bridge span beams).

Longitudinal reinforcement in both prestressed and non-prestressed beams consisted of 3Ø12 A-V. The concrete strength averaged 35MPa.

The indicated beams, which are given in tab. 3, were made without transverse reinforcement (μ_{SW}=0%) and with the presence of transverse reinforcement with its percentage μ_{SW}=1.3% (2Ø5 B_p – I located with a step *S*=5cm) and μ_{SW}=1.9% (2Ø6 A – III located also with a step *S*=5cm). The T-profile beams had an average and large width of the overhangs of the compressed flanges: *bcb* =115mm (2.58 h'_f) and b_{cb}=230mm (5.52 h'_f).

Based on tab. 3, it was found that in beams without transverse reinforcement and without prestressing the lower longitudinal reinforcement, the overhangs of compressed flanges increased the bearing capacity along inclined sections with an average width of 2.58 h'_f – 1.118 times, and with a large overhang width equal to 5.52 h'_f– 1.322 times (beams B – 2 and B – 3). In prestressed beams without transverse reinforcement with average values of prestressing of the lower longitudinal reinforcement, the overhangs of compressed flanges increased the bearing capacity along inclined sections with an average width of 2.58 h'_f – by 1.378 times, and with a large overhang width equal to 5.52 h'_f – by 1.617 times (beams B

- 5 and B - 6), which is more than the effect of overhangs of compressed flanges on the bearing capacity along inclined sections in beams without prestressing. In prestressed beams without transverse reinforcement with strong prestressing of the lower longitudinal reinforcement, the overhangs of compressed flanges increased the bearing capacity along inclined sections with their average width by 1.304 times, with a large width by 1.39 times (beams B - 8 and B - 9. C beams with transverse reinforcement (2Ø5 B_p – 1 with a step *S*=5cm), without prestressing the lower longitudinal reinforcement, the overhangs of compressed flanges increased their bearing capacity along inclined sections with their average width - by 1.855 times, with a large width by 2.019 times (beams B-11 and B - 12).

In prestressed beams with the presence of transverse reinforcement with an average value of prestressing of the lower longitudinal reinforcement, the overhangs of compressed flanges increased their bearing capacity along inclined sections with their average width by 1.845 times, with a large width by 1.616 times (beams B - 14 and B - 15) In prestressed beams with strong prestressing of the lower longitudinal reinforcement in the presence of transverse reinforcement, similarly as in beams without transverse reinforcement, the effect of overhangs of compressed flanges increased the bearing capacity along inclined sections, respectively, by 1.353 times in a beam with a small width of overhangs (beam B - 17) and 1.38 times in a beam with wide overhangs of compressed flanges (beam B - 18), which is significantly less in comparison with beams with average values of prestressing. The influence of the overhangs of compressed flanges on the bearing capacity along inclined sections in T-profile beams with a slight increase in the number of transverse reinforcement (2Ø6 A-III located with a step S=5cm - beams from B - 19 to B - 27) occurred in the same way as in the above beams from B - 10 to B - 18 with transverse reinforcement 2Ø5 B_p – 1 with a step S=5cm.

As can be seen from tab. 1, rectangular beams without transverse reinforcement (μ_{sw}= 0%) are most affected by the shear span length on the bearing capacity along inclined sections, where with an increase in the shear span from c=1,5h_0 to c=4h_0 the bearing capacity decreased by 2.44 times (110kN/45kN – tab. 1 - cross-sectional diagram 1, column 7). With an increase in the amount of transverse reinforcement from μ_{sw}=0,167% to μ_{sw} =0,5% (see tab. 1 horizontally - cross-sectional diagram 1) the influence of the shear span length, in the range from c=1,5h_0 to c=3h_0, on the bearing capacity along the inclined sections of rectangular beams decreased by 1.44 times (2.39/1.66).

Tab. 1 also shows that in T-profile beams, the effect of the shear span on the bearing capacity along inclined sections is much less than in similar rectangular beams. At the same time, similarly to rectangular beams, in T-profile beams with an increase in the amount of transverse reinforcement, the effect of the shear span on the bearing capacity along inclined sections also decreases.

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ANALYSIS OF THE GRANULOMETRIC COMPOSITION OF THE ORE MASS DURING UNDERGROUND MINING OF DISSEMINATED COPPER-NICKEL ORES

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Abstract. With the depletion of industrial ore reserves, the acuteness of the problem of improving the quality of ore raw materials increases, since there is objectively a correlation between the granulometric composition (size) of useful components in ores and their stable content.

At the Norilsk copper-nickel deposits, there is a tendency for an intensive decrease in the content of metals in industrial reserves, which is accompanied by an increase in the indicators of variability in the quality of ores. It was found that the value of the nickel content in pieces of broken-off ore mass with a particle size of 5 to 35 cm changes in the aisles from 0.34 to 0.2%, and copper, respectively, from 1.3 to 0.22%, that is, the range of fluctuations is, respectively, 0.14 and 1.08% or relative change - 1.7 and 5.9 times.

Mixing and uniform distribution of the average content of useful components in the chipped ore depends on its flowability and lumpiness, determined not only by the average size of the lumps, but also by the granulometric composition of the ore mass. In this work, the analysis of the granulometric composition of the broken-off minerals in the face and the establishment of the weighted average size of a piece of ore mass during underground mining of disseminated copper-nickel ores were considered on the example of the "Norilsk-1" deposit, in the conditions of the "Zapolyarny" mine.

Keywords: ore mass, particle size distribution, segregation, photoplanimetry method, quality stabilization.

The relevance of the work is determined by the deterioration of the ore-raw material base of the mining enterprises of the Norilsk industrial

region, which leads to a decrease in the quality of commercial ore and an increase in the variability of quality indicators in mining [1]. One of the most important factors influencing the formation of variability in the quality of mined ores is granulometric segregation. It is especially manifested in the conditions of mining disseminated copper-nickel ore deposits, where there is a contrast and correlation between the size, strength and content of the useful component in the ore and host rocks. In the course of mining operations, the shape and size in the cross section of an ore or rock lump affects the process of spontaneous separation of the ore mass by grain size distribution in a bulk or pile. Segregation degrades the mixing properties of the ore mass and leads to fluctuations in metal content, which have a relatively high frequency and low amplitude.

The size of a piece of ore mass is a function not only of the parameters of drilling and blasting operations, but also of the physicomechanical properties of ores and rocks, for example, strength, fracturing, etc. In this regard, the main task of the study is to analyze the granulometric composition of the ore mass in the bottom hole and establish the weighted average size of the piece chipped ores during underground mining of disseminated copper - nickel ores.

The "Zapolyarny" mine mines the northern and, partially, southern parts of the Norilsk-1 sulfide copper-nickel ore deposit, confined to the differentiated gabbro-dolerite intrusion of the same name. The intrusion comes to the surface in the upper reaches of the Ugolny stream on the slopes of Mount Rudnaya. From the north, the "Prirezki" field is limited by the mining allotment of the exhausted mine № 7, from the west - by the contour of the ore body, from the east - by the guard entirely between open and underground mining operations. In the south, the cut-off field is limited by the contour of the mining allotment, to the south of which there are reserve areas of the Norilsk-1 deposit. Underground mining in the plan is located much to the west of the open pit of the "Zapolyarny" mine and is separated from it by a guard, more than 300 meters wide. The front of the clean-up works "Prirezki" is more than 1000 meters away from open pit mining and continues to move away [9].

The main type of ores of the deposit are disseminated copper-nickel ores, which occur in the lower part of the intrusion in the form of a bed-like deposit of disseminated ores up to 50 meters thick (on average about 18 m). The main ore minerals of the deposit are pyrrhotite, pentlandite, chalcopyrite, cubanite, bornite, magnetite, etc. The richest in metal content are taxite gabbro-dolerites localized in the lower part of the ore body [6]. The picrite gabbro-dolerites located above are poor, and the metal concentra-

tions gradually decrease from bottom to top. Deterioration of strength properties occurs from taxitic gabbrodolerites to picrite (from bottom to top). In the upper part of the ore body, during the transition from picrite gabbrodolerites to olivine-biotite and olivine gabbro-dolerites, there is an improvement in strength properties. The presence of impregnated sulfides does not significantly affect the strength. The tectonic situation in the "Prirezki" field is rather calm. The annual productivity of the mine is 1 million 200 thousand tons, with the average nickel and copper content in the mined ore, respectively, 0.31 and 0.43%. When developing a deposit, a caving development system is used [2,3].

The area of the ore body shown in fig. 1 was taken for the study. When determining the granulometric composition of the ore mass after breaking in the face, the well-known method of photoplanimetry was used, a direct measurement method using photographic materials provided by the "Zapolyarny" mine. The photographs were taken during production operations associated with the release of ore mass. The ore was tapped at an interval of 5 ladles, under the following conditions: the distance between the ends of the blast holes in the fan was 2 m and the distance between the fans was 2 m, the width of the stripped layer was 14-15 m, and the volume of ore produced was 650 m^3; bucket capacity of Caterpillar R1700 LHD loaders - 5.7 m^3.

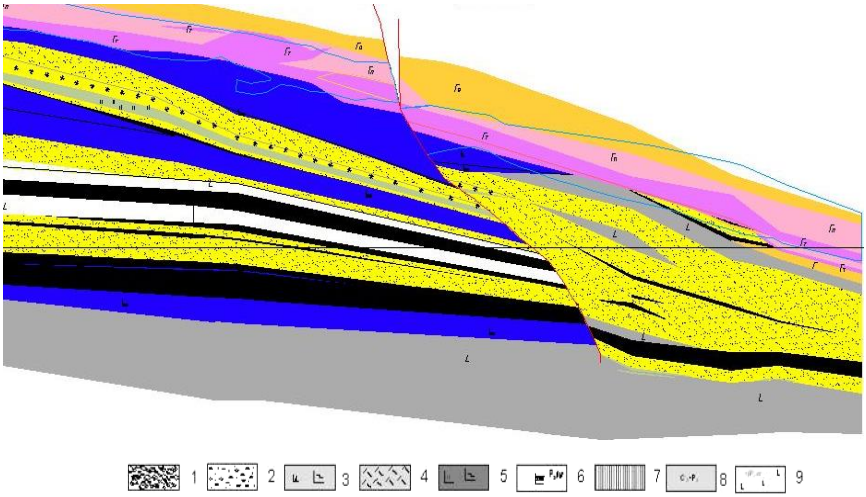

Fig. 1. Geological size along the border of panels 9/10 of the "Prirezki" field of disseminated copper-nickel ore deposit Norilsk-1: 1 – technogenic dumps; 2 – quaternary deposits; 3 – glomero-porphyry basalts, porphyry, tholeiitic, poikilitic; 4 – tuffites, tuffs, tuff breccias; 5 – basalts picrite, porphyry, glomeroporphyry, tholeiitic, poikilophytic; 6 – two-feldspar, labradorite, titanium-augite basalts of the Ivakino Formation; 7 – differentiated intrusion of gabbro-dolerite, including deposits of low sulfide and disseminated ores; 8 – coal-bearing rocks of the Tunguska series of the Middle Carboniferous - Upper Permian; 9 – Ergalakhsky intrusive complex of Permian: dolerites and diabases

The volume of various pieces of ore mass in the studied intervals was determined from the ratio of the area of the broken-off ore mass in individual areas to the general contour of the analyzed area in percent. By comparing the geometrical parameters of the ore lumps with the size of the mine insulating self-rescuer SHSS-T, the scale was determined [5]. The size of the insulating self-rescuer SHSS-T is 111x146x248 mm (fig. 2).

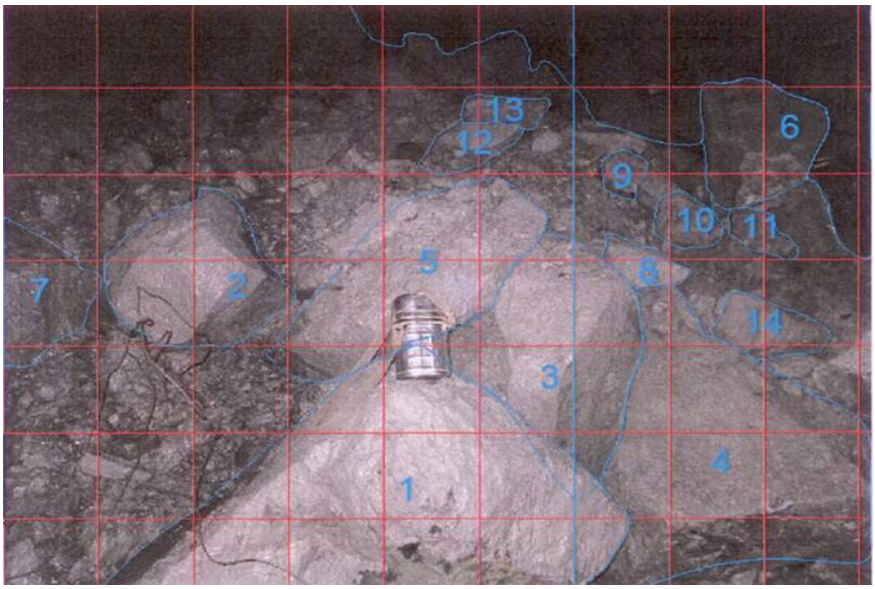

Fig. 2. Contours of individual pieces of ore mass in the volume of broken ore

Table 1.
Analysis of the fractional composition according to fig. 2 (for 1 interval)

square	piece number	%	size in mm	%
3533965,44		100,00		100,00
2388633,11		61,25	less 100	
430520,00	1	12,18	998,00	38,75
154171,00	2	4,36	473,50	
239604,00	3	6,78	720,00	
837,34	4	0,02	796,33	
222964,00	5	6,31	628,00	
97236,00	6	2,75	356,00	
72743,29	7	2,06	344,00	

20888,43	8	0,59	185,00	38,75
12519,30	9	0,35	150,00	
22000,00	10	0,62	173,00	
16807,21	11	0,48	154,00	
23143,8168	12	0,65	181,00	
17026,1358	13	0,48	174,00	
38922,0824	14	1,10	198,00	

In the final analysis, pieces with sizes in the range 0 + 100 mm were combined, and pieces of size 100 ÷> 1000 were taken into account separately. The final tab. 2. presents the results after calculations.

Table 2

The final results of the output of the lumpy fraction of the ore mass based on photographic materials

Size of pieces of ore mass, mm						
from 0 to 100	from 100 to 200	from 200 to 400	from 400 to 600	from 600 to 800	from 800 to 1000	>1000,
The output of the lump fraction of the ore mass,%						
61,32	1,04	4,82	6,33	7,61	7,87	11,01
Average metal content in size classes,%						
0,35	0,29	0,27	0,24	0,19	0,11	0,05

Figure 3 shows a histogram of the distribution of the granulometric composition of the chipped ore.

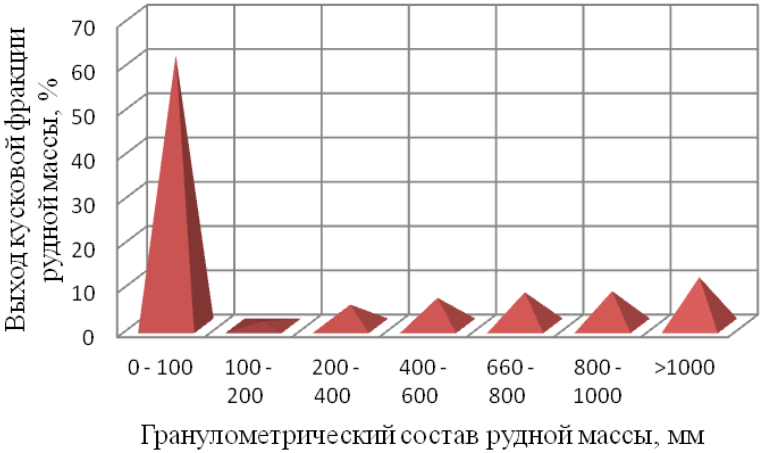

Fig. 3. Histogram of the distribution of the granulometric composition of the ore mass at the "Zapolyarny" mine

In accordance with the results of processing photoplanograms, the yield of size classes was: 0-100 mm - 61.3%, 100-200 mm - 1.04%, 200-400 mm - 4.82%, 400-600 mm - 6.33%, 600-800 mm - 7.61%, 800-100 mm - 7.87 and more 1000 mm - 11.01%. Based on the results obtained, using photographic materials, the weighted average size of a piece of ore mass was established, which averaged 265 mm.

The results obtained allow us to conclude that an increase in the volume of large lumps relative to the weighted average size of a lump in the chipped ore mass enhances the flakiness or heterogeneity factor, which leads to segregation of the ore mass in the bulk, ie, to separation according to the granulometric composition. Separation of the ore mass by size in the bulk after blasting operations leads to an increase in the variability of quality indicators in the total ore flow and a decrease in the quality of marketable ore. This is especially evident in the process of cleaning work during the development of the lower part of the intrusion of the "Prirezki" field of the disseminated copper-nickel ore deposit Norilsk-1, where the contours of the ore body have complex outlines, and there are significant inclusions and interlayers of waste rocks in the mined volumes of the deposit.

When solving mining and technological problems to ensure the stability of the quality of mineral raw materials, it is necessary to take into account the factor of inhomogeneity of the size of ore and rock pieces, which leads to the segregation of the ore mass. The state of the mineral resources of the "Zapolyarny" mine is typical for the future Norilsk ore region, since

the main resource of metals is the reserves of disseminated ores. In this regard, the search for effective mining and technological solutions for the future is of great importance for the non-ferrous metallurgy of Russia.

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THE DEPENDENCE OF THE FUNCTIONAL AND TECHNOLOGICAL PROPERTIES OF DOUGH ON THE TYPE OF ADDITIVES

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Abstract. The article presents a new scientific research on the functional and technological properties of the dough depending on the type and concentration of the flour and hydrocolloids. The tasks of the research are to determine the concentration of colloids that makes dough plastic and strong, to identify the dependence of the concentration of flour on the type and properties of hydrocolloids and to study organoleptic quality indicators. To find the optimal ratio of flour and each type of the structure-forming agents, such as soy protein isolate, xanthan gum, and potato starch, the methods of mathematical programming have been used. The results of the control measurement of the viscosity of the sample with the optimal composition indicate that the chosen mathematical model corresponds to the elastic and viscous properties of the dough.

Keywords: dough, soy protein isolate, mathematical model, mathematic programming, viscosity.

At present, the range of rice flour products is not sufficiently represented on the market and is mainly limited to the products in which rice flour is used as a mixture with wheat flour [1]. Most of the published recipes for gluten-free products relate to bread and bakery products, the range of which is determined by national traditions, purpose in diets and menus, and special requirements for nutritional value.

The development of the recipes for such specialized dishes as meat dumplings, dumplings, pancakes, that cannot be met at the market so

widely as other products, based on rice flour, is becoming more and more relevant.

The purpose of the work is to study the functional and technological properties of the dough depending on the type and concentration of flour and hydrocolloids.

The objects of the study are four types of unleavened dough prepared with various structure-forming agents to improve hydrocolloid properties, and a control sample made according to recipe No. 412 of the collection of recipes [1]. Wheat flour with humidity of 13% and gluten of the 1st group-quality and rice flour with a moisture content of 14% were also used in the study.

So, rice flour does not form gluten, which gives the dough necessary viscoelastic properties, while at the same time it contains a large amount of starch, which is manifested in the production of sticky dough that does not retain its shape. It is found that when rice flour is brewed, the starch is gelatinized, while the dough becomes elastic and less sticky [2].

It is known that water significantly affects the rheological properties of rice flour dough, its elasticity and resistance to deformation, and its ability to retain gas. In addition, the water-holding capacity of the dough affects the quality of products, namely, its texture, appearance, taste, and shelf life. This makes it possible to study the physical and chemical properties of the main structural components in the feedstock.

Therefore, one can make a conclusion that in the production of rice flour products, it is necessary to use a mixture of various hydrocolloids, the combination of which provides the required technological properties of the dough and the quality of the finished products. Soy protein isolate and natural polysaccharide xanthan gum are selected as a system of such hydrocolloids.

Xanthan gum is known as a common thickener and one of the most trouble - free hydrocolloids to use. It is active in a wide range of temperatures, in alkaline, acidic and even salty solutions. It is formed by the breakdown of glucose by specially grown bacteria. In the process of their vital activity, the gum precipitates and is subjected to drying, and then – grinding. Afterwards, it can be considered to be ready for further processing.

First, xanthan gum was produced at the research center at the USDA in the 50s, its commercial production began in the 60s, and in 1969 it was included into the register of permitted additives for food use. It is recognized worldwide as the best natural gelling agent that has a high viscosity and an excellent stabilizing activity. Moreover, these qualities are retained even after freezing. Food stabilizer E415 can be successfully combined with gelatin, pectin, starch and other thickeners. This quality has made it indispensable in the modern food industry.

Xanthan gum reveals its potential when interacting with other textures. By increasing the viscosity of liquids, it prevents the separation of liquids in gels and stabilizes emulsions and foams. It is also used in the production of gluten-free products as it can partially replace gluten, preserving its properties. In the production of flour products, the recommended dosage of xanthan gum is 0.1-0.2% by weight of flour [3].

The products made from soy seeds are divided into three groups that differ in protein content: full-fat flour with a protein content of 40-50%, protein concentrate with a protein content of 65-70% and protein isolate containing at least 90% protein [4].

Isolates have a neutral taste, smell and color - white or cream, they are well soluble in water, forming proteinates, in salt and alkaline solutions. When solutions and concentrated suspensions are heated, the isolates form strong non-regenerating jellies with a high water content. They have fiber-forming properties and stabilize fat emulsions in water, foams, and starch suspensions [4].

The expediency of using protein products from soy seeds in the production of pasta, confectionery and flour products is associated with the need to increase the biological value and improve the technological and taste qualities of the resulting products.

In the production of bakery products, the addition of protein isolates positively effects the hydrodynamic properties of the dough. In an alkaline environment, the water absorption capacity increased significantly, and the consistency of the dough is improved, although the degree of loosening, on the contrary, becomes worse. Adding an isolate to pasta reduces the duration of their drying as a result of the redistribution of moisture between the proteins and starch of flour and the protein of the enricher, due to this water passes from a stronger state to a less strongly bound one and is easily removed [5].

It is known that the production of high-quality pasta requires flour made from durum wheat. When using additives of protein products from oilseeds, it becomes possible to use soft wheat flour.

In the confectionery industry, soy isolate is used as an additive that make it possible to design and produce confectionery masses with specified rheological characteristics, as well as a protein concentrator. Even a small amount of protein isolate in the recipe of a confectionery product helps manipulate with such functional and technological indicators as the viscosity, foam- and gel formation, emulsifying, water and fat-absorbing abilities [6-12, 15].

Soy protein has a high biological value. 100 g of isolate contains at least 90% of protein. Fat is about 0.5%, raw fiber no more than 6.0%. In addition, the food supplement is rich in micro and macro elements. It actively

stabilizes metabolism, affects the proper functioning of hormones and the thyroid gland, and it is an excellent antioxidant.

Protein concentrates and isolates from soybeans stimulate the elimination of heavy metal salts and radionuclides from the body, which reduces the risk of cancer.

The samples were examined using organoleptic and physico-chemical methods. The quality of flour was determined according to GOST 26574-2017 with the establishment of a transition period for GOST 26574-85 up to 01.01.2021. The dynamic viscosity of the dough was determined using a Brookfield viscometer. The methods of mathematical experiment planning were used to design the recipes of the unleavened dough. To define the reference dependence of viscosity on shear rate, the coefficients of non-linear model equations were estimated by using the methods of regression analysis in Statistica v6. For the experimental samples, the equation of the viscosity dependence was determined as a model of non-linear multiple regression. The graphs of the viscosity dependence on the shear rate compared to the reference rate were made. The methods of mathematical programming were used to find the optimal ratio of flour and each type of structure-forming agents (soy protein isolate, xanthan gum, and potato starch) in the dough to maximize the approximation of the viscosity curve to the reference one. For this purpose, an objective function with limits on the shear rate was compiled. Using the MathCAD v15, the optimal values of the content of the components such as rice flour - 27.78%, soy protein isolate - 7.22%, potato starch - 32.22%. xanthan gum - 0.28 % were found an the nutritional value of the samples was determined by the calculation method.

To study the influence of structure-forming agents on the quality of unleavened dough, it was prepared according to the recipe presented in table 1.

Table 1. The recipe for the production of unleavened pizza dough (net, g)

Raw materials	Control	Sample 1	Sample 2	Sample 3	Sample 4
Wheat flour	240	-	-	-	-
Rice flour	-	100	126	100	246
Soy protein isolate	-	26	-	26	26
Xanthan gum	-	1	1	-	1
Potato starch	-	116	116	116	-
Water	100	100	100	100	100
Olive oil	15	15	15	15	15
Salt	5	5	5	5	5
Output	360	360	360	360	360

Flour was poured into a kneading machine, then water heated to 30-35°, soy protein isolate, xanthan gum and potato starch were added in accordance with the recipe, then olive oil and salt were also added, the dough was kneaded until it had a uniform consistency. The prepared dough has been kept for 30-40 minutes to swell the gluten and become elastic, afterwards it can be used for cooking pizza.

Figure 1 shows a graphical representation of the dependence of the dough viscosity on the shear rate in the reference composition.

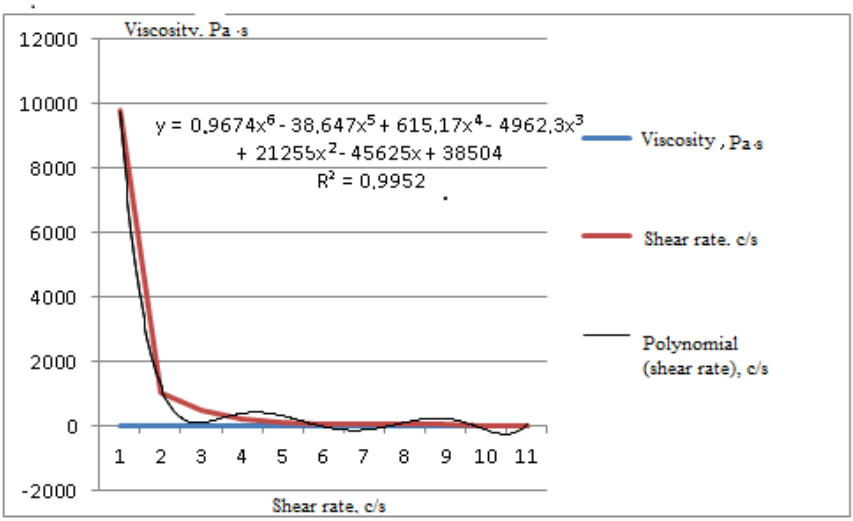

Figure 1. Dependence of dough viscosity on shear rate in the reference composition

The obtained coefficients are significant at the level of 0.05, the share of variance of the initial data explained by the model (the coefficient of determination R^2) is 0.9952 [14].

Table 2 presents the results of measuring the dynamic viscosity of the experimental samples of fresh dough depending on the shear rate.

Table 2. Dependence of dynamic viscosity of the experimental samples of fresh dough on the shear rate

Shear rate, c/s	Sample Number			
	1	2	3	4
0.015	11850	6260	4480	2115
0.035	4390	2680	2520	1949
0.045	3485	2055	2230	1558
0.050	2715	1925	1560	1562
0.065	2130	1515	1265	1313
0.125	1245	1165	818	679
0.250	615	610	379	356
2.000	114	118	84	78
3.000	73	39	58	52
3.450	66	33	51	47

The results of the control measurement of the viscosity of the sample with the optimal composition indicate that the selected mathematical model corresponds to the elastoviscoplastic properties of this dough and the curve changes depending on the composition of the dry dough mixture. To find the optimal ratio of each type of flour and tapioca starch in the dough for the maximum approximation of the viscosity curve to the reference one, the numerical methods for finding optimal solutions to multidimensional problems-mathematical programming methods were used. To do this, the target function was created. For example,

$$F(x_1;x_2;x_3;x_4) = \int_{0.017}^{3.33} (v(w,x_1,x_2,x_3,x_4,-ve(w))^2 dw, \qquad (1)$$

where the shear rate is limited from 0.017 c/s to 3.33 c/s.

As a result of the study of the influence of viscosity on the shear rate, it can be noted that by means of the mathematical model and regression analysis, it was possible to select such a ratio of raw materials when the technological properties of the fresh dough are almost as good as the control one. The results show that the optimal ratio of dry components in the recipe of fresh gluten-free dough will be rice flour 27.78%, soy protein isolate 7.22%, potato starch 32.22%. xanthan gum 0.28 %.

The results of the control measurement of the viscosity of the sample with the optimal composition indicate that the selected mathematical model corresponds to the elastoviscoplastic properties of this dough and the curve changes depending on the composition of the dry dough mixture. It can be noted that the application of the mathematical model and the

regression analysis make it possible to select the ratio of the prescription components so that the resulting product has rheological characteristics approximate to the control sample.

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FUNDAMENTALS OF DESIGN OF ROADSIDE RECREATIONAL FACILITIES IN THE LIGHT OF INCREASING MOBILITY AND MIGRATION MOBILITY OF THE POPULATION

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Abstract. The article discusses new ways of forming objects of roadside recreational architecture, which will positively affect the sustainable development of regions. This phenomenon is associated with the emergence of new forms of motivation among residents of large cities and an increase in the environmental and social burden on the urban environment. The study of the objects under consideration was based on the study of the high density of movements in large cities and on the need to reduce and transfer this density to recreational and tourist facilities in the form of transit roadside architectural formations of a new type. This interpretation will determine not only the ways of modern economic and social development of rural settlements and small towns, but also the methods of forming a modern recreational and tourist cluster of the country. The need to introduce roadside recreational facilities in architectural design will help increase the competitiveness and attractiveness of rural settlements and small towns. The formation of the national recreational and tourist industry of the Russian Federation will lead to an improvement in the quality of life of the population and an improvement in the spatial structure of the economy in the regions.

Keywords: recreational facilities, mobility, mobility of the population, suburban architecture.

State of the problem. In the context of the exacerbation of the global economic crisis (against the background of deepening and strengthening of social and economic contradictions), the scientific search for a new paradigm for the development of objects of the suburban environment and their spatial formation becomes more urgent. This search is dictated not only by the *increasing mobility and migration mobility of the country's population*, but also by the difficult conditions for the development of small and

medium-sized businesses in the suburban and inter-settlement environment [1,2].

The characteristic basis of modern life is automobiles and increased transport behavior of the population of Russia. All this significantly affects the behavior of each individual, their social activity, changes in the variety of behavioral patterns and influences the formation of new motivations and needs of our compatriots. Therefore, the study of changes in the diversity of patterns of Russian citizens becomes a starting point in the analysis of their transport behavior. The infrastructural conditions of the region, of course, allow for the physical movement of citizens. However, at the same time, it is necessary to take into account the social and economic needs of Russian citizens, which should not be left without the attention of the architect.

It should be noted that a person, car or other vehicle and the infrastructure of communication links manifest themselves as an independent system. This phenomenon is universal; it can occur in any region of the country and in any social group. The "**Driver-Car**" system is being transformed into a new *social entity*, just as the "**Horsemen**" entity was in the medieval period. For the social and consumer services of the group under consideration, a different approach and other requirements for the design of facilities and necessary premises for a new recreational and tourist cluster of the country are required [3,4].

The influx of tourists and population growth in large cities of Russia, such as Moscow, St. Petersburg, Nizhny Novgorod, Yekaterinburg, etc., intensify interregional contrasts and hinder the country's social and economic development. As a result, the vulnerability of the population increases in the form of "*normal accidents*[1]". The process of population growth leads to a significant increase in movements in places of population concentration with a high density of movements. The growth in the intensity of movements leads to the emergence of group and individual protests and the emergence of other social tensions. In cities where traditional vulner-

[1]Normal accidents // Kravchenko S.A. Dictionary of the latest sociological vocabulary: theories, concepts, personalities (with English equivalents). ... *Not a very "bright" future awaits us. There are no simple solutions to complex problems, just as, in principle, there are no "laws" that guarantee the universal prosperity of mankind, as the first sociologists believed. ... The quality of the future society is only in the hands of the people themselves, who ... can adequately reflect on new challenges in the form of normal accidents.* American sociologist Charles Perrow (born 1960) metaphorically called modern vulnerabilities "normal accidents" - accidents and disasters caused by its natural interaction with complex technical and technological systems that periodically give "normal" failures. "... Serious incidents are inevitable, even with the best management and full attention to safety ..." M.: MGIMO University, 2011.

abilities in the form of urgent problems have not been resolved, accidents, road accidents, terrorist attacks and disasters are increasing due to the natural interaction of a high social load on urban landscapes with the complex technical and technological systems of large cities, which periodically fail. As a result, the possibility of *normal accidents*, increased crime, poverty and population deviation are becoming more frequent[2].

Usually in large cities to organize traffic flows[3] movements are analyzed. This is necessary to design the capacity of public transport and the throughput of a communication route, and, in general, to improve the transport infrastructure and the efficiency of its functioning.

With optimal transport planning and improving the organization of traffic, the task of optimizing the route network of public urban transport and the task of planning and developing transport communications to ensure traffic safety are solved. Transport infrastructure to ensure life in cities and regions is one of the most important infrastructures. The potential for the extensive formation of transport networks in many large cities has been exhausted, or is close to being exhausted. Against the background of the growth of the automobile population, this leads to an increase in catastrophes and accidents on transport communications. Movements can be represented as the sum of transport routes. Movement refers to the movement of people from some point of departure to another point of arrival. Movement can be simple, complex, pedestrian, transport and constitute a chain of movement [5,6].

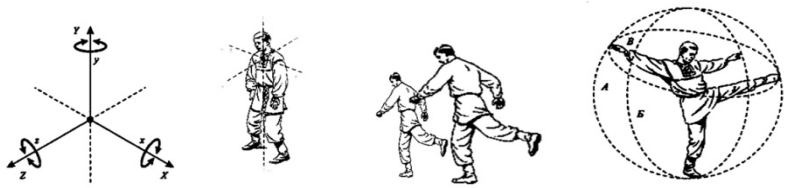


Fig. 1 Scheme and types of pedestrian movements

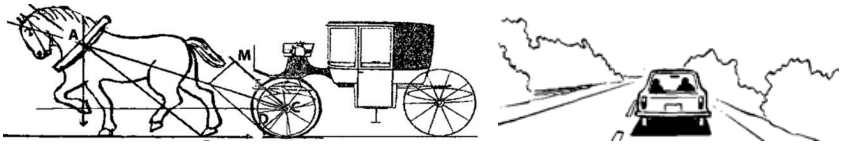
[2]Diagnostics of vulnerabilities in the form of "normal accidents" // Ch.Perrow: *The essence of the complexity of normal accidents is also that they can occur in the form of emergent events, or they may not occur at all. It is possible "in vain" to spend huge human and material resources on preventing or at least minimizing new vulnerabilities.* //see.: Perrow Ch. Normal Accidents: Living with High Risk Technologies. NewBrunswick, N. J.: Rutgers University Press, 1999, Law 2006.

[3]The theory of traffic flows is a science that analyzes the modes of movement of vehicles in various road conditions, taking into account their dynamic capabilities, the composition of the traffic flow and the psychophysiological characteristics of drivers The evolution of automated traffic control systems has led to the emergence of intelligent transport systems (ITS), covering all aspects of traffic flow.

In our case, we are more interested in pedestrian movements, the density of movements per unit of time (the number of movements per day per 100 m^2). This indicator is called the intensity of movements - this is one of the characteristics of the social activity of the population. The needs of the population of large cities and small rural settlements in movement are determined by the level of development of social production, the social structure of society, the prevailing way of life and the nature of settlement. Scheme and types of pedestrian movements, see fig. 1.

Movements are conditioned by material and intertwined with social and spiritual needs that depend on space and time. Movements characterize the mobility of the population, which significantly depends on mobility. Population mobility and transport behavior are changing social and economic relations. The main types of movement are walking, moving on animals, moving on mechanized means. For types of transport movements, see fig. 2.

Overloading transport communications in excess of the capacity lead to fatal consequences. The arisen traffic jams on the highway are subject to the phenomenon of hysteresis, when traffic exceeds the bandwidth of the band, the traffic enters an unstable operation zone [7,2].



1) **2)**

Fig. 2 Types of transport movements

1. Moving by carriage. 2. Moving by car.

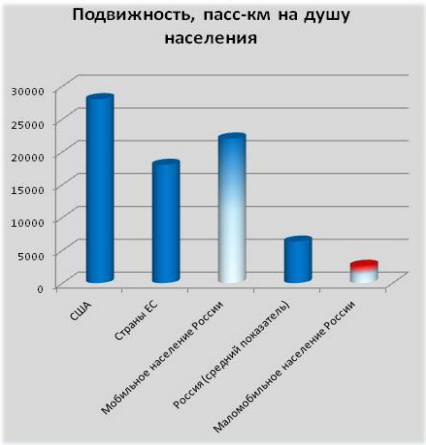
The federal target program "Development of domestic and inbound tourism in the Russian Federation" singles out rural tourism as a *new promising direction* of the recreational and tourist industry in Russia. The definition of agritourism as ...*one of the most important directions in solving the employment of the rural population and a promising direction in the development of...*[4] rural areas is given. A new promising direction for *settling* in suburban areas includes the territories of rural settlements and the territory of inter-settlement spaces.

Each form of movement in which society is involved requires special forms of architectural and planning organization of objects in the considered environment. Therefore, the optimization of rational decisions of the

[4]On the concept of sustainable development of rural areas of the Russian Federation for the period up to 2020.

architecture of objects of the suburban environment is based on the analysis of mobility and transport behavior of the population. The data of the analysis of transport behavior will allow accumulating empirical material and tracking the mobility of the population and its dynamics.

It is necessary to study the features of the architectural shaping of road service objects in modern economic conditions from the standpoint of business and recreational development, from the standpoint of an entrepreneur, organizer of objects and infrastructure in the roadside space. Key concepts and definitions of the study are the multifunctionality and complexity of roadside recreational facilities that meet the needs of travelers. Combining technical and recreational facilities in a roadside environment creates favorable conditions for their interaction in the creation of roadside clusters. This is the economic feasibility.



1) 2)

Fig. 3 Dynamics of population mobility in Russia

Source - Federal State Statistics Service

1. Dynamics of the population mobility in Russia.
2. Population mobility in some countries.

The analysis shows that the mobility of the Russian population is growing due to the growth of motorization of the population. The average per capita mobility of the Russian population remains extremely low - about 6,300 pass-km per year, which is more than 4 times less than the USA, Canada, Australia and about 3 times less than in the EU countries. The dynamics of the population mobility in Russia, see fig. 3.

The main objects of roadside service include: camping, motel, catering, recreation area, gas station, washing station, trade, service station. At recreation sites, according to the Federal Law, it is possible for travelers to take a short rest, eat, etc. This requires tables and benches, toilets, waste bins, and lighting of the entire territory provided at night [9].

In real design, many technical and public functions are combined in one or more closely spaced objects. These objects are called roadside recreational facilities, and given their versatility and complexity, they should be called roadside recreational complexes (RRC). The versatility of the architecture of RRC facilities, which include food, recreation, entertainment and medicine facilities, can solve the problem of forming the architecture of roadside recreational facilities.

Recreational development, as the development of the territory of roadside space through the design of recreational enterprises, is interested in the transition from the creation of single objects of roadside recreational complexes (RRC) to the formation of their connected aggregate in the form of clusters.

In the social economy, a cluster is understood as the temporary interaction of enterprises that are spatially subordinate and competing in the same market. This characterizes production, agro-industrial, service and other clusters. They steadily use the potential of the labor force resource and the region's space [6,7,8].

The difference between the RRC cluster in the recreational sphere and all kinds of other service clusters in its route territorial organization. The route and the corresponding flow of travelers - motorists and professionals, connects objects, transforming them from competing into interacting elements of the system. Thanks to the flow, an RRC cluster is being formed, the use of the labor force and space of the region is intensified.

Conclusions. The analysis of existing roadside recreational facilities and modern architectural projects showed that this direction of architecture is in a phase of sustainable development. Transferring the high density of movements from large cities to the countryside, to recreational and tourist facilities in the form of roadside clusters, will reduce vulnerability factors in the form of "normal accidents". This interpretation determines not only the ways of modern economic and social development of rural settlements and small towns, but also the methods of forming a modern recreational and tourist cluster in Russia.

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DEVELOPMENT OF ARCHITECTURAL MODELS OF SOCIAL TOURISM IN RUSSIA

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Abstract. This article analyzes new ways of developing objects of recreational architecture. The formation of these objects will positively affect the sustainable development of regions and become an important part of international economic relations. For the program for the development of tourism and recreational architecture, the Russian government in 2020 allocated 15 billion rubles. The creation of social tourism facilities is associated with an increase in the environmental and social pressure on the urban environment and with a decrease in the flow of outbound tourism from the pandemic and the closure of borders. The formation of the objects under consideration was caused by the high density of movements in large cities and the need to reduce and transfer this density to recreational and tourist facilities in the form of transit roadside architectural formations of a new type. This determines not only the ways of modern economic and social development of rural settlements and small towns, but also the methods of forming a modern recreational and tourist cluster of the country. The article is devoted to the formation of architectural models of social tourism in Russia, which have links with the recreational space, which is an open public space in the countryside. These sites are classified as ecological, rural or roadside tourism. The multifunctionality and complexity of the facilities enhances the synergistic effect of their joint work when creating recreational and tourist clusters.

Keywords: recreational and tourist clusters, roadside service facilities, travelers' rest, multifunctionality of facilities.

The recreational and tourism industry came under attack from the coronavirus infection in Russia and became a consequence of the return of citizens from foreign travel due to the spread of COVID-19. The government of the country has outlined grant support for the tourist industry and is launching a new national project - the NATIONAL UNION OF THE HOS-

PITALITY INDUSTRY (NUHI). These conditions require architects to address issues of the architectural organization of social tourism [1,2].

The recreational and tourist industry of the Russian Federation is developing based on geographic, economic, demographic and social conditions for the development of society. Socially-oriented policy of the Russian government focused on the emergence of new forms and motivations of recreational and tourist services among residents of large cities.

The practice and experience of international tourism has shown its significant impact on the socio-economic development of the state, and this influence increases with the development of the globalization of the world economy, as an integral part of international trade and international economic and cultural relations. However, with a steady increase in the number of tourists in all countries, the share of the recreational and tourism industry in the country's economy remains 1-2.5%. This is due to objective and subjective factors.

Large cities of Russia (Moscow, St. Petersburg, Nizhny Novgorod, etc.) concentrate large recreational resources of the architectural, cultural-historical, archaeological and engineering-technical direction. Developed infrastructure, transport accessibility of unique objects and attractive places attract large flows of tourists to the cities. However, this creates negative factors in cities that negatively affect cultural and social life. Criminal tension is increasing, the number of road accidents is increasing, the technogenic load on natural landscape complexes is increasing, and the ecological situation is deteriorating. The population of the city in peak periods increases 2-3 times, this leads to accidents in complex social and infrastructure systems.

The price of staying and resting in large cities is much higher than resting in the countryside or small villages. The suburban environment has a lower population density and lower recreational loads on natural landscape complexes. Therefore, the search for the architectural organization of socially oriented tourism must be formed in the suburban areas or countryside. It is no coincidence that in many countries, recreation in the suburban environment or in roadside spaces is gaining popularity [3,7].

Several models of the architectural organization of socially oriented tourism are proposed for use in modern practice in Russia in the countryside:

1- Rural tourism,

2 - Ecological tourism,

3 - Autotourism, or tourism in a roadside environment,

4 - Cultural and educational tourism.

1. Rural tourism [1]. This direction in the organization of recreational and tourist business can be considered not only as a holiday in the countryside, but also participation in the harvest, caring for animals and other participation in traditional labor in rural areas. This destination in the tourism industry will help many tourists to become more closely acquainted with local cultural and national customs. A person who is tired of the hustle and bustle of the city begins to lead a measured rural life. For a new way of life, the recreant is ready to financially and physically support the economy of the region while staying in this environment. This direction in tourism is well developed in countries such as Spain, Italy and France [2].

Experts consider agricultural tourism in the sphere of business in a broader aspect, which is understood as a sector of economic activity, where the main means of production are territorial natural landscape complexes. Other spheres of the region's economy should adjust to this type of recreation and provide favorable conditions for the inflow of additional funds into the regional economy. One of the first argotouristic farms in Russia was organized by an Italian in 1999, which is successfully operating in our time near the village of Mednoe, Tver Oblast.

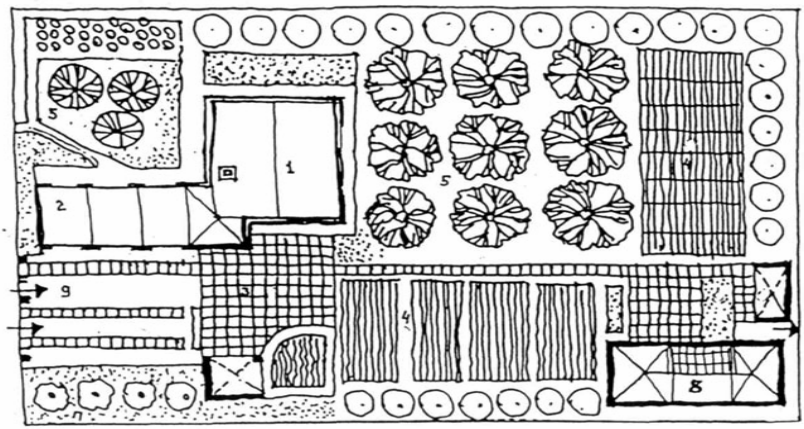

Fig. 1 Architectural organization of the farmstead plan:
1-owner's house; 2-block for accommodation of tourists; 3-recreation area; 4-zone of the vegetable garden; 5-garden area; 6-zone of the utility yard; 7-lawn; 8-hotbed and greenhouse; 9-entrance zone.

[1]Rural tourism or agritourism is a sector of the recreational and tourism industry focused on the use of natural, cultural, historical and other resources of rural areas and its features to create an integrated tourism product. Rural tourism is a type of tourism that involves the temporary accommodation of tourists in rural areas for the purpose of recreation and participation in agricultural work without the tourist deriving material benefits.

Peasant farms are the main accommodation facilities in argotourism farms. This is a single family house in a rural environment that includes accommodation for family members and visiting tourists. The peasant estate has farm buildings for keeping livestock, sheds for storing agricultural implements, a greenhouse or hotbeds. In the adjoining space there is a garden, a vegetable garden with beds and flower beds, the territory is fenced. Peasant farmstead is a place of residence and a place for rest of agrotourists (fig. 1).

A modern tourism business in a rural environment provides not only traditional houses, but also modern facilities implemented to accommodate tourists. For example, several types of agricultural estates have been created in Belarus. The main criterion for the classification of an agricultural estate will be comfort. Vacationers choose an agriturismo according to their personal preferences. A traditional country manor or residential complex with many amenities, sports and leisure facilities.

In agro-estates, tourists lead a rural lifestyle. They go hiking and horseback riding, communicate with the local population, get acquainted with folk customs and nature here. Traditional types of recreation at the farm are combined with agricultural work on a common basis with local residents, where tourists can also be engaged in rural work.

Agriturismo is a new type of business for the rural environment, this type of small business is based on a family business with the involvement of specialists in certain types of recreational activities.

2. Ecological tourism[2]. Ecotourism aims to promote and create harmony between ecology and tourism. Travel agencies have always been interested in preserving natural and landscape objects and in reviving the economy of the territories of the regions that receive tourist flows. For the formation of environmental education among tourists and the local population, it is necessary to conduct intensive tours or trips organized by travel companies to enhance the motivation of employees who are mainly engaged in promoting the ideas of ecotourism and tourism products of this company [8,9].

Carrying out activities to transform the recreational and tourist space occurs with the emergence of new types of recreational activities. Ecological tourism also includes the rehabilitation of natural landscapes to improve the ecology of the tourist region, which is an important lever for the devel-

[2]Ecological tourism is a direction of tourism that involves visiting territories not affected by anthropogenic impact. The purpose of the trips is to get information about the nature of the visited region, acquaintance with culture, ethnography, archaeological and historical sights. Ecological tourism is an activity for organizing travel, including all forms of nature tourism, in which the main motivation of tourists is observation and introduction to nature while striving to preserve it (GOST R 56642-2015 "Tourist services. Ecological tourism. General requirements"

opment of ecological activities. Environmental activities should always be aimed at supporting the economy, culture, education and medicine in the region. The main task of ecotourism is to preserve the unique landscapes in their original form and educate people to respect nature. Ecological tourism is aimed at visiting sites that help preserve the biocenosis, at contemplating the beauties of nature, at maintaining the cultural heritage of the regions and regions visited [11].

Create well-equipped and specially protected ecotourism routes for the purpose of environmental education of the population by establishing tourist navigation signs and information stands along the route (GOST R 56642-2015 "Tourist services. Ecological tourism. General requirements"). Eco-tourism plays an important role in the environmental education system, in the promotion of fair and sustainable tourism with the appropriate support of the International Social Tourism Organization (ISTO)

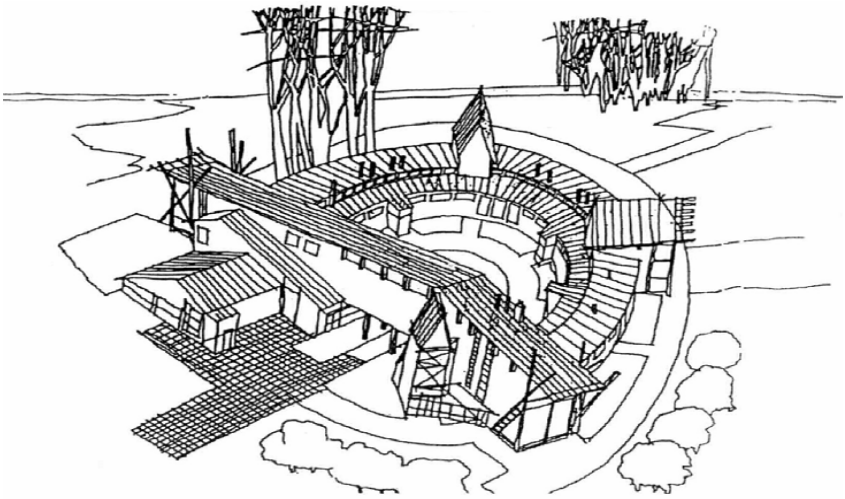

Fig. 2 Architectural organization of the multifunctional ecotourism complex:
1 - entrance area, car parks; 2 - block for accommodation of ecotourists; 3 - eco-restaurant; 4 - lecture hall; 5 - gym.

The main objects of accommodation and activities for ecological tourism: multifunctional complexes made of ecological local renewable materials (wood, reeds, straw, algae, etc.); temporary quickly erected buildings based on pneumo-frame structures; seasonal buildings for summer ac-

commodation for ecotourists; traditional residential buildings with a garden, vegetable garden, household and household buildings, with the required engineering equipment to accommodate ecotourists (fig. 2,3).

Multifunctional ecological tourism complexes should have an entrance area with eco-parking for cars, a living area with rooms for ecotourists. The complex includes catering facilities, a lecture hall, a gym and other public premises (fig. 2,3).

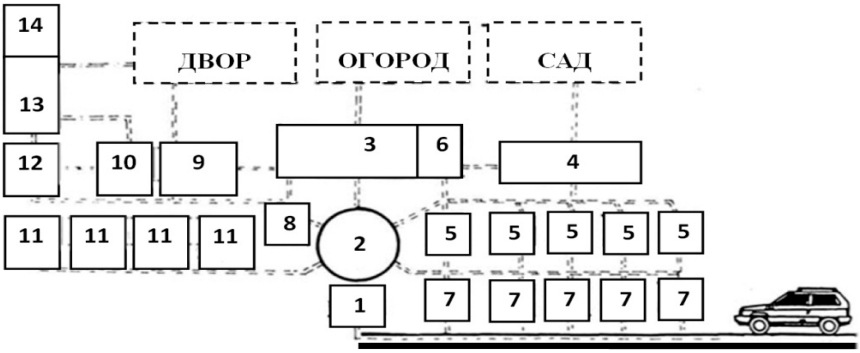

Fig. 3 Model of the architectural organization of social tourism in the roadside environment

1 - entrance hall; 2 - front-reception; 3 - dining room; 4 - veranda;
5 - bedroom for recreants; 6 - office; 7 - garage or car parking;
8 - pantry; 9 - kitchen; 10 - households block;
11 - rooms of the owner's family;
12 - boiler room; 13 - household premises; 14 - outbuildings

Ecotourism began to develop in Russia later than in Europe and the United States. The main reasons are the lack of communication facilities and highways in the peripheral regions of Russia. However, Russia is a very promising country for this tourism and recreation. The creation of models for the organization of social ecological tourism based on the principles of social justice and sustainable development of our country has a huge potential in remote regions of the Russian Federation [1].

The development of ecotourism is aimed at the integrated development of domestic and inbound tourism in the Russian Federation by creating conditions for the formation and promotion of a high-quality competitive tourist product in the domestic and international tourist markets, strengthening the social role of tourism and ensuring the availability of tourist services, recreation and recovery for citizens.

Tourism is one of the industries with the greatest multiplier effects for the economy. Investment in tourism industries creates added value in transport, trade and services, construction and production of building materials and other types of economic activity. An important socio-economic effect of tourism development for the population participating in the formation and provision of services is the growth of employment and income of the population, the formation of an entrepreneurial culture.

Federal executive bodies should be guided by the provisions of the Strategy when developing state programs of the Russian Federation and other program documents. Approved by the order of the Government of the Russian Federation dated September 20, 2019 № 2129-r "Strategy for the development of tourism in the Russian Federation for the period up to 2035".

3. Car tourism, or tourism in a roadside environment. The most popular in the Russian Federation is automobile tourism, which is socially oriented and conducive to sustainable development of regions in our country. Roads and roadside space are becoming the main means of production for motorists. This dictates new approaches to creating an artificial environment in a roadside space and its relationship with the natural environment.

The need for the construction of roadside recreational complexes has become apparent in recent years due to the increase in population mobility, the expansion of road construction, and a change in the sector of population needs (fig. 4).

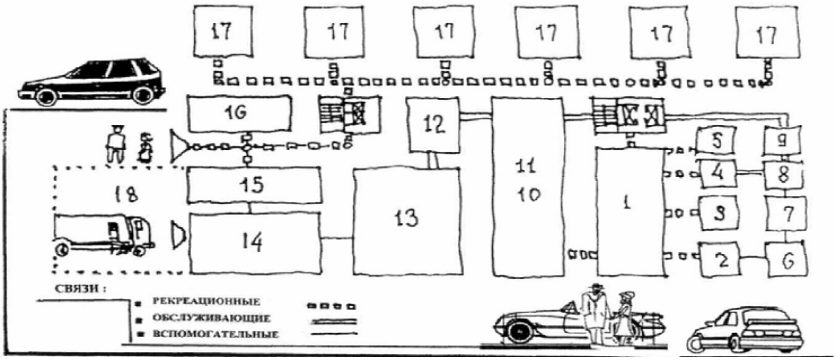

Fig. 4 Model of the architectural organization of the ecological complex of social tourism

1- lobby*; 2*- administrator*; 3*- hairdresser*; 4*- wardrobe*; 5*- bathrooms*; 6*-direction*;7* - accounting*; 8* - storage chamber*; 9* - common room*; 10* - restaurant*; 11*- buffet*; 12* - handout*; 13*-production room*; 14*- warehouses*; 15*- repair shops*; 16* - staff room*; 17* - rooms*; 18* - utility yard.

Autotourism is a type of travel in which the main means of travel of a tourist is a personal car (GOST R 57806-2017 "Tourist services in the field of amateur tourism. General requirements");

Autotourism is the most socially oriented in Russia, which requires architects to search for new models of the architectural organization of tourism on the roads. The development of socially oriented tourism in Russia will be helped by the cluster organization of tourist complexes. Clusters play a decisive role in the formation of tourist centers and in attracting visitors to them, increasing their competitiveness. The successful development and organization of regional clusters occurs when the management strategy is implemented [4,5,6].

The development of tourism in the suburban environment becomes the most relevant during the period of overcoming the crisis caused by the COVID-19 pandemic, the closure of interstate borders and the observance of post-quarantine measures, when the need for social and sustainable domestic tourism increases sharply. When forming clusters for car tourists in roadside spaces, the service of rural residents and tourists of various types of rural and ecological tourism is being improved. There is competition between clusters for attracting services, capital, investment and population, which can be defined as "*competition between regions*". The struggle for the consumer of tourist services takes place through creating the required level of comfort. These factors become the basis for the sustainable development of the region. Recreational clusters can achieve long-term competitive success through sustainable economic development. The recreational region becomes competitive in which the well-being of the population increases and the dynamics of growth of the local population takes place [14,15].

The lack of a regulatory framework and tools for finding optimal architectural and construction solutions for roadside clusters reduces the effectiveness of the system of roadside facilities and recreational and tourist services in the region as a whole [11].

Bus stations and air terminals, railway stations, passenger stopping points and platforms, sea and river stations, piers and wharves, checkpoints on the state border of the Russian Federation become points of entry for tourist flows of auto tourism.

4. Cultural and educational tourism. Special tools for the development of the social model of cultural and educational tourism in the rural environment are:

1) architectural formation of objects of tourist display in a rural environment, including with the use of modern technologies;

2) development of programs of objects of tourist display, focused on innovative methods of working with visitors, as well as the promotion of tourist services;

3) improvement of programs for the training of tour guides and guide-translators;

4) development of national and regional information resources and digital services for cultural and educational tourism in the rural environment;

5) development of a system for the sale of electronic tickets for visiting objects of display of cultural and educational tourism in a rural environment, including single tickets for visiting several objects, tourist cards in rural areas of the constituent entities of the Russian Federation.

Conclusions. The cumulative impact of all types of architectural models of social tourism in Russia on the environment and individual components of the natural environment within recreational areas should not increase the environmental load.

The proposed models of the architectural organization of socially oriented tourism for use in the suburban environment of the Russian Federation: rural tourism, ecological tourism, auto tourism, or tourism in the roadside environment, cultural and educational tourism will help to distribute tourist flows and create favorable conditions for the development of rural, suburban and roadside environment in Russia.

An important social consequence of the development of tourism for the local population is of the greatest importance to health improvement, an increase in life expectancy, strengthening of the institution of the family, intellectual, spiritual, creative development, patriotic education, social adaptation and the formation of respect for the cultural and religious diversity of the Russian Federation.

The economic significance of socially oriented tourism for use in the rural environment - accelerating the economic growth of the Russian Federation, providing employment for the population.

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APPRAISAL OF AIR POLLUTION BY INDUSTRIAL UNDERTAKING

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Annotation. The problem of ecology in the Kemerovo is more important through the industrial focus of the region. Consequently, there is a need to search and analyse information affecting this area. This work is an example of processing information related to air pollution by harmful substances in the city of Kemerovo using geoinformation systems. The result of the work is the areas of the map where the industrial air pollution exceeds the maximum norm.

Keywords: ecology, pollution, geoinformation systems, emissions, QGIS, harmful substances.

Introduction

Industry in the modern Russian Federation accounts for GDP equal to 32.4 %. The forecasts of the Ministry of Economic Development and Trade are showing that industrial production will continue to grow in 2021 by 2.6%, in 2022 by 3.6%, after the decrease in industrial production in 2020 against the background of the epidemic by 4.1 %. The development of industry without an effective policy of greening the industry allows for a constant increase in the level of emissions of harmful substances into the atmosphere.

Based on the report of "FinExpertiza", an association of independent professional audit, evaluation and consulting firms, Kuzbass took the second place in the environmental rating of 2019. According to the organization, the mass of emissions of harmful substances in the Kemerovo region equalled 1.8 million tons, which is the second indicator in Russia, losing the first place in the Krasnoyarsk Territory (2.6 million tons). Of the 1.8 mil-

lion tons, only 70 thousand tons fell on transport, the rest — on industrial projects [2].

According to the report "On the state and environmental protection of the Kemerovo region" of the Department of Natural Resources of the Kemerovo region, the concentration of some harmful substances in the air of the largest cities of the Kemerovo region, seriously is over the norm. So, in February 2019, in the Central district of Novokuznetsk, the concentration of benzapilene exceeded the allowable value by 36 times. In the Kirovsky district of Kemerovo, this indicator exceeded the norm by 14.6 times [3].

Goal setting

Using the tools of geoinformation systems, it is necessary to make a map of the air pollution of the city of Kemerovo, adding several objects and the area of effect of harmful pollutants. Based on this data, you need to evaluate:

- Area of total pollution
- Areas of pollution by individual substance
- Areas with the highest values of pollution by a combination of substances

Solution

The basis was taken a map layer from the OSM (OpenStreetMap) of the Kemerovo with three located objects that emit harmful substances into the atmosphere. In this case are AZOT, TOKEM, ZTM.

3 substances were selected as polluters (Table 1). These polluters are distributed by each object, where MPC - is maximum permissible concentration of a specified substance. It should not affect living organisms for 20-30 minutes.

Table 1- Polluters

Substance	MPC mg / m^3
Carbon oxide (CO)	5
Ammonia (NH3)	0,2
Sulphur dioxide (SO_2)	0,5

A grid was constructed for each object, where emission value specific to that area is recorded, and then vector layers with grids were combined by means of the built-in tools for working with QGIS 3.16.

To get the result displayed by emissions from the three objects for one substance in each grid cell, in the DBMS PostgreSQL, the following formula was used:

$$Result = \frac{\sum_{i=1}^{n} Ci}{MPCi} * 100$$

Where, Ci is the pollution coefficient from object i. So we move to a single scale that shows the actual pollution situation as a percentage.

For the conversion of the finished database table with the calculated values of the pollution level, from the vector format to the raster layer, was using the function of constructing centroids. To make the resulting centroids a layer that displays isolines (See fig.1.), the QGIS – Contour Plugin was used, which creates a contour layer based on the attribute of the point layer, visualizing, based on graded display tools using a color scale. The module is written in Python and uses the numpy and matplotlib libraries.

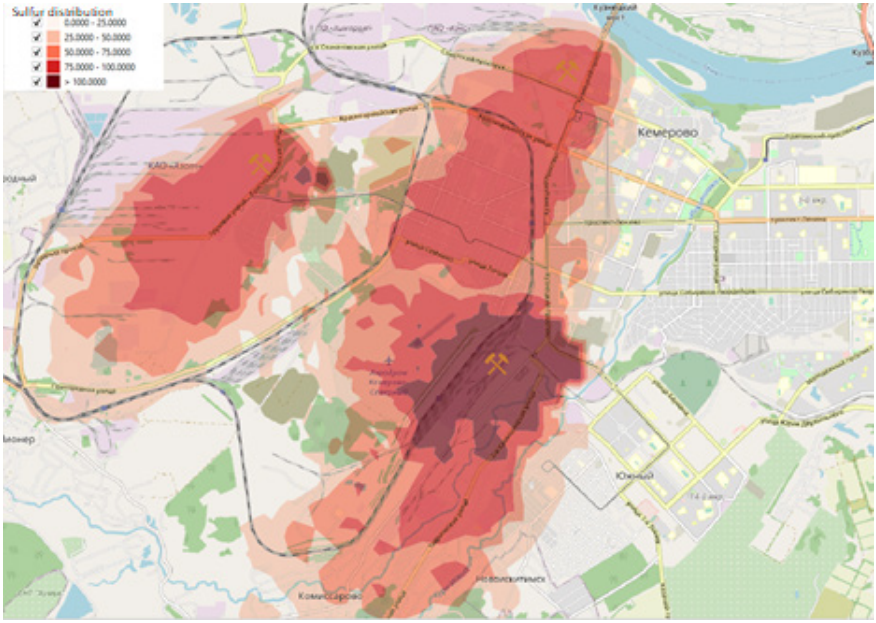

Figure 1. Mapping of the isoline layer of the sulfur dioxide distribution

As can be seen from Figure 1, the scale of pollution with one substance from three objects is also displayed for allowable values that do not carry useful information. To show the areas where it is most dangerous to be located, based on randomly selected pollution values around objects, parts

of the layer with a percentage value less than 100 were discarded. So, the current layer shows the most dangerous area for a person, because the concentration of the substance exceeded the maximum permissible concentration limit (MPC). Each factory produces 3 substances, which is why it is necessary to make similar layers for carbon monoxide (CO) and ammonia (NH3) and apply layers using QGIS, based on the darkest areas. The result of overlapping layers with the exception of allowed values for human pollution can be seen in Figure 2.

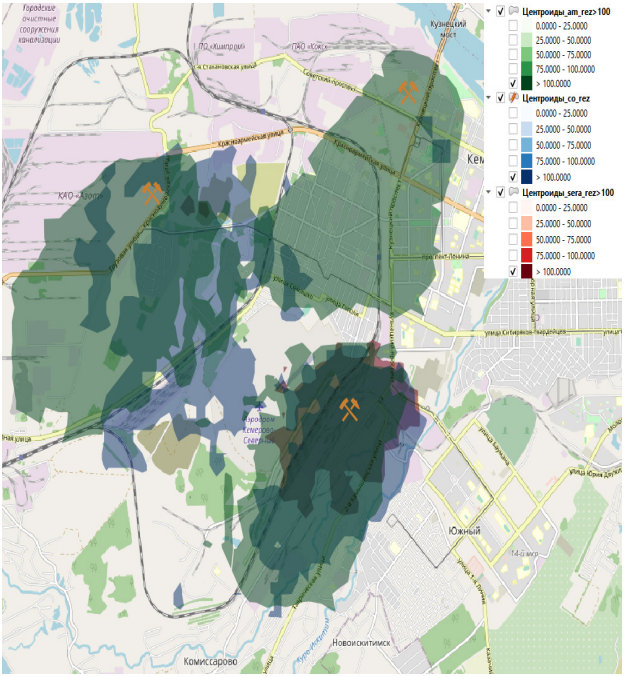

Figure 2. Combined map distribution of substances with unacceptable MPC

Conclusion

As a result of the performed work, the areas of pollution were found where the sum of emissions of three objects seriously exceeds the permissible consumption rate.

Thus, the resulting pollution map can be used for further analysis. For example, to become the basis for study the level of emissions from factory indicated on the map or assessing the areas most unfavorable for life, based on the environmental situation.

In the frame of our project, the square of pollution of the area where three substances exceed the MPC norms, based on the received map, was ~ 3103872 m2. The area where the most unfavorable ecological situation is between the Kemerovo-Severny airfield and the Yuzhny district.

Based on the obtained results, which can be used for different analytics, it can be concluded that GIS systems are a very powerful set of tools suitable for carrying out different types of research.

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ECONOMIC SECURITY OF THE BORDER REGION: FORECASTING AND STRATEGIZING

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Abstract. The article deals with theoretical and practical issues of assessing future changes in the level of economic security of the border region. The requirements for regional models are analyzed for modeling and assessing changes in the level of economic security. Based on the results, the application of situational forecasting and strategizing based on prototypes of CGE models is substantiated. On the example of the Russian exclave (Kaliningrad Oblast), the possibilities of modeling economic security are shown. Based on the results of calculations, as well as taking into account the previously conducted studies of the border regions of the Western border of Russia, systemic constraints in ensuring economic security are revealed. On this basis, the use of a new concept in the theory of economic security of regions - convergent economic security is substantiated in relation to border regions.

Keywords: economic security, modeling, border regions, situational forecasting, strategizing.

Introduction

In the process of studying the dynamics of economic security on the example of the regions of the Western border of Russia in the interval 2000–2018 [3, 6, 7] we established the following relationship. The progressive socio-economic development of the region is not always and not necessarily accompanied by positive shifts in economic security, but the opposite is true - an increase in the level of economic security leads to an improvement in the socio-economic situation. In this regard, in assessing future changes in the level of economic security, the tasks of its modeling are actualized. At the same time, there is a need to assess the attainability of targets for both the socio-economic development of the region and the level of economic security. Therefore, when choosing predictive regional

models, we are talking about the functional capabilities of developing forecasts not only in the class of standard problems "what will happen if ...?", Reflecting situational forecasting, but also on the terms "what is needed to ...?" Associated with strategizing. Therefore, this article discusses the results of using situational forecasting and strategizing technology based on CGE models to assess future changes in the level of economic security of the border region. The features of the economic security of border regions are considered, and modeling capabilities are shown on the example of the exclave Kaliningrad Oblast (Russia) From a scientific point of view, "... an exclave region is a unique object of regional science, since it is much closer to the idealized concept of a region used in regional science" [1]. There are not so many similar types of regions in the world [2], which puts them in the category of phenomena, but also requires closer attention and a unique approach to studying and considering the object of research - economic security. Based on the results of the calculations, the author proves the need to introduce and apply the concept of convergent economic security in relation to border regions.

Features of modeling economic security: methods and data

The advantages and disadvantages of various tools and technologies for regional forecasting and modeling were considered in the author's earlier works [1]. Studying the specifics of economic security on the example of the border regions of Russia, in particular the Western border of Russia [3, 6, 7], Studying the specifics of economic security on the example of the border regions of Russia, in particular the Western border of Russia

1. Opportunities for strategic goal-setting: defining goals and objectives of regional development, forming a list of main development indicators, specifying the target state of the region in the form of a target plan.

2. Implementation of situational forecasting and the formation of development scenarios for the medium and long-term (up to 20 years) perspective, the choice of a scenario of development leading to the best, in the sense of a given criterion, approach to the target state.

3. A high degree of detailing of forecasts by the number of output indicators - balanced medium-term and long-term multivariate forecasts for thematic areas of socio-economic development of the region (macroeconomic indicators; indicators of investment activity, innovation and technological progress; demographic indicators; indicators of the population's standard of living; main social indicators; labor market indicators; main financial indicators; consumer market indicators; indicators of foreign trade activities of the region, etc.).

4. Taking into account in the model of dividing the regional economy into aggregates of economic agents within the boundaries of sections and subsections of OKVED, which allows you to track sectoral strategies, consider sectoral indicators and link them with types of economic security, assess the formation of added value in the section (subsection) of the regional economy and its distribution by directions of use.

5. Balancing macroeconomic and sectoral forecasts, where the problem of ensuring equilibrium in the markets for goods and services (intermediate, investment, consumer, government, labor, etc.) is being solved. Possibilities of forming balances according to known accounting forms: investment, consolidated financial, labor resources, cash income and expenses of the population.

The prototype of such regional models is usually Computable general equilibrium models (CGE-models). With regard to the regions of Russia, the construction of such models, the development of a methodology for situational forecasting and strategizing is carried out under the scientific supervision of dr. of econ. sci., prof. V.A. Tsybatov [4, 5]. In Kaliningrad Oblast, with his participation, a software-analytical complex for situational forecasting and strategizing of socio-economic development was developed[1]. Accordingly, with its use, calculations were carried out for the period up to 2035 for the Kaliningrad Oblast and further the possibilities of modeling economic security will be shown. The main advantage of the software-analytical complex as a prototype of the CGE-model against the well-known regional models should include obtaining: 1) fully balanced mid-term and long-term multivariate forecasts for all thematic areas of the socio-economic development of the region (more than 1000 indicators); 2) an assessment of the degree of attainability of the stated goals of the socio-economic development of the region (more than 100 targets); 3) an ordered set of the best (according to the selected criterion) scenarios of regional development. The information base of the initial data is formed from the information available in open sources, published by the regional statistics bodies. As a result, the conditions for the socio-economic development of the region can be simulated to ensure economic security. That is, a new scientific problem is being solved - under what conditions the region can improve its position and move to the zones of least risk in terms of economic security. The attainability of the set goal is checked, as well as the compliance with it of the existing potential of the region.

[1]Certificate of state registration of the Computer Program № 2016617454 dated July 06, 2016, issued by the Federal Service for Intellectual Property (authors - K.Yu. Voloshenko, V.A.Tsybatov, L.P. Pavlov)

Modeling changes in economic security for the Russian exclave

On the example of the Kaliningrad Oblast, the assessment of changes in the level of economic security is considered in the framework of two scenarios:

1. the main scenario corresponding to the most probable conditions for the development of the region in the medium and long term (the impact of the COVID-2019 pandemic, geopolitical tensions, low investment activity, preservation of the structure of the economy by sectors, industries and manufacture);

2. controlled scenario, which characterizes the accelerated socio-economic development of the region to achieve the threshold level of economic security, where the potential and resources of the region act as a limitation.

For the calculations, target scenarios were developed for the baseline 2018, which is due to the lack of some statistical data for a later period. The information base was formed in the interval 2013–2018. Due to the lack of some information in the information base (the level of completeness was only 84.5%), software verification, addition and balancing of data were carried out using special procedures and technology of the software-analytical complex.

According to the results of the calculations, it was established that the target indicators of the socio-economic development of the region were not achieved - the values of the plan fulfillment according to the scenarios, respectively, amounted to 92.95 and 84.5% (fig. 1). The indicators for health care expenditures are half fulfilled, the target value of the rate of capital accumulation is not achieved, the situation is unsatisfactory in the share of own income, the growth of real per capita disposable money income of the population is provided less than the target level, but at the same time the replacement rate for pension income is higher than the planned one. In general, the level of achievement of target indicators indicates a difficult investment situation in the region, continued dependence on federal funding, low income security of the population.

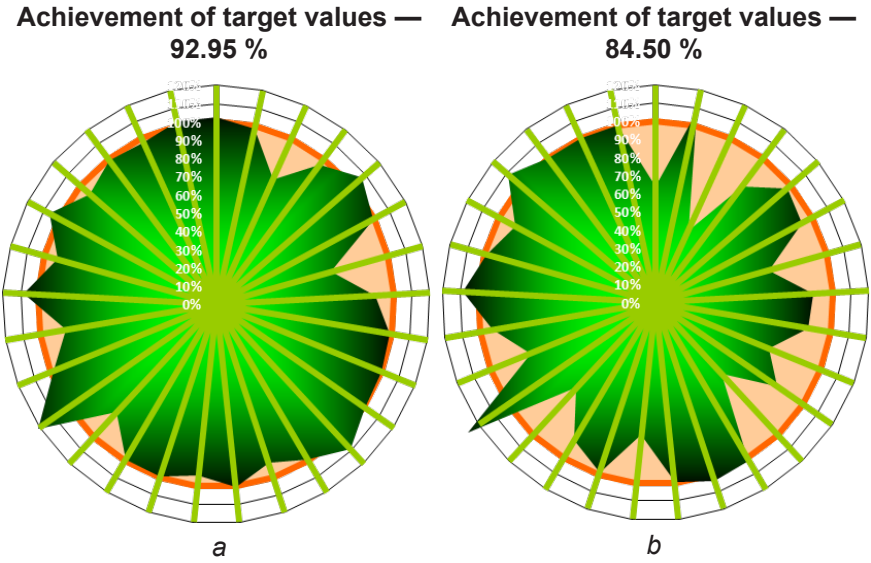

Fig. 1. Strategic diagram, 2035:
a — main scenario; b — controlled scenario
Source: Author's calculations.

In the interval 2018–2035, the cumulative growth rate of the gross regional product under the main scenario will be 151.8% against 185.9% under the controlled scenario. The indicated dynamics is supported by the growth of labor productivity. By types of products, the output will be dominated by intermediate (44%) and consumer (28%) goods and services. The share of investment goods and services will be 6%, infrastructure and government services, respectively, 15 and 7%. The structure of investments in fixed assets according to the scenarios has a similar dynamics - the amount of own funds is significant, the share of the federal budget is decreasing, among other investments, the volume of funds of organizations and the population attracted for shared construction will continue to grow. According to the main scenario, the recovery growth of investments prevails, the controlled one - the recovery growth after 2030 is replaced by the investment one. The investment type of reproduction is the nature for manufacturing industries (first of all, the production of machinery and equipment, food and chemical industries, the production of vehicles, etc.), agriculture, trade, transport. At the same time, according to the main scenario, the existing rate of accumulation of fixed capital will be sufficient

only to compensate for the disposal of fixed capital, as evidenced by a decrease in the degree of depreciation of fixed assets by the end of the horizon. Production capacity will also grow according to a controlled scenario. The change in the types of capital reproduction is traced at the level of dynamics of the rate of accumulation and depreciation of fixed assets according to the scenarios. Thus, there is a significant reduction in the depreciation of fixed assets (up to 15-20%), which indicates an active growth of new production capacities in the region. This situation is possible only in the context of the development of new high-tech and science-intensive industries in the region.

Based on the results of forecasting the socio-economic development of Kaliningrad Oblast according to two scenarios, the integral sub-indices of economic security were calculated using the author's methodology [3, 7]. It involves finding an integral weighted estimate for groups of general, particular and special indicators. *General* ones include security indicators that are common for all regions, *particular* - indicators that take into account the impact on security of the borderline factor, *special* - certain types of economic security (demographic, food, financial, environmental, etc.).

According to the main scenario, the region is in the *zone of moderate risk*, according to the controlled scenario, it is approaching the border of the *zone of stability* (fig. 2).

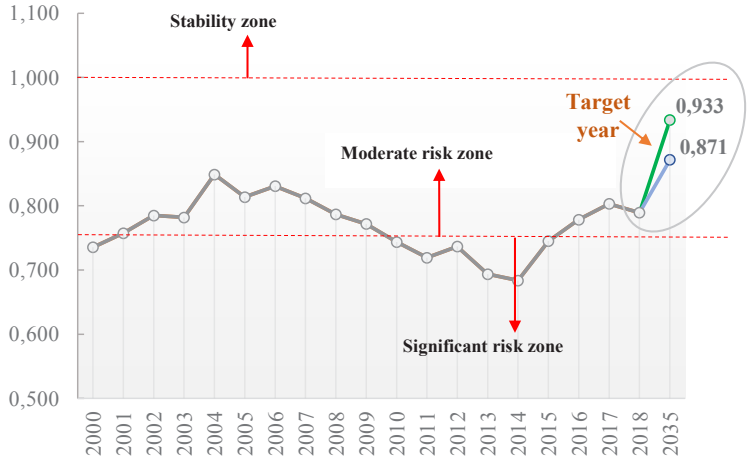

Fig. 2. Dynamics of the integral index of economic security

However, it is unlikely to enter the zone of stability, since there are a number of systemic restrictions that significantly worsen the position of the region in terms of individual indicators in the sub-indices of economic security. Firstly, these are limitations of the economic and demographic type, common to all regions of Russia, associated with low natural population growth and low life expectancy at birth. Secondly, the high dependence of regional production and consumption on external supplies of products. Regional economic growth inevitably in exclave conditions with low own production potential and resource supply leads to an increase in the volume of imports or imports of products from the regions of Russia. The dynamics and volumes of imports are influenced in general by the change in the geopolitical situation and the current EU and US sanctions, as well as the response measures of the Russian Federation. The volumes of import of products to the Kaliningrad Oblast depend on the policy of neighboring countries (Lithuania and Belarus) in terms of the transit of goods, as well as the organization of transport and logistics infrastructure, the capabilities of which are also limited today. Thirdly, it is the complexity of the innovative, scientific and technological support of regional growth.

Conclusions

The systemic constraints in the development of the Russian exclave revealed in the course of the modeling persist over the entire forecast horizon (2020–2035). They determine the boundaries of economic security, which are lower than the average for the regions of Russia. And it follows that the stability of the regional system, as well as its balance, remain until deviations from the threshold values can be compensated for by internal potential and resources. The presence of systemic restrictions was established for other border regions of the Western border of Russia [7]. The forecast calculations carried out on the example of the Kaliningrad Oblast, as well as the assessment of the dynamics of the economic security of the regions of the Western borderlands, allows us to formulate an important position: for the border regions, a situation is found when the threshold level of indicators of economic security is under no circumstances reached, which is a consequence of the action of systemic restrictions in the development of the territory. It follows from this that in the theory of economic security for border regions or territories in conditions similar to them, a new concept arises - *convergent economic securit*y. This means that the territory is approaching the level of economic security corresponding to the minimum border of the risk of causing damage to the regional system through the use of internal potential and resources. In general, it reflects

the dependence of sustainability in terms of resource reproduction and economic security in ensuring development, which is specific for the border type of the region. What are the boundaries of economic security and risk for maintaining sustainability, as well as the consequences and possible damage to the regional system - these are questions that represent a new non-trivial scientific task that requires further study.

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BIOMORPHOLOGICAL FEATURES AND PRODUCTIVITY OF *AMARANTHUS PANICULATUS* IN THE NORTH-WEST OF THE RUSSIAN FEDERATION

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Abstract. Amaranthus paniculatus from the Amaranthaceae family is distributed in all zones, but mainly in the tropics and subtropics of America and Africa. Amaranth species are grown all over the world as cereals for flour and oil, as fodder, vegetable and ornamental plants. Some species of amaranth (Amaranthus caudatus) have medicinal properties and are used in scientific folk medicine, as well as in traditional oriental medicine.

The article presents the results of studying Amaranthus paniculatus in the natural and climatic conditions of the North-West of the Russian Federation (for example, the Leningrad Oblast). The dynamics of phenological phases, the total duration of the growing season, the duration of interphase periods, the structure of the yield and the level of productivity are shown.

In conclusion, amaranth varieties Voronezh and Crimson are recommended for cultivation in the North-West of the Russian Federation. Sowing must be carried out in the third decade of May. Harvesting for forage purposes begins 50-64 days after germination. Harvesting for seeds can be done in 90-92 days. In order to avoid large losses of seeds, it is better to harvest in a separate way. The yield of the recommended varieties is 2.6-3.6 t/ha.

Keywords: amaranth, variety, phases of development, seeds, cultivation, yield.

The amaranth family - *Amaranthaceae* includes about 65 genera and up to 900 species, common in all zones, but mainly in the tropics and subtropics of America and Africa. The genus amaranth - *Amaranthus* has 60 species, of which 21 species are found in Russia [1]. Many species of this genus have become hard-core cosmopolitan weeds. Amaranth is the oldest crop cultivated in South America even before its discovery. Currently,

amaranth species are grown in Southeast Asia, Africa and other regions as grain crops for flour and oil, as fodder crops, vegetables and ornamental crops. Some amaranth species (*Amaranthus caudatus*) have medicinal properties, their seeds and leaves are used in traditional oriental medicine and are approved for use in the UK [2]. It is known that amaranth is a high-protein, very productive crop with a high content of essential amino acids in seeds and leaves. Amaranth oil contains a lot of squalene, tocopherol and other biologically active substances, it is widely used in dietary nutrition and cosmetology, and is also used in the production of functional food products [3].

Work on a comprehensive study of amaranth in different soil and climatic zones of Russia has been going on for several decades, domestic varieties have been bred. Earlier it was found that paniculate amaranth has a high ecological plasticity and adaptive potential, which makes it possible to cultivate it in the North-West of the Russian Federation [4]. Due to the relevance of the issue, we studied the dynamics of growth and development of three *Amaranthus paniculatus* varieties in the North-West of the Russian Federation and determined their productivity.

Amaranthus paniculatus L. (=*Amaranthus cruentus* L., *A. hybridus* L. subsp. *cruentus* (L.) Thell., *A.hybridus* subsp. *paniculatus* (L.) Hejny,) [1] – an annual herb. The object of our study was the varieties of amaranth paniculata - Crimson, Voronezh and Lipetsk. The experiments were carried out in the nursery of medicinal and essential oil plants of the St. Petersburg State Agrarian University in 2019-2020. The soil of the site is sod-podzolic medium loamy, highly cultivated. Soil cultivation included autumn plowing with fertilization at the rate of P_{80} K_{130}; in the spring, cultivation was carried out and nitrogen fertilizers were applied at the rate of 150 kg/ha of active ingredient. The seeds were sown in the third decade of May, when the soil warmed up to 10-12°C, the experiment was repeated 3 times, the seeding depth was 1.5 cm, the seeding rate was 0.5-0.8 g/m^2. The distance between the rows is 45 cm, between the plants 30 cm. The care of the plants consisted in weeding and loosening. The following phenological phases were distinguished: shoots, vegetative phase (cotyledon leaves, true leaves, stem growth and branching), flowering, ripening of fruits and seeds.

Shoots of amaranth appeared in 9-11 days in 2019 and after 5-9 days in 2020. Shoots were uniform in all varieties, the seedlings had different colors: Crimson variety - dark purple, Voronezh variety - light green and Lipetsk - pink. The height of the seedlings was 1, 2-1, 3 cm, the size of the cotyledon leaves was 0.6-0.7 x 0.2 cm. The phase of cotyledonous leaves

began in all varieties in the 1st decade of June, the phase of the second true leaf - in the second decade of June. The branching phase of shoots in the Crimson and Voronezh variety fell on the first decade of July, and in the Lipetsk variety - in the second decade. The height of the plants in the first two varieties was 12-13 cm, in Lipetsk up to 30 cm. The size of the leaves varied during this period: in Crimson - 6.4 x 4.1 cm, in Voronezh - 10.2 x 6.2, in Lipetsk - 12, 2x6.7. It is known that amaranths are light-loving plants. Their leaf arrangement is alternate, the upper leaves are almost sessile, the lower ones are on long petioles, therefore the upper leaves do not shade the lower ones, creating a kind of leaf mosaic. The flowering phase began at the Crimson and Voronezh in the third decade of July, and at the Lipetsk in the first decade of August. Inflorescences are paniculate thyrsus. In the Lipetsk variety, the panicles are purple, in the Voronezh variety - green, and in the Crimson variety - dark green. The highest plant height at this time was in the Lipetsk variety - 54-56 cm, in other varieties - 37-40 cm, the leaf sizes, respectively, - 12.6x8.5 cm and 11-12x5-7 cm. Flowering in amaranth paniculata is very stretched and lasts over 30 days. At the same time, flowers, developing fruits and ripening seeds are noted on the plant. Mature seeds fall off easily. Therefore, the harvesting of plants for seeds began when the first seeds ripened. The criteria were: yellowing of the stem base, dropping of the lower leaves and strong reddening of the middle leaves. The plants were harvested in a separate way. First, the plants were cut and laid out on the tables for ripening the seeds indoors. Then the inflorescences were threshed.

The dynamics of the passage of development phases in 2020 was generally close to the indicators of 2019, the differences of 2-3 days were within the experimental error. The Lipetsk variety had a later fruiting and seed ripening - in the second decade of September. This variety was characterized by the highest proportion of immature and deformed seeds up to 20%. For the Crimson variety, this figure was 5-8% over the years of research, for Voronezh - 10-15%.

Analysis of biological and morphometric characteristics of plants by the end of the growing season showed that their height reached 90-98 cm (tab. 1), the largest weight of 1000 seeds was in amaranth of the Voronezh variety. The color of the collected seeds corresponded to the characteristics of the variety. The most productive was the Voronezh variety up to 30.2 g/m^2, the less productive was the Lipetsk variety.

The prospect of plant cultivation in new soil and climatic conditions involves an assessment by many criteria, including the need to take into account the air temperature and the duration of the growing season. We

used indicators such as the sum of active temperatures, the average air temperature for the interphase period, and the amount of precipitation for this period. These meteorological indicators reflect the need for amaranth paniculata varieties for warmth, moisture and the possibility of its cultivation (tab. 2).

Table 1. Morphometric indicators of varieties of amaranth paniculata

Variety/ Year	Average plant height, cm	Weight of 1000 seeds, g	Color of seed	Average number of seeds per plant, pcs.	Weight of seeds from 1 plant, g	Seed yield, t/ha
Crimson 2019 2020	 95 92	 0,51 0,51	black	 42800 44600	 21,8 22,7	 2,6 2,7
Voronezh 2019 2020	 95 98	 0,75 0,77	yellow	 39120 39300	 29,3 30,2	 3,5 3,6
Lipetsk 2019 2020	 90 93	 0,70 0,72	gray	 13715 14200	 9,6 10,2	 1,1 1,2

A comparative analysis of the data showed that the Lipetsk variety was distinguished by the longest growing season, it is more demanding on heat and in the North-West was less productive than the Crimson and Voronezh varieties.

Table 2. The duration of the interfacial periods and the conditions for the growth and development of amaranth paniculata

Variety	Interfacial period duration, days	Sum of active temperatures for the period, °C	Average air temperature, °C	Amount of precipitation, mm
Shoots - flowering (harvesting for forage purposes), days 2019				
Crimson	60	1240,7	17,2	119,6
Voronezh	64	1222,4	17,3	118,7
Lipetsk	68	1469,2	16,2	122,6
Shoots - flowering (harvesting for forage purposes), days 2020				
Crimson	53	1505,0	19,7	201,9
Voronezh	50	1542,0	19,5	218,5
Lipetsk	68	1581,5	19,4	218,5

Shoots - fruiting (harvesting for seeds), days 2019				
Crimson	90	1814,6	15,7	186,1
Voronezh	92	1814,6	16,0	186,1
Lipetsk	103	2084,9	15,8	225,2
Shoots - fruiting (harvesting for seeds), days 2020				
Crimson	90	1970	17,9	274,6
Voronezh	91	2012	17,6	293
Lipetsk	101	2120,5	17,5	296,2

The duration of the germination-flowering interphase period, when the plants are harvested for forage purposes, varied in all varieties from 53 to 68 days. Varieties Crimson and Voronezh complete development cycle from germination to harvesting in 90-92 days. With the length of the frost-free period in the Leningrad region 180 days, the plants studied by the variety have time to complete their development cycle and form seeds. Heat supply by the end of the growing season was 1814 -2120 °C. During the observation period, the plants were not affected by diseases and were not damaged by pests.

Thus, the results of the study showed that the Voronezh and Crimson varieties are promising for cultivation for seeds in the Northwest of Russia. Sowing must be carried out in the third decade of May. Harvesting for forage purposes begins 50-64 days after germination. Harvesting for seeds can be done in 90-92 days. In order to avoid large losses of seeds, it is better to harvest in a separated way. The yield of the recommended varieties is 2.6-3.6 t/ha.

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NOTES

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