SCIENTIFIC RESEARCH OF THE SCO COUNTRIES: SYNERGY AND INTEGRATION

上合组织国家的科学研究：协同和一体化

Proceedings of the International Conference

Date: August 9

Beijing, China 2023

上合组织国家的科学研究：协同和一体化国际会议

参与者的英文报告

International Conference “Scientific research of the SCO countries: synergy and integration”

Part 4

2023 年 8 月 9 日。中国北京
August 9, 2023. Beijing, PRC

Proceedings of the International Conference
“Scientific research of the SCO countries: synergy and integration” - Reports in English

(August 9, 2023. Beijing, PRC)

ISBN 978-5-905695-82-7

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ISBN 978-5-905695-82-7

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MEDICAL SCIENCES

EARTH SCIENCES

DOI 10.34660/INF.2023.42.65.152

青春期女孩对亲子关系和身体形象的看法
PERCEPTIONS OF CHILD-PARENT RELATIONSHIPS AND BODY IMAGE AMONG ADOLESCENT GIRLS

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注解。 这篇文章探讨了对亲子关系的看法与青春期女孩对自己身体的满意度之间的联系。 报告以 62 名女孩为样本进行研究，结果如下。 结果表明，青春期女孩对与父母关系的看法与对自己身体的满意度之间存在关联。 还显示了自尊与亲子关系的某些特征之间的关系。 研究样本揭示了青春期女孩对其身体态度的预测因素。

关键词：身体形象满意度、亲子关系、自尊。

Annotation. *The article deals with the connection between perceptions of child-parent relationships and adolescent girls' satisfaction with their own bodies. The results of the study obtained on a sample of 62 girls are presented. The results show that there is a relationship between adolescent girls' perceptions of their relationships with their parents and satisfaction with their own bodies. The relationship between self-esteem and some characteristics of child-parent relationships is also shown. Predictors of the attitude to their body in adolescent girls are revealed on the studied sample.*

Keywords: *satisfaction with body image, child-parent relations, self-esteem.*

Body image and attitudes toward one's body is one of the most popular topics in modern psychology. Many studies show that negative body image can lead to serious psychological problems - low self-esteem, self-loathing, depression, feelings of loneliness, eating disorders, dysmorphophobia. The problem of body image becomes especially important in adolescence. This is due to the hormonal

restructuring of the organism at this age, changes in body shape, as well as the increasing importance of relationships with peers, a new level of self-awareness, the growth of a critical attitude towards oneself. The results of many studies show that one of the decisive factors influencing attitudes towards one's body is the relationship between children and parents [1, 2, 4, 7, 8].

The purpose of this study was to investigate the relationship of child-parent relationship with the level of satisfaction with their own body in adolescent girls.

Sample. Sixty-two girls 14-17 years old (M=15.6) and 11 mothers participated in the study, totalling 73 participants.

Methods: " Body Self-Image Questionnaire" (BSIQ) O.A. Skugarevsky, S.V. Sivukha; "Parent-child interaction (PCI) I.M. Markovskaya; "Adolescents about parents" (ADOR) E. Shafer, adapted for Russia; "Self-esteem scale" T. Dembo - S.Y. Rubinstein. Dembo - S.Y. Rubinstein.

The obtained data were processed using Mann-Whitney, Wilcoxon, Spearman correlation criteria, regression analysis was also applied.

Results of the study

The study of dissatisfaction with one's own body showed that 56.4% of the girls surveyed were significantly dissatisfied with their bodies.

Two comparison groups were identified: Group 1 included 35 girls who were dissatisfied with their own bodies and Group 2 included 27 girls who were satisfied with their own bodies.

Comparison of groups according to the method "Dembo-Rubinstein Self-Esteem Scale" showed that significant differences between groups exist on the scales "Self-Esteem" ($U = 150$, $p<0.001$) and "Level of Attraction" ($U = 624$, $p<0.05$).

Higher self-esteem is characteristic of the group of girls satisfied with their body of girls. Girls who are not satisfied with their bodies have a greater discrepancy between the level of self-esteem and the level of pretensions, which indicates that their self-real is far from the self-ideal.

Comparison of groups according to the results of the **PCI methodology**, aimed at studying the interaction between mother and child, showed that girls who are satisfied with their own body consider their mother more anxious ($U = 199$, $p<0.05$), they are more satisfied with the relationship with their mother than girls who are dissatisfied with their own body ($U = 195$, $p<0.05$).

Comparison of the groups on the **ADOR technique** revealed that girls satisfied with their own body" significantly higher scores on "Positive interest of the mother" ($U = 617.5$, $p<0.05$) and "Positive interest of the father" ($U = 329$, $p<0.05$). Positive interest means, attitude based on psychological acceptance, care, help. Girls who are dissatisfied with their bodies consider their mother to be more directive ($U = 597.5$, $p<0.05$), as well as higher estimates of "Father's directiveness" -

rigid control, authority, based on ambition ($U = 311$, $p<0.05$) and "Father's hostility" - over-demanding, oriented to the standard of "ideal child" ($U = 383$, $p<0.001$).

Girls who are satisfied with their own body more often describe their relationship with their mother in positive terms: *"We trust each other, my mother always understands me, listens to me, supports me. An understanding, kind person."*, more often mentioning trusting relationships and less often conflicts in relationships. Girls who are not satisfied with their bodies use more negative statements in describing their relationship with their mothers *"We have very strained relations, I try not to tell her anything. She almost doesn't pay attention to me, controls my every step"; "I am afraid that my mother will start to judge me for any actions..."; "She almost doesn't trust me to do anything myself. Her mood changes very sharply. She can shout for something and then after a couple of minutes she becomes affectionate"*.

Thus, the group of girls who are satisfied with their bodies is characterised by positive evaluation of relations with their mothers and perception of mothers as more anxious. Girls dissatisfied with their bodies perceive their mothers as indulgent, seeking to satisfy any desire of her daughter, treating her daughter as a small child, and at the same time, strict, bossy and always right.

Also for girls who are dissatisfied with their bodies, the perception of fathers as more self-confident, adhering to one model of upbringing, without sharp changes from permissiveness to harsh punishments, knowing exactly the boundaries of what can and cannot be done, strict, demanding from their daughters strict obedience to the norms of behaviour and morality accepted in their culture. These are fathers who are oriented towards a certain standard of an "ideal child".

In order to study the relationship between the attitude to one's own body, self-esteem and the perception of child-parent relations, a correlation analysis was conducted using Spearman's rank correlation coefficient (r).

It was found that:

- Girls' satisfaction with their own body and high level of self-esteem are positively correlated with high level of maternal anxiety;
- Girls' high level of self-esteem is associated with maternal strictness;
- Significant discrepancies between girls' self-esteem and level of pretensions correlate with dissatisfaction with their own bodies and maternal inconsistency, abrupt changes in mothers' styles and educational methods (transition from very strict to liberal and vice versa, transition from psychological acceptance of the daughter to her emotional rejection);
- Hostility on the part of the father and directiveness of both parents, correlates with dissatisfaction with their own body in girls. Daughters of more demanding fathers also evaluate their body as less attractive, beautiful.

To identify possible predictors of body dissatisfaction among adolescent girls based on the results of the BSIQ, PCI and ADOR, we conducted regression analyses using F-Fisher and Student's t-test. The BSIQ (body attitude) scores were defined as the dependent variable, and the PCI and ADOR scores were defined as the independent variable.

Regression analysis of the PCI scales as independent variables showed that mother's anxiety for her daughter ($p<0.001$), mother's acceptance of her daughter ($p<0.05$) and satisfaction with the relationship with her mother ($p<0.001$) could be considered as predictors of adolescent girls' satisfaction with their bodies. Also, at the trend level, it can be said that emotional closeness with mother can be a predictor of adolescent girls' satisfaction with their bodies (at $0.05 \leq p \leq 0.1$).

Regression analysis of ADOR scales as independent signs found that such indicators as mother's directiveness ($p<0.05$) and father's directiveness ($p<0.05$) and father's hostility ($p<0.001$) can be considered as predictors of adolescent girls' dissatisfaction with their bodies. It should be noted once again that a mother's directiveness in this methodology is understood as strict control, tendency to use her power, severity of punishments, and ignoring the interests of her daughter. The father's directiveness is understood as a strict indication of the daughter's place in the family and society, and the father's hostility is understood as over-demanding, emotionally alienating, rejecting relations.

Next, we analysed the results of mothers' testing using the **PCI methodology**. Twelve mothers took part in the study. 11 of them had daughters who were not satisfied with their own bodies. Among these mothers only 27% assessed their relationship with their daughter as close, only 27% showed emotional acceptance of their daughter. All of the mothers studied were dissatisfied with their relationship with their daughter.

To test the differences between the dependent samples of mothers and daughters on the perception of relationships in the mother-daughter dyad (according to the methodology of PCI), the Wilcoxon T-criterion was applied. It turned out that mothers and daughters have significantly different scores on the scales "Emotional distance - closeness", "Parental authority" and "Satisfaction with relations with the child" (at $p \leq 0.05$). Differences in scores (at the trend level) were noted for the scales "Undemanding - demanding and "Inconsistency - consistent" (at $0.05 \leq p \leq 0.1$). Mothers rated these indicators higher than daughters. Thus, we can speak about the discrepancy in the perceptions of child-parent relationships between mothers and daughters who are dissatisfied with their bodies; mothers tend to evaluate their relationships with their daughters better than daughters.

Discussion of the results

As the results of the study show, mother's anxiety towards her daughter is a positive factor in the formation of daughter's self-esteem and body image. This

may indicate that girls perceive mother's anxiety as a concern for themselves. At the same time, hypercare and hyperprotection are rather negative factors in the formation of body image.

In addition, at the level of tendency, we can note the influence of emotional closeness with mother on satisfaction with their body. These findings confirm the results obtained in other studies [3, 6], which showed that daughters' relationship with their mother is positively related to girls' body image attitudes. The emotionally closer, warmer the relationship between mother and daughter, the more satisfied the girl is with her body, parental support has a positive relationship with adolescents' satisfaction with their bodies. In the works of Marceau, K., Ram, N., & Susman, E. J. it is shown that adolescents living with emotionally warm and available parents feel healthier and safer than their peers living in families with emotionally cold parents [5].

Thus, the study of the relationship between perceptions of child-parent relationships and adolescent girls' satisfaction with their own body allows us to draw the following conclusions

1. There is a relationship between adolescent girls' perceptions of child-parent relationships and their satisfaction with their bodies:

Girls who are satisfied with their bodies perceive the mother as more anxious, accepting, emotionally close and satisfied with the relationship with her daughter;

Girls who are dissatisfied with their bodies tend to perceive the mother as more directive;

Girls who are dissatisfied with their bodies perceive the father as more demanding, hostile and directive;

Dominant hyperprotection and hyperprotection from the mother are associated with daughter's dissatisfaction with her body. While close and trusting relationships with parents are positively related to body satisfaction.

2. The relationship of self-esteem and evaluation of one's appearance with certain characteristics of child-parent relationships is shown:

Higher self-esteem is demonstrated by daughters of more anxious mothers, and a higher level of pretensions is characteristic of daughters of stricter mothers;

Authoritarian upbringing can lead to low self-esteem in girls.

3. Predictors of adolescent girls' attitudes towards their bodies have been identified:

Mother's anxiety for her daughter, mother's acceptance of her daughter and satisfaction with the relationship with her mother can be considered as predictors of adolescent girls' satisfaction with their bodies. Also at the trend level, it can be said that emotional closeness with mother can be a predictor of adolescent girls' satisfaction with their bodies.

Mother's and father's directiveness and father's hostility can be considered as predictors of adolescent girls' body dissatisfaction.

4. There is a discrepancy in the perceptions of child-parent relationships between girls who are dissatisfied with their bodies and their mothers. Mothers are more satisfied with these relationships and have higher estimates of emotional closeness with their daughters, as well as higher estimates of their own authority and consistency of upbringing.

The analysis of the results leads us to the conclusion that body image in adolescent girls is related to perceptions of relationships with parents. In families with warmer, friendly relations, daughters are more often satisfied with their bodies, while in families with an authoritarian style of upbringing, with a high level of strictness, with hyperprotective, hyperprotective parents, daughters are more often dissatisfied with their bodies.

This, in our opinion, is due to the fact that in families where there are trusting relationships, where mothers take care of the child, but give him freedom of choice, there is room for support and protection. Besides, this style of upbringing is more typical for adults who have adequate self-esteem, including the assessment of their bodies. This means that they transmit to their children a healthier attitude towards themselves and their bodies. Modern research confirms that parental attitudes towards their bodies (conscious and unconscious) are internalised by children.

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DOI 10.34660/INF.2023.39.29.153

将愤怒情绪转化为控制情绪作为情商发展的标准

TRANSFORMING THE EMOTION OF ANGER INTO CONTROL AS A CRITERION FOR THE DEVELOPMENT OF EMOTIONAL INTELLIGENCE

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抽象的。 这篇文章专门讨论愤怒的情绪及其对提高克服障碍的能力的影响。 愤怒的动机已被指出。 值得注意的是，愤怒与保护、消除障碍、控制和领导的愿望有关。 将愤怒转化为保护性阻止机制、态度或状态的改变是可能的。 愤怒的控制和调节程度与情商的发展和对环境的影响有关。 愤怒情绪转化为控制情绪是情商发展的标准，也是心理功能的体现。

关键词：愤怒，情绪控制，愤怒情绪的转化，情商。

Abstract. *The article is devoted to the emotion of anger and its influence on increasing the ability to overcome obstacles. The motives of anger are indicated. It is noted that anger is associated with the desire for protection, removal of obstacles, control and leadership. It is possible to transform anger into protective-blocking mechanisms, a change in attitude or state. The degree of control and regulation of anger is associated with the development of emotional intelligence and influence on circumstances. The transformation of the emotion of anger into control is a criterion for the development of emotional intelligence and a manifestation of the psyche functioning.*

Keywords: *anger, emotion control, transformation of the emotion of anger, emotional intelligence.*

Anger is a strong emotion that mobilizes physical and mental resources in the struggle for survival. The importance of the emotion of anger lies in the release of psychic energy to overcome obstacles, control the behavior of others, influence events and phenomena. The role of anger in focusing consciousness on obstacles should be especially noted. It is known that excessive anger becomes dangerous for a person, can lead to uncontrollable conflicts, the emergence of psychosomatic diseases and poor health [2]. Human civilization has developed and continues to improve ways of managing anger, suppressing and transferring its energy both to

a socially useful channel and to destroy peoples and cultures. In any case, anger turns on the hidden or explicit mechanisms of the personality, leading to the restructuring of its system. The displeasure that accompanies anger prompts one to look for ways to control it and, thus, can contribute to the development of skills and abilities of self-control, managing people and circumstances, and activates the psyche functioning as a whole.

The methodological basis of the study was: general scientific principles: dialectical logic (contradictions, consistency, unity of analysis and synthesis, ascent from the abstract to the concrete, comprehensive consideration); empirical methods: literature analysis, comparison and grouping method, interpretation. Together, their use makes it possible to consider options for the transformation of anger and the possibility of transition of anger into control as a function of the psyche, to isolate this option as a criterion for the development of emotional intelligence, the formation of a multidimensional assessment of the emotion of anger.

Motives for anger may vary. For example, protective-defensive ones. Devaluation is considered as one of the ways of psychological protection, characteristic of both an individual and a group subject [4]. Anger also encourages the transfer of responsibility to another person, group, society and even culture. Also, the motive of anger may reflect an attempt to draw attention to one's own person and devalue the opponent. Of particular interest is the motive for controlling others, events and phenomena. At the same time, the ability to control anger is important for information processing, therefore, for the development of intelligence, in particular, emotional intelligence, as the ability to use the energy of emotions to solve various problems [6].

A public demonstration of anger is inherent in a person in situations where he claims to lead and change established rules. Subsequently, the leader is empowered to demonstrate anger. However, the leader has the ability for high self-control and influence on others and circumstances. It is the influence on conditions or significant circumstances that distinguishes a strong leader.

It is known that anger reflects an external accusation, with the help of which it is convenient to manipulate public opinion. In conflict situations, the opponent's behavior causes a whole range of complex emotional states. Initially, a person tries to manipulate, subordinating the recalcitrant to his will. Further, in case of failure, in order to resolve the conflict for the benefit of oneself, a desire may spontaneously arise to humiliate the opponent, harm him and maintain a high level of self-esteem. Similar motives are characteristic of a person with a loss of control.

For the initial mobilization of intellectual resources, there must be an obstacle or a problem. Anger serves as a guide in an effort to eliminate obstacles on the way to getting what you want. With a high level of emotional intelligence, a person has the ability and skills to transform anger into other states. A feature of anger is

the relative short duration of its course and the ability to quickly assess a critical situation. Rapid response allows you to solve the problem with minimal use of the time resource, i.e. anger as a basic emotion creates conditions for the development of emotional intelligence. At the same time, the level of development of the latter will depend on the general ability to control emotions [1]. It is important that when a difficult situation is successfully resolved, calmness sets in, which not only indicates the previous effective choice of a behavior strategy, but also allows you to restore the expended strength, and also brings relief to others.

When trying to suppress anger, psychological defense mechanisms can turn on, blocking not only mental energy, but also leading to reduce creative potential of the individual. Such a response drastically reduces the likelihood of circumstances being controlled and creates the preconditions for the development of psychosomatic diseases. This shows the need for timely learning, from childhood, the sublimation of anger into a transformative creative activity. Any experience sets the direction for building an emotional forecast of the situation [3]. Therefore, when anger is manifested, it is necessary to focus the subject's attention on the knowledge of the object that caused the anger, in order to prevent superficial assessment and erroneous judgment. Perhaps anger is a consequence of underestimating the object. People should be educated to focus on the possibilities of environmentally solving problems for the benefit of society.

Thus, anger is associated with the desire for protection, removal of obstacles, control and leadership. An important function of anger lies in its ability to mobilize mental resources, overcome obstacles and speed up the solution of the problem. With the inability to quickly cope with the problem (ineffectiveness of the chosen behavioral strategy), a transformation into protective-blocking mechanisms occurs, a change in attitude or state. Anger as a powerful mobilization mechanism activates mental resources to increase emotional intelligence [5]. Learning to sublimate anger into a transformative creative activity must be done at an early age and refined throughout life. The degree of control and regulation of anger is associated with the development of emotional intelligence and influence on circumstances. The ability to control anger is a criterion for the development of emotional intelligence and the manifestation of movement as a functioning of the psyche.

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DOI 10.34660/INF.2023.44.29.154

俄罗斯学生对现代中国画传统与创新的研究（以张大千作品为例）
THE STUDY OF TRADITIONS AND INNOVATIONS IN MODERN CHINESE PAINTING BY RUSSIAN STUDENTS (ON THE EXAMPLE OF ZHANG DAQIAN'S WORKS)

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注解。 本文致力于探讨俄罗斯学生研究中国文化的新方法。 选取20世纪中国独特的绘画大师张大千的作品作为案例研究。 该作品的理论意义在于研究张大千在中国传统文化背景下的创作形成阶段、艺术家的个人特征以及20世纪中叶欧洲绘画的新思潮。 这项研究旨在增强俄罗斯学生不仅学习中国画基础知识，而且学习哲学、民族传统、神话等"文化"一般概念的许多方面的兴趣。 其现实意义在于将所分析的材料运用到艺术史活动、博物馆作品、教育实践中。

关键词：文化、中国、俄罗斯、绘画、张达采、传统、创新、文化交流。

Annotation. *This article is devoted to the development of new approaches in the study of Chinese culture by Russian students. The work of Zhang Daqian, a unique Chinese master of painting of the 20th century, is chosen as a case study. The theoretical significance of the work lies in the study of the stages of formation of Zhang Daqian's creativity against the background of traditional Chinese culture, personal characteristics of the artist, as well as new trends in European painting of the mid-20th century. This study is aimed at strengthening the interest of Russian students in studying not only the basics of Chinese painting, but also philosophy, national traditions, mythology and many other aspects of the general concept of "culture". The practical significance lies in the use of the analysed material in art history activities, museum works, educational practice.*

Keywords: *culture, China, Russia, painting, Zhang Datsyan, traditions, innovation, cultural exchange.*

Chinese art is a special, unique part of world culture, which stands out for its unique colouring, ancient history, and centuries-old traditions. Among the cultural values of China, works of fine arts stand out, which are perceived by many foreigners as exotic, a characteristic sign of the Celestial country. Chinese painting is a separate "universe" in the world of art. And in this "cosmos" there are its "stars":

Qi Baishi, Zeng Fanzhi, Xu Beihong, Cao Bei-An and others. The names of these masters of painting are well known in China itself, but they say little to the average European, in particular, to the average resident of Russia, except for specialists in Chinese art and lovers of the East.

In recent years, Russia and China have made considerable efforts to promote cultural exchange between our countries. This is necessary in a dynamically changing world. However, it is extremely difficult to conduct a dialogue without knowledge of the cultural background of each side. Hence the need for their comprehensive consideration and study.

For example, one of the oldest Russian universities - Voronezh State University, on the basis of the Faculty of Philology, has been running a department of "Arts and Humanities" for more than a dozen years. As part of the curriculum, students learn the subtleties of the relationship between the history and theory of art, as well as study the role of art itself in various spheres of human activity (theatre, cinema, fashion, advertising, design, etc.).

During the existence of the direction "Art and Humanities" the study of disciplines was conducted mainly within the framework of the problems of European art, and only in recent years the vector of active interest in the development of art history disciplines has turned towards the East. In a broad sense, this is the area of consideration of problems of culture and art of the countries of the independent commonwealth (Kazakhstan, Turkmenistan, Tajikistan, etc.), as well as more distant territorial states (China, Japan, India, etc.).

Modern Russian students show great attention to various aspects of Chinese life, are motivated by its successes and achievements, more and more young people are determined to seriously study the language and culture of the Celestial Empire. In the framework of our article we will focus on a specific example of Chinese culture acquisition by Russian students. As an object of study we have chosen Chinese painting. They say about it: "it is more than just images on rice paper, it merges philosophical-cultural, social, religious, ethical functions, philosophy of being" [1]. [1].

The relevance of the study of this topic for students is largely due to the interest in the phenomenon of the unique creative heritage of the Chinese artist Zhang Daqian (1899-1983), whose paintings in the late 80s of the XX century became more popular than the works of Picasso himself. The desire to unravel the mystery of the artist's talent and high creative rise became the stimulus for studying this issue. We outlined the main ways of work, which later helped us to get closer to unravelling the mystery of Zhang Daqian's creativity:

1.*Contemplation of paintings and literature collection*. The main objective at this stage is to gradually "get into the topic" of the research. Students should carefully examine Zhang Daqian's paintings, group them by theme and genre, analyse

the artist's biography and identify the main periods of his work; Systematisation and observation become the main methods in the work.

2. *Studying the initial period of Jan Daqian's creativity*. At this stage it is necessary to pay attention to the origins and traditions of Chinese painting, which influenced the early work of Zhang Daqian. And one more task is set before students - to determine the genre and stylistic features of the early works of the painter. The method of deduction will help to cope with these tasks.

3. *Consideration of the innovative period in the work of Zhang Daqiang.* This stage is the most difficult and interesting, as all periods in Zhang Daqian's work lead us to understand his special, individual, innovative features, which became "signs" of recognisability of the Chinese artist's work, both in Asia and in Europe. The method of comparison will enable us to identify some points of similarity and difference in the use of traditional Chinese painting techniques at different stages of the master's work, as well as to see the features of new, European influence in his works.

So, having studied the biographical material, we found out that Zhang Daqian (birth name Zhang Zhengquan) was born in 1899 in the city of Neijiang, (Sichuan Province). His relatives, being educated people, taught the future artist drawing, reading and penmanship. These skills and artistic talent of the young man helped him to ensure financial stability and become quite a famous man in his hometown. At the age of seventeen Zhang Daqian graduated from the high school Tsyujin city Chongqing. At this time, the young man actively studied poetry. For the artist it was one of the key moments in his life, which influenced the further life and formation of his character. Subsequently, Zhang Daqian wrote more than 1000 poems.

In 1916, the young Zhang Daqian travelled to Kyoto, Japan, to study fabric drawing. In his spare time, he continued to paint. In 1919, Zhang Daqian returned to his hometown, where he successfully began to sell his paintings. In the winter of the same year, he became a monk at the Chanding Temple in Songjiang County. Monk Yilin, to whom the young man enrolled as an apprentice, gave him the name of one of the Buddhist gods - Datsyan, which in Buddhism means "a billion universes". It was with this name that the artist became known to the world along with cult figures of art.

Later Zhang Daqian continued his education in Shanghai, where he was mentored by the most famous calligraphers of the Shanghai school - Zeng Nongzhan (Xi) and Li Ruiqing (Mei'an). Highly valued calligraphy blurred the boundaries between painting and poetry, where a character was perceived as "a 'speaking ornament', introduced by painters into a painting in the form of a poetic inscription, supplementing its meaning and enriching its decorative structure" [2]. [2]. Both artists loved the works of Ming dynasty artists Shi Tao and Zhu Da. The words

of a monk of the Buddhist sect Chan, a master of landscape, orchids, bamboo Shi Tao made an indelible impression on Zhang Datsyan: “Brush and ink must keep up with the times” [3] and influenced the formation of Zhang Datsyan [3] and influenced the formation of his artistic taste.

Since 1924, interest in Zhang Daqian’s work has been growing, including among painters of the older generation (Wu Changshuo, 1844-1927 and others). During this period, the works of the young, capable artist already masterfully combined all the fundamentals of traditional Chinese painting: the image itself, poetry and calligraphy.

In Shanghai, Zhang Daqian entered the circle of the Qiuying Society, whose representatives adhered to both old customs and views on society and art, and progressive sentiments. During this period of his life, Zhang Datsyan paints paintings of nature: mountains, water, flowers and birds. Newspapers of the time wrote about him as a rising light among Shanghai artists. In 1925, friends helped him organise his first solo exhibition of one hundred paintings.

Two years later, Zhang Daqian became fascinated with painting from nature. He climbed Mount Huangshan four times. He was attracted by the beauty of deserted terrain, majestic and untouched landscapes. During this period, the artist wrote many paintings in the genre of *shan-shui* (mountain-water), in which the man felt himself not the centre of the universe, but a small part of it [4]. The artist depicted the diversity, harmony and grandeur of the world, in which man merges with nature. The painter seems to look “from above” at the landscape, creating the effect of depth and multidimensionality. The feeling of boundlessness of the terrain is supported by the foggy haze and water surface. Thus, the artist showed the best traditions of ancient Chinese painting in his works.

In 1934 Zhang Daqian moved to Beijing, the centre of Chinese traditional culture. In the capital of China, the artist continued to perfect his skills. Here he met Pu Xinyu (1896-1963), whose paintings reflected the ideology of the Chinese intelligentsia. The masters became friends, they were called “southern Zhang and northern Pu”.

In 1936, a collection of works by Zhang Datsyan was published. In the preface to the collection, Xu Beihong called Zhang Datsyan “the genius of the last five centuries” [5]. An important stage in the life of the master is the move in 1941 to the sacred caves of Mogao in Dunhuang. The three-year experience of working in the treasury of the first Buddhists led the artist to the idea of revising his previous views on traditional art. He experienced an unprecedented spiritual uplift from what he had seen in the caves, and the thought arose in him that studying the frescoes would help him reach new heights in the art of painting. After his trip to Dunhuang, Zhang Daqian’s style changed greatly: the palette of colours was

enriched, the size of paintings became larger, images became more voluminous, and the scope of painting increased.

The artist became even more famous after creating a number of paintings with the lotus at their centre ("Lotuses in Five Colours" 1940, "Lotuses" 1948, "Golden Lotus"). Zhang Daqian was particularly fond of this flower. He believed that it was lotus painting that showed the basic skills of using brush and ink. "Reaching out from the dark depths of the waters towards the sun, the lotus seems to permeate all the floors of the universe and represents the unstoppable force of vital growth. And its delicate flowers, blossoming above the water itself, appear as a symbol of mental purity, invulnerable to the "mud and mire" of mundane light" [6, p. 314-3-3]. [6, c. 314-315].

Since the 1940s, Zhang Datsyan has actively exhibited his works in the richest countries of the world. The exhibition of the artist, organised in the city of Lanzhou in 1943 was visited by more than ten thousand admirers of his talent. All his works presented at the exhibition were sold. In 1946, Zhang Daqian's works were exhibited in Shanghai, London, Paris, Geneva and Prague. From 1952, he travelled successively to Argentina, Brazil and San Francisco in the United States. In 1958, Zhang Daqian was recognised by the International Fine Arts Association in New York as the best contemporary artist.

In 1956, a momentous event happened not only for the artist but also for all art lovers: in Nice, Zhang Daqian met Pablo Picasso. In a great meeting of "East" and "West", the masters of their time exchanged paintings.

It is believed that until the 60s of the twentieth century Zhang Daqian was a traditionalist painter, and after living in the United States, and then in Taiwan, he painted in a modern manner, with elements of impressionism and expressionism. However, his paintings were distinguished by their uniqueness and recognisability. What was the secret of Zhang Daqiang's pictorial structure? Perhaps in a special artistic style of painting, which he himself developed back in 1965 - the technique of interrupted ink and broad strokes, gravitating towards the style of *se-yi*. It should be noted that there are two styles of traditional Chinese painting: *gongbi* and *se-yi*.

Gongbi — "a diligent / fine brush technique", it involves realism and high detailing of the subject, painting fine details. "This type of fine art is characterised by the use of silk or paper scrolls, ink and colours diluted in water" [7, c. 22]. Zhang Daqian's early landscapes are painted in this manner.

Se-yi literally means "to embody the prototype". The main task of this style is to express the philosophical meaning of phenomena through schematic, conditionally - generalised image: "Lines could not only depict the object on the canvas, but also the dimensionality of beauty, and a sense of its rhythm" [8, p. 64]. [8, c. 64]. This style implies a free manner of writing. Here the main thing is not external

similarity, but his own special vision, the master's mental mood, the essence of the object, it is the transfer of ideas and feelings of the artist. The style of *se-yi* is characterised by broad, free strokes with a broad brush.

Zhang Datsyan's landscape "Ancient temples among clouds" (1965) is an example of such creativity. It is noticeable that the artist is not afraid to experiment with colours, central figures and drawing styles. He combines the technique of intermittent ink and broad strokes, thus outgrowing his teachers and creating a new style of painting. His painting is filled with expression, it looks almost abstract. A maelstrom of ink and colours, i.e. abstract clouds, becomes the central point of the viewer's gaze. This image seems to be a bold experiment, a kind of break from tradition. Some researchers believe that Zhang Daqian did not accidentally use blue colour so abundantly, perhaps there is some symbolic meaning hidden in it: "The Chinese often say that blue paint is extracted from indigo, but it is brighter than indigo. This expression is used when they want to say that a student has surpassed his teacher or subsequent generations have surpassed their predecessors" [9, p. 91] [9, c. 91]. It is not for nothing that Zhang Daqian said that his way of painting mountains among clouds is different from the way Mi Fu, Mi Yuren, Gao Kegong or Fang Kongi paint, he makes his own way [10]. Thus, the artist implied that he had surpassed previous generations of masters, but did not renounce his origins.

Thus, we see that the long period preceding the emergence of Zhang Daqian's new style of painting was marked by years of comprehension and perfection of traditional Chinese painting, which became the basis for the work of the great Chinese artist of the 20th century. We have noticed that Zhang Datsyan's work, as a unity of contradictory, combines spirituality, calmness, mystery of the East and brightness, dynamics, emotionality of the West. Thus, the artist has developed recognisable features: the use of the technique of interrupted ink and broad strokes, the combination of black, dark blue and turquoise colours as the main colours to accentuate attention, the detail of the depicted objects, deep philosophical and religious meaning. It is these aspects of the Chinese master's work that attract the attention and interest of foreign admirers of his talent.

In conclusion, I would like to note that the study of Chinese painting by Russian students noticeably influences the motivation for further research in the field of Chinese culture: the work of Zhang Daqian's predecessors and contemporaries is studied, literary sources of antiquity, philosophical and religious books, symbolism of certain images, etc. are analysed.

Expanding the range of knowledge in the field of Chinese culture has become a task for both students and teachers, as the process of learning new material is usually a joint creativity of the instructors and learners for the sake of new discoveries and dialogue of cultures.

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DOI 10.34660/INF.2023.98.34.155

徐悲鸿与安德烈•科瓦尔丘克作品中意义的统一
UNITY OF MEANINGS IN THE WORKS OF XU BEIHONG AND ANDREY KOVALCHUK

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注解。 该研究致力于"致敬人民，致敬大师"项目，致力于俄中友好关系，体现在北京徐悲鸿博物馆的展览空间中。 中国古典艺术家徐悲鸿和俄罗斯著名雕塑家安德烈•科瓦尔丘克的作品展示揭示了两位杰出艺术家共同的世界观，他们创作于不同的时代，但将他们的艺术道路视为东西方艺术的综合体 。

关键词：徐悲鸿，中国画，安德烈•科瓦尔丘克，雕塑家，艺术语言。

Annotation. *The study is devoted to the project "Paying homage to the people and paying tribute to the master", dedicated to friendly Russian-Chinese relations, embodied in the exhibition space of the Xu Beihong Museum in Beijing. The exposition of works by the classic Chinese artist Xu Beihong and the famous Russian sculptor Andrei Kovalchuk revealed a common worldview of the two outstanding artists, creating at different times, but perceiving their way in the art as a synthesis of art of the East and West.*

Keywords: *Xu Beihong, Chinese painting, Andrei Kovalchuk, sculptor, artistic language.*

When visiting China's special place in Beijing in 2019, the memorial museum of a prominent Chinese artist and teacher, the father of modern Chinese painting, president of the Central Academy of Fine Arts and chairman of the Chinese Artists' Association[1] Xu Beihong (1895-1953), who combined national traditions

[1] Wikipedia. The free encyclopedia. Chinese Artists Association. [Electronic resource] // URL: https://en.wikipedia.org/wiki/China_Artists_Association (circulation date : 05.08.2023).

with the achievements of European painting, a significant event was meeting the artist's son and grandson.

Xu Qingping and Xu Zi spoke about the events of the master's life and work, his pedagogical activities, which had an undoubted impact on the formation and improvement of realist painting in China. Xu Beihong was the first chairman of the Union of Artists of China, played a great unifying role in the creative community of his country and did a lot to strengthen the established organisation of artists.

In Russia, the year 2023 has been declared by decree of Russian President Vladimir Putin[2] as the Year of the Teacher and Mentor[3]. In this year, it is especially important to honour the memory of the great teachers of the past and support the modern generation of teachers who give their knowledge and experience to the younger generation for the benefit and prosperity of the motherland.

Knowing how much effort pedagogical activity requires, in the presence of other social work, the creative heritage of Xu Beihong amazes with the volume and quality of his works in various types and genres of art, bringing new qualities to the Chinese art, preserving and developing its national basis.

In the halls of the Xu Beihong Museum in Beijing in January 2020, a joint exhibition of works by the outstanding classic Chinese painter and graphic artist Xu Beihong and the Russian sculptor, Chairman of the Union of Artists of Russia, Academician of the Russian Academy of Arts, People's Artist of Russia, Laureate of State Prizes of the Russian Federation Andrei Kovalchuk entitled "Pay tribute to the nation and pay tribute to the master" was opened. The main theme in the work of Xu Beihong and Andrei Kovalchuk is the portrayal of historical figures and contemporaries, heroes of those or other important events for the country. These are portraits of different formats, monumental compositions and monuments. A special theme that brings together in the work of the two masters is the love for the world of animals.

In interpreting the external appearance of "Mammoths" A.N. Kovalchuk refers to the images left by primitive tribes in caves in the form of rock paintings, as well as to the findings of fossil remains discovered by scientists in the Russian North. "Mammoths" (2007-2018) by the sculptor is the embodiment of familiality, loyalty and thoroughness. The measured, majestic movement of the group of animals represent the symbolism of the long-gone, but left a trace in the history of mankind. Symbolically, each sculpture conveys the feeling of vitality and movement

[2] Decree of the President of the Russian Federation No. 401 of 27 June 2022 "On the Year of the Teacher and Mentor in the Russian Federation". Document Bank. Ministry of Education of the Russian Federation [Electronic resource] // URL: https://docs.edu.gov.ru/document/id/3237 (circulation date : 05.08.2023).

3 The Year of the Teacher and Mentor. Ministry of Education of Russia. Ministry of Education of the Russian Federation [Electronic resource] // URL:https://docs.edu.gov.ru/document/id/3237 (circulation date : 05.08.2023).

of mammoths, going with a certain rhythm from the distant past - forward to the present.

In the series of sculptures “Horses” by Andrei Kovalchuk (2009-2019), the author’s understanding of the “wild” uncultivated nature in the modern worldview concept and the penetration of ideological evolution and metaphorical representation into the development of genre forms of sculpture are perceptible. One of the tasks that the sculptor set for himself was to define the character of the horses’ swift running, their movement, elusiveness and transience of life through the cognition of the Universe. Everything in this movement embodies a mesmerising and inspiring energy that gives a sense of contact with the real, deep, true, with the feeling and rhythm born of nature itself.

The primordial feeling of unity with the natural basis of the universe, with the cosmic cycles that form the great spiral of life becomes the leitmotif of “Horses” compositions. The return to the origins as a reference point in Andrei Kovalchuk’s work is the deep essence of understanding the problem of humanity, the basis of world creation in art, which united the past, present and future.

For Xu Beihong, the depiction of horses has become a broad theme of his art. Creating anatomically verified drawings in the technique of “water and ink”, combining the traditions of art of the West and the East, the artist developed a recognisable artistic language of creativity, manifested in the generalisation of forms and dynamic composition. The series “Horses” depicts, first of all, the vital energy, dynamics and character of animals: temperamental, calm, playful.

The unity of themes and meanings, the worldview of Xu Beihong and Andrei Kovalchuk, was reflected in the exposition of the exhibition, which included, in addition to 30 bronze sculptures, many photographs of the sculptor’s monumental works installed in different cities and countries, including a wall photograph of the memorial “To the Victims of Chernobyl”, which became the first monumental work by A. N. Kovalchuk. In the centre of the sculptural composition, the author created a three-metre tall figure of “a man irradiated by the destructive rays with his hands raised in the form of a cross,” notes A.N. Kovalchuk, “standing as if in the centre of the nuclear explosion”[4], and protecting the planet from the impending radioactive cloud. This is both a symbol of Christian sacrifice, crucifixion, expressed in the special plasticity of the figure, and the attempts of an ordinary man to the last, despite the seeming futility of actions, to resist the world disaster, without thinking about himself for a second.

Going beyond the exposition, special attention is drawn to the opening on 30 September 2019 on the shore of a small lake in the Sunny Island Park of the ultra-modern metropolis of Harbin, which is the capital of the Chinese province

[4] Andrei Kovalchuk. Not everyone can survive in a competitive environment. The newspaper “Culture”. №33. 28 August-3 September 2003, p.8.

of Heilongjiang (China), of Andrei Kovalchuk's monumental sculpture "Swan", created by the artist as a sign of friendly Russian-Chinese relations, after the master's long study of the history of the city, which has become a musical centre and festival venue for many of its residents.

The sculpture is a carrier of the modern sound of reality, like a mirror reflecting new rhythms of time. Thanks to the artist's use of modern material - steel and its properties, the smooth surface of the sculpture allows the viewer to learn to cognise the new, ever-changing reality in the refraction of the reflected world.

Andrei Kovalchuk, a master of plastic forms, designed the frame of the future sculpture in a 3D model at the sketch stage, which could be a modern art object in form. Steel, the material of the sculpture, is characterised by the lightness that is necessary for reading in the 21st century the symbolic content of the meanings embedded in the very idea of the Swan, which is at the same time a treble clef.

The image of the bird has an amazing plasticity. It is a peculiar symbol of transformation, sliding and synthesis in the combination of musicality and the image of grace transformed by the sound of silence reflected on the water surface of the lake. When the sculpture is viewed from each side, a new semantic facet, a new visual reading of form, plasticity and motif emerges before the viewer. Andrei Kovalchuk has created for himself and for the viewer a new territory of meanings, familiar but long forgotten by many of us - a path in which eternity and our inner world are reflected.

The work of Xu Beihong and Andrei Kovalchuk and their views on art have absorbed the knowledge and traditions of the vast heritage of the previous millennia of various cultures of the East and West: Egypt, India, China, Italy, Greece, which in synthesis allowed the birth of a completely new for its time dynamism of artistic language.

The exhibition "Paying Tribute to the People and Paying Tribute to the Master" in the memorial hall of the Xu Beihong Museum was conceived as a tribute to the friendship between Chinese and Russian art circles, as a tribute that the current Chairman of the Russian Artists' Union, Andrei Kovalchuk, pays with the most sincere feelings to the first Chairman of the Chinese Artists' Association.

Special thanks go to Ma Fenghui, Secretary General of the Chinese Artists Association and Head of the Beijing Office of Exchange and Cooperation Abroad, Mrs Hu Jianfen, President of the Pan Tianshou Foundation and curator of the project, and Li Jing, a well-known Chinese fine arts teacher, artist and Assistant to the President of the Pan Tianshou Foundation, for their invaluable assistance in holding the exhibition at the museum of the great Xu Beihong!

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Illustrations:

Ill. 1. Andrei Kovalchuk at the opening of the exhibition "Paying Tribute to the People and Paying Tribute to the Master" with his sculpture Xu Beihong

Ill. 2. Xu Beihong Memorial Museum on the opening day of the exhibition "Paying homage to the people and paying tribute to the master".

Ill. 3. Grand opening of the exhibition "Paying tribute to the nation and paying tribute to the master".

Ill. 4. Andrei Kovalchuk presenting an award to the project curator Mrs. Hu Jianfeng at the grand opening of the exhibition "Paying Tribute to the People and Paying Tribute to the Master".

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Ill. 5. Poster of Andrei Kovalchuk's memorial "To the Victims of Chernobyl" at the exhibition "Paying Tribute to the Nation and Paying Tribute to the Master".

Ill. 6. The "Mammoths" series (2007-2018)
Andrei Kovalchuk at the exhibition
"Pay homage to the people and Pay Tribute to the People and Pay Tribute to the Master".

Ill. 7. The series "Horses" (2009-2019) by A. N. Kovalchuk at the exhibition "Paying Tribute to the People and Paying Tribute to the Master".

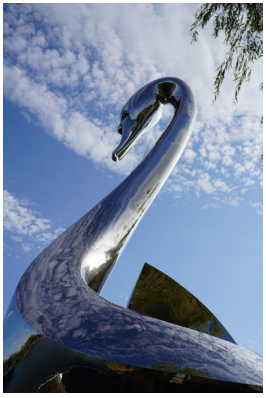
8. Xu Beihong. Horse.

Ill. 9. Xu Beihong. Branches of trees.

Ill. 10. Xu Beihong.

Ill.11. Andrei Kovalchuk. Sculptural composition "Horses". Khanty-Mansiysk. 2009

Ill. 12. Andrei Kovalchuk. Sculpture "Swan". Harbin, China. 2019



Ill. 13. Andrei Kovalchuk. Sculpture "Swan". Harbin, China. 2019

DOI 10.34660/INF.2023.59.15.156

俄罗斯南部小型水库白鲤生长速度特征（以Volchye Vorota水库为例）

CHARACTERISTICS OF THE GROWTH RATE OF THE WHITE CARP (*HYPOPHTHALMICHTHYS MOLITRIX*) IN SMALL RESERVOIRS OF SOUTHERN RUSSIA (ON THE EXAMPLE OF THE VOLCHYE VOROTA RESERVOIR)

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抽象的。 水库放养水产养殖对象的效率用商业回报指标来表征。 在确定工作方向时，建议将增长率解释为从放流到水库那一刻到进入渔业年龄期间鱼类生产力的增加。 使用各个发育阶段的生长系数确定生长速率。 给出了季节性和年平均浮游植物生物量的数据，并估计了白鲤在生长季节的食物供应。

关键词：白鲫鱼，水库，食物供应，每日营养节律，生长速度。

Abstract. *The efficiency of stocking reservoirs with aquaculture objects is characterized by an indicator of commercial return. When determining the direction of the work, it was proposed to interpret the growth rate as an increase in fish productivity from the moment of release into the reservoir to the age of entry into the fishery. The growth rate was determined using growth coefficients at individual stages of development. The data on seasonal and average annual phytoplankton biomass are given and the food supply of the white carp during the growing season is estimated.*

Keywords: *White carp, reservoir, food supply, daily rhythm of nutrition, growth rate.*

In the south of Russia there are a large number of small reservoirs, which, in combination with favorable climatic conditions, can be used for the development of pasture fish farming. However, the natural fish productivity of small reservoirs is quite low, this is primarily due to the predominance of low-value fish species in them and the low number of valuable commercial species. The ichthyofauna of such reservoirs was formed, as a rule, from native river fish, which are mainly represented by benthophages and do not fully use the food base of these reservoirs, primarily phytoplankton and zooplankton resources.

Intensive development of phytoplankton in most reservoirs of the Stavropol territory often creates great difficulties in the technological and fishery operation of these reservoirs and, as a rule, leads to deterioration of their sanitary condition. The most effective and economical method of combating the blooming of reservoirs is biological, based on the use of white carp, capable of filtering out phytoplankton and detritus and thereby improving the sanitary condition of the reservoir.

Pasture cultivation of fish is based on the principle of mastering the natural productive potential of reservoirs by stocking them with fast-growing fish species that do not compete in nutrition with native species.

The Volchye Vorota reservoir in the Stavropol territory was chosen as a model reservoir. The reservoir was built in the mid-50s on the Tomuzlovka river. The area of the reservoir at a normal retaining level is 550 hectares, the volume of water is 29.7 million m^3, the average depth of the reservoir is 5.2 m, the maximum is 12.0 m.

Since 2005, the annual stocking of the reservoir by yearlings of the silver carp has been carried out. The annual output of carp juveniles is 150.0-200.0 thousand copies, which allowed the formation of stable stocks of this species.

The hydrochemical regime of the reservoir corresponds to fish-breeding standards: water mineralization ranges from 0.4 to 0.9 g/l, the dissolved oxygen content is 6.2-10.8 mg/l, the active reaction of the medium is 7.4-8.5 units. The favorable hydrochemical regime of the reservoir has a positive effect on the development of hydrobionts.

The basis of the ichthyofauna is limnophilic fish, spawning of which takes place in the spring-summer period. The native ichthyofauna consumes mainly the products of zoobenthos and partly zooplankton. Phytoplankton production is completely excluded from the diet of the fish population. The favorable hydrochemical regime of the reservoir has a positive effect on the development of this particular biological resource. The stocking of the reservoir with a white silver carp made it possible to dispose of an unused food resource – phytoplankton.

The analysis of long-term data allowed us to establish that the combination of a long vegetation period, shallow water of the reservoir and high water temperatures contribute to the intensive development of phytoplankton.

The algofauna in the reservoir does not differ in great species diversity and has about 40 species. The maximum number of species of planktonic algae is observed in coastal shallow, well-warmed areas. In the deeper parts, the species composition of phytoplankton is much poorer.

The development of phytoplankton in the reservoir is good. The high phytoplankton biomass is primarily due to the development of diatoms (*Cyclotella comta*, *Asterionella formosa*, etc.) – 47.0%. The development of other phytoplankton

groups in the reservoir is significantly lower, the proportion of euglenic algae (*Euglena viridis*, *Trachelomonas volvocina*, *Monomorphina pyrum*, etc.) is 27.1%, green (*Scenedesmus quadricauda*, *Tetraedron minimum*, *Chlorella vulgaris*, etc.) is 10.0% and blue–green (*Merismopedia punctata*, *Oscillatoria ornate*, *Anabaena variabilis*) - 15.9 %.

The main biomass of phytoplankton in the summer and autumn periods is created by representatives of diatoms and euglen algae, the biomass of which can range from 0.82 to 2.7 g/m^3. The average biomass of phytoplankton is 1.8 g/m^3, including blue-green algae 0.29 g/m^3.

As part of the phytoplankton community, green, euglenic and diatomaceous algae make up an average of 84.0%, therefore, the average long–term phytoplankton biomass index of 1.5 g/m^3 was used when calculating the residual forage base.

In the conditions of the south of Russia, the transition of the white carp to phytoplankton nutrition occurs already in the first year of life. So, carp fingerlings weighing 25.0 g consume exclusively algoflora. The basis of food, up to 98.0% of the mass of the food lump, is algae [1].

To determine the possible annual growth of ichthyomass in the reservoir, it is necessary to know the ratio between the amount of food consumed by fish (i.e. their diets) and the products of the main groups of forage organisms. The native ichthyofauna consumes mainly the products of zoobenthos and partially zooplankton, phytoplankton is not included in the food spectrum. When calculating the potential annual growth for the white carp, the biomass of blue-green algae was subtracted from the average phytoplankton biomass. It is noted that representatives of green, euglenic, diatoms are eaten most intensively [3, 4]. At the same time, blue-green algae, as a rule, are avoided by the white carp because of their low nutritional value or even toxicity [2, 5].

Utilization of phytoplankton by the white carp, taking into account the average biomass of microalgae (1.5 g/m^3), annual production of phytoplankton (1650 tons), the degree of use of the feed base (50%) and the feed coefficient (20), is able to provide a total increase of the white carp during the growing season at the level of 55.0 tons.

The stocking of the reservoir was carried out by the young of the white carp in the spring. 170.0 thousand copies were produced. juveniles with an average weight of 37.0 g ± 4.4 g. In autumn , the average weight of the silver carp was 329.0 ± 65.0 g with an average length of 25.1 ± 1.3 cm .

It should be noted that the spectrum of nutrition in different age groups of the white silver carp did not differ. Silver carp actively consumed algae of the genera Navicula, Monoraphidium and Scenedesmus. The degree of filling of the intestines on average during the growing season is 3 points. The daily feeding rhythm of the white carp has three maxima with slight fluctuations: from 6.00 to 8.00,

from 13.00 to 15.00 and from 18.00 to 20.00 (Figure 1). Increased intensity of nutrition was noted only during the daytime, at night the food activity of the silver carp sharply decreases.

On average, the filling of the intestine in the spring season is at the level of 2.1 score. The maximum filling of the stomach was noted in the summer-autumn period – 3.7 score. The average weight of a food lump in three-year-olds was 53.4 g with an average fish weight of 2190 g.

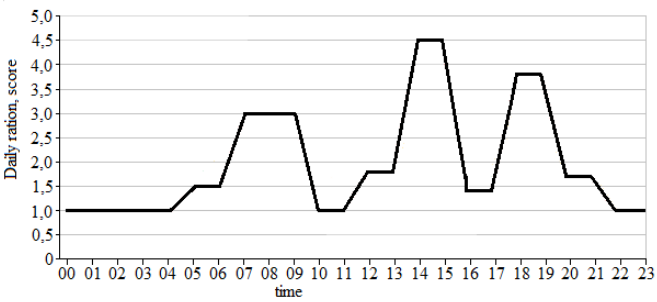

Figure 1. *Diurnal feeding rhythm of the white carp*

When the water temperature drops to 15 °C in autumn, a gradual decrease in the intensity of nutrition is observed. The average weight of a food lump in mid-October is no more than 19.6 g. Due to good food supply and optimal hydrological feeding conditions, the growth rate of the white carp is quite high (Figure 2).

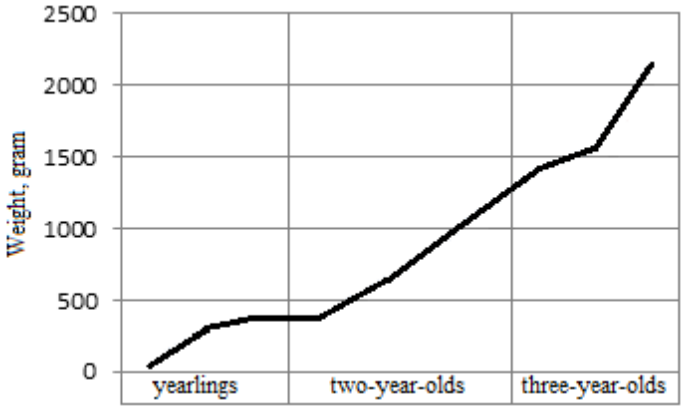

Figure 2. *Growth rate of the white carp*

The size and mass characteristics of the various age groups of the white silver carp are shown in Table 2.

Table 2

Linear and mass growth of the white carp

Age	Length, cm	Weight, g
0+	14,1±1,4	40,2±6,2
1+	37,7±1,7	864,0±89,7
2+	48,5±1,9	2189,6±129,1

The state of the habitat and fodder for the entire period of cultivation were favorable and provided a satisfactory physiological condition of the white carp. Three–year–old white carp are characterized by optimal hemoglobin concentrations - 8.54 ± 0.58 g% with fluctuations from 7.7 to 9.6 g% and whey protein - 31.38 ± 1.47 g/dl with fluctuations from 29.2 to 33.4 g/dl. The cholesterol content did not exceed 91.3±3.73 mg/dl and glucose – 5.12±0.13 mmol/l.

The work carried out on the fishery operation of the reservoir gave a positive result. The growth rate of the silver carp is the main feature directly related to productivity, therefore, when carrying out work on pasture cultivation, it is necessary to take into account all the features of growth. With the age of the fish, the growth rate increases, as does the magnitude of the absolute increase. The highest increase in silver carp was noted at the age of 2-3 years.

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DOI 10.34660/INF.2023.11.72.157

阿布哈兹的中国木兰品种
CHINESE MAGNOLIA SPECIES IN ABKHAZIA

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注解。 苏呼米植物园木兰收藏中，东南部品种占有重要地位，其中中国植物的代表，以其观赏性、文化性朴素而著称，可广泛应用于阿布哈兹的城市和园林绿化。

关键词：苏呼米植物园、白玉兰、白玉兰、紫玉兰、德拉瓦伊玉兰、圆玉兰。

Annotation*. In the collection of magnolias of Sukhum Botanical Garden a significant place is occupied by South-Eastern species, among which representatives of Chinese flora are distinguished by their ornamentality, unpretentiousness of culture and can be widely used in urban and garden landscaping of Abkhazia.*

Keywords: *Sukhum Botanical Garden, Magnolia denudata, Magnolia biondii, Magnolia liliflora, Magnolia delavayi, Magnolia obovata.*

The magnolia collection in the Sukhum Botanical Garden is currently one of the best on the Black Sea coast of the Caucasus. A significant part of it consists of representatives of South-East Asia (Vasiliev, 1956; Karpun, 2010, Karpun, Khvartskiya, 2016), among them species representing the flora of China stand out:

Magnolia denudata **Desrouss** grows in Sinop Park (Sukhum). It was apparently planted at the foundation of the park, which was laid out in 1876-78 (Fig. 1).

Figure 1. *Magnolia denudata*

Spreading 4-stemmed tree, with loose crown, 15.0 m high, crown diameter 12 x 8 m. The main trunk splits into four from a height of 1 m, its diameter before splitting is 1 m. Annual shoots are greenish-brown, slightly pubescent. Leaves obovate, margin smooth, straight, apex elongate, pointed. Mature leaves of medium severity, green, slightly shiny, pubescent on the underside along the veins, with greyish bristles in the corners. Leaf size 12.5-21.5cm long, 7-12cm wide, light green petiole 2-3.5cm long.

Flowering is abundant. Buds are ovate, pointed, straight with greyish pubescence. Flower corolla is goblet-shaped, 14 cm in diameter, 9 cm high, 9-petalled. Petals are 9.5 cm long, 4-5 cm wide, loose, spatulate with a smooth edge. The colouring of the petals is white. Gynophore light green, carpels filiform, weakly curved. Androphorus burgundy with white dots at stamen attachment sites, anthers 1-1.2 cm long, slightly curved. The odour is strong and delicate. Fruits do not set.

***Magnolia biondii* Pampan** was introduced to the Sukhum Botanical Garden in 1935 at the age of 15 years This is an old-aged specimen (Fig.2).

It is a tree 15.5 m tall with a trunk diameter of 90 cm and a broadly trapezoidal crown 10 x 11.5 m. Annual shoots are green-greyish-brown, not pubescent. Leaves are obovate, 11.5-12.5 cm long, 5.2-6.7 cm wide, wavy at the edges with an elongated, pointed apex. Mature leaves are soft, light green, pubescent on the underside along the veins and in the corners of the veins, bristles greyish; petiole light green, 1.5-1.7 cm long.

Flowering is irregular. Buds are oval, straight, with brownish pubescence. Cup-shaped corolla, 6-8 cm in diameter and 7 cm high; 6-9 lobed; petals 6-7 cm long, 3-3.5 cm wide. Petals white with a purple stripe along the central vein on the outside, white inside. Gynophore green with short filiform, tightly adherent margins of carpels. Androphorus light green, anthers 1.8-2 cm long, curved, white-pink. The odour is pleasant. Fruiting is weak. Fruits are small-seeded (5-10 seeds) leaflets, curved, red. Seeds oval, black, seed sarcotesta orange-red.

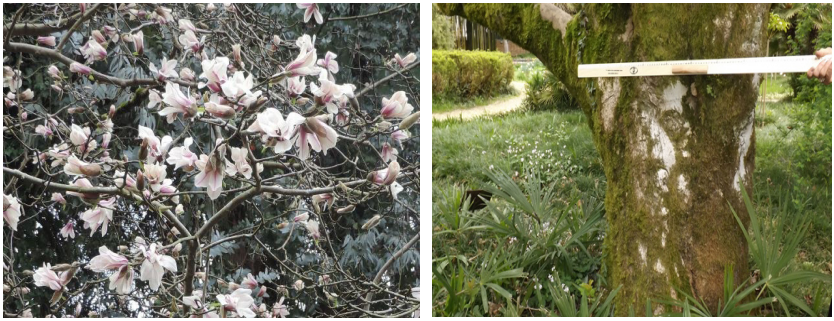

Figure 2. *Magnolia biondii*

Magnolia liliflora Desrouss - natural range Central and Western China (Hubei, Sichuan). In Russia in culture since 1790. Most widely distributed on the Black Sea coast of the Caucasus - from Tuapse to Batumi. In Sukhum Botanical Garden it was planted at the age of 15 in 1935.

Deciduous shrub or small tree up to 5 m tall, with a spreading dense crown. The branches are light grey, glabrous, intertwining. Leaves broadly elliptic or obovate, 9-18 cm long, 5-8 cm wide. Leaf petiole 1-2 cm long.

It is represented everywhere, including in this region, by garden forms (Bailey, 1927; Krussmann, 1977; Treseder, 1978; Callaway, 1999). All of them were long ago introduced to Europe, where they received European names, these are: *cv. Gracilis* (1807, syn.: *M. l. var. gracilis*), cv. *Purpurea* (1797, syn.: *M. purpurea* Curtis), and cv. *Reflorens* (1850).

Cv. *Gracilis* is a relatively low, multi-stemmed and thin-branched shrub with a pronounced aerial axil, especially with age. Flowers are small with narrow evenly coloured petaloids, fruits are formed very rarely. In Abkhazia it is propagated only by seeds and can be planted in rather dense groups. An old specimen grows in the Botanical Garden (Fig. 3).

Figure 3. *Magnolia liliflora cv. Gracilis*

Cv. *Purpurea* is a rather vigorously developed shrub with large trunk-branches and unexpressed xylem. Flowers are large, with narrowly ovate petaloids, dark purple in the lower part and lighter in the upper part. Single fruits with germinating seeds are produced, giving viable seedlings. It is desirable to plant single specimens. There is a strong opinion that this is the form that should be considered the type form for this species (Treseder, 1978; Callaway, 1999). There are large old specimens in Sinop Park and Sukhum Arboretum (Fig. 4).

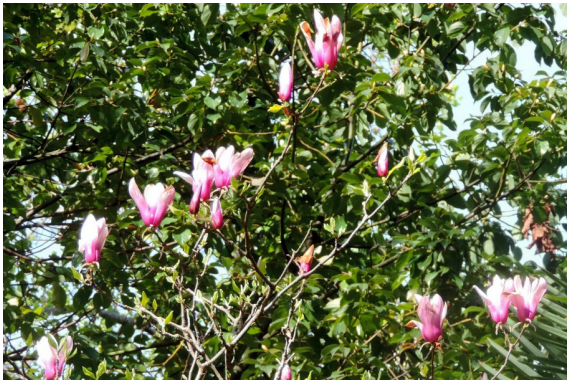

Figure 4. *Magnolia liliflora cv. Purpurea*

Cv. *Reflorens* is a well-developed, dense-crowned shrub. Spring flowering is long, flowers are large, with slightly twisted petaloids, red-purple outside and slightly reddish inside. Fruits form irregularly, seeds germinate.

Secondary flowering is normally observed in late summer-early autumn. Old specimens grow in Sinop Park and the Botanical Garden (Fig. 5).

Figure 5. *Magnolia liliflora cv. Reflorens*

Magnolia delavayi **Franch** is the only evergreen East Asian magnolia present in the region at present. It has been growing in the Sukhum Botanical Garden since 2009 (Fig. 6).

Figure 6. *Flower Magnolia delavayi*

It is a three-stemmed tree, 6.5 m high, with a dense spreading crown, 5 x 6 m in diameter.

Annual shoots are brown, pubescent. Leaves are broadly elliptic, wavy, 16-24 cm long, 5-6 cm wide. The leaf apex is acuminate. Mature leaves are very stiff, green. The pubescence is medium on the underside along the veins and in the corners. Flowering is medium. The buds are ovate, blunted, erect, not pubescent. During the daytime, only buds in various stages of development can be seen on *Magnolia delavayi*. The flower blooms in one day, opening at night.

The corolla of the flower is cup-shaped, 6 petals closed. Petals are 9-12 cm long and 5-8 cm wide. The colouring of the petals is milky-white on the outside and inside. Gynophore greenish, stigma cream, closed. Androphorus pink, anthers bent 2-3 cm long, 1-1.5 mm wide.

The plant did not first bear fruit until 2022, the fruit is full-grown, the seeds are mature.

Magnolia obovata **Thunb**. Natural range: China, Gui-Zhou, Hubei, Northern and Southern Japan, Far East of Russia.

Its occurrence in the natural flora of Russia is rare. It is included in the Red Book of the USSR. Cultivated in Russia since 1865. In Sukhum Botanical Garden since 1978; 8-year-old seedling, at planting 1.5 m high, received from Kiev. At the age of 55 years, deciduous tree 9.5 metres high, with a broadly pyramidal, somewhat loose crown.

Leaves are obovate, 30-40 cm long, 15-20 cm wide, green above and bluish-blue below. The leaf petiole is 3.5-5 cm. Flowers are cup-shaped, creamy-white, up to 10 cm in diameter, fragrant. Petals 9, sepals 3, obovate; stamens numerous, carmine-red. Fruit up to 20 cm long, bright red. Blooms after leaf blossom, April-May (Fig. 7).

Fruiting is good. Seeds are black, ripening in October.

In addition, there is another specimen of this species 53 years old, 10 m high, also flowering and fruiting.

Figure 7. *Magnolia obovata*

All the species mentioned in this article are high-mountainous, growing in nature at altitudes from 200 to 2000 metres above sea level. The plants cultivated in the Sukhum Botanical Garden, located in the lowland coastal zone, their vital state and ability to reproduce show their wide possibilities.

Our studies of biologo-ecological features allow us to characterise these species as ecologically plastic, capable of broadly changing adaptive response depending on growing conditions.

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DOI 10.34660/INF.2023.22.41.158

苏呼米植物园花卉观赏植物收藏中的中国植物代表
REPRESENTATIVES OF CHINESE FLORA IN THE COLLECTION OF FLORAL AND ORNAMENTAL PLANTS OF THE SUKHUM BOTANICAL GARDEN

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注解。 中国亚热带地区与阿布哈兹海滨地区自然气候条件有显着相似性，为引进提供了充分的机会。 在苏呼米植物园的收藏中，作为中国植物区系代表的花卉和观赏植物虽然不像乔木和灌木那样分布广泛，但仍然占有重要地位。

关键词：中国植物志、简介、花卉和观赏植物、苏呼米植物园收藏。

Annotation. *Natural and climatic conditions of subtropical areas of China and the seaside zone of Abkhazia have significant similarities, which provides ample opportunities for introduction. In the collection of Sukhumi Botanical Garden floral and ornamental plants - representatives of Chinese flora, are not as widely spread as tree and shrub species, but still occupy a significant place.*

Keywords: *Chinese flora, introduction, floral and ornamental plants, collections of Sukhumi Botanical Garden.*

The subtropical regions of China are the most interesting for attracting plants for cultivation in Abkhazia. Climatic analogues of these two regions are close enough (Vlasova, Arshinova et al., 2005; Adzinba, Bogaychuk, 2011) and create conditions for successful introduction.

Tree and shrub plants from China and Taiwan are very widely represented in the collection of Sukhumi Botanical Garden, where their growth and development are comparable to those in their native land.

Floral and ornamental plants from Southeast Asia are more modestly represented, although among them there are several colourful representatives of the Chinese flora, which are a very prominent component of our collection (Papazian, 2021).

Bletilla striata (*Bletilla striata* Reichb.fil.) from the *Orchidaceae* family takes the first place among well-represented species - this abundantly flowering plant

decorates our park for a month (May), is perfectly acclimatised, reproduces well on its own, is not damaged by diseases and pests (photo 1).

Photo 1. *Bletilla striata*

Of the great variety of hosta species and varieties in the Liliacaeae family in the Sukhum Botanical Garden, the Chinese species Hosta lancifolia (*Hosta lancifolia* Engl.) and especially its variegated forms occupy a prominent place in our collection (photo 2).

Photo 2. *Hosta lancifolia*

Liriope muscari (*Liriope muscari* (Decne.) L.H.Bailey) and its variegated form (cv. *Variegata)* of the Liliaceae family are indispensable plants for edging and zoning of various flower compositions of any configuration, propagated both by seeds and vegetatively (photo 3).

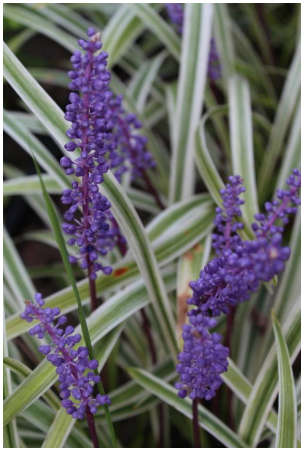

Photo 3. *Liriope muscari cv. Variegata*

The annual aster - Chinese aster (*Callistephus chinensis* Ness) of the *Asteraceae* family has been well represented in Abkhazia for a long time. It reproduces beautifully by seeds, blooms long and abundantly from early summer to deep autumn (photo 4).

Photo 4. *Callistephus chinensis*

Rohdea japonica (*Rohdea japonica* Roth) fam. *Liliaceae* ornamental throughout the year , in nature, in addition to Japan, are widely distributed in China and Taiwan. The plant is perfectly acclimatised, well propagated by seeds and vegetatively (photo 5)

Photo 5. *Rohdea japonica*

Anemone japonica (*Anemone japonica* Siebold. et Zucc. syn. A. *hupehensis* Boynton) fam. *Ranunculaceae* is perfectly adapted and reproduces perfectly independently, its native range includes subtropical regions of China (photo 6).

Photo 6. *Anemone japonica*

Of the recently added to our collection of flowering plants, Tricyrtis formosana (*Tricyrtis formosana* Baker), fam. Tricyrtis (*Tricyrtidacea*). This species quickly adapted, goes through all the main phenophases, and reproduces well. Blooms in winter (photo 7).

Photo 7. *Tricyrtis formosana*

Of the two species of lycoris (*Lycoris*) fam. Amaryllis (*Amaryllidaceae*) present in our collection, Lycoris radiate (*Lycoris radiate* Herb.), whose birthplace is China, Japan, acclimatised better, as it gives mature seeds, from which the offspring of its own reproduction is obtained (photo 8).

Photo 8. *Lycoris radiate*

Also, in the Sukhum Botanical Garden are presented: Persicaria sinica (*Persicaria sinica* Migo) fam. *Polygonaceae*, Hydrangea paniculata (*Hydrangea paniculata* Sieb.) fam. *Saxifragaceae*, Rehmannia elata (*Rehmannia elata* N.E. Brown) fam. *Scrophulariaceae*, Roscoea cautleoides (*Roscoea cautleoides* Gagnep.) fam. *Zingiberaceae*, Pleione formosana (*Pleione formosana* Hayata) fam. *Orchidaceae*, which are currently undergoing initial introduction testing.

As can be seen from this brief review, all Chinese species have fully acclimatised in the conditions of Abkhazia, have the potential for self-renewal and the widest possible use in ornamental gardening.

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DOI 10.34660/INF.2023.11.27.159

苏呼米植物园收藏的中国原产新植物
NEW PLANTS OF CHINESE ORIGIN FOR THE COLLECTION OF THE SUKHUM BOTANICAL GARDEN

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注解。 文章介绍了近年来苏呼米植物园收藏的三种原产于中国的植物。 它们都具有良好的适应能力，经过主要物候期，能够自我更新，具有很强的装饰性，并且对景观设计很有意义。

关键词：中国、射干、大花菊、地黄、苏呼米植物园收藏。

Annotation. *The article presents three species of plants of Chinese origin, which have been added to the collection of Sukhum Botanical Garden in recent years. All of them are well adapted, pass the main phenophases, are capable of self-renewal, are highly decorative, and are of interest for landscape design.*

Keywords: *China, Belamcanda chinensis, Incarvillea grandiflora, Rehmannia elata, Sukhum Botanical Garden collection.*

Florists all over the world consider it their primary task to enrich the existing, in one or another region of the globe, established assortment. This happens by attracting new plants that have not been previously cultivated in the given conditions. For Abkhazia, whose ornamental floriculture is primarily based on introduced plants, this problem is also very relevant.

Wide introduction possibilities of the coastal strip of Abkhazia create all conditions for large-scale work on attracting new plants

The geography of the main sources of introduced plants is determined for a given flora by its current geographical and floristic relations with other floras of the Earth, i.e. on the basis of their common origin, and in cases where there is no such kinship, on the basis of phytoclimatic analogy.

The subtropics of Transcaucasia are entirely included in the floristic area of the Ancient Mediterranean. This flora is connected in its origin, first of all, with the floras of Southeast Asia and America, and it is these floras that include the most promising plants for introduction into this region.

In the Asian part, the most interesting region for us is Southeast Asia, a macro-region, the subtropical part of which has a climate most similar to the natural and climatic conditions of Abkhazia.

Common features of climate, as well as common origin, allow us to consider South-East Asia, and first of all China, as one of the most suitable points of introduction to Abkhazia.

The collection of floral and ornamental plants of the Botanical Institute of ASA is constantly being replenished. New taxa that have not been cultivated in the region before are being introduced and the most promising ones are selected. We find it most interesting to consider a few plants of Chinese origin that have recently been added to the collection of the Sukhum Botanical Garden.

Belamcanda chinensis **(***Belamcanda chinensis* DC**)** is a representative of a monotypic genus of the Iris family (*Iridaceae*). It is native to China and Japan (Mironova, 2008; Alekseeva, 2009; Gudrun, 1984). Based on molecular studies, in 2005 the species was included in the genus *Iris* - Iris domestica *(Iris domestica* Goldblatt & Mabb*)*. It has not been cultivated in Abkhazia before. In the Sukhumi Botanical Garden since 2017 - one of the most unpretentious and fast multiplying plants.

Perennial herbaceous plant. Rhizome is short. Leaves are sword-shaped, bluish-green, 85-90 cm, arranged in one plane.

Inflorescence is a broadly branched brush. Flowers are yellowish-orange with dark purple speckles. The flower is wide open, with 6 petals, arranged, like the leaves, practically in one plane. The diameter of the flower is 5-7 cm. The number of flowers in an inflorescence is 20-25, each flower lives one day. The total number of flowers on one plant is from 60 to 110. Flowering is long (July-October) (Fig. 1). Fruits begin to set as early as in July, as individual flowers bloom, so that the entire flowering period can be observed both flowering and fruiting at the same time, which gives the plants additional decorativeness. The fruit is a three-nested boll 3-5 cm long. Seeds are large, black, shiny (0.5-0.7 cm) from 12 to 22 pieces in one box. Seed germination is high up to 98 %. Already planted in the park on a permanent place, more than 80 seedlings obtained from their own seeds. The plant is also perfectly vegetatively propagated; it is completely undemanding in care, as well as unpretentious to growing conditions.

Period of ornamentation

month	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**
leaves												
blossoms												

Figure 1. *Belamcanda chinensis. General view, flower*

Incarvillea (*Incarvillea Juss*) fam. *Bignoniaceae*. 17 species of perennial herbaceous plants growing from China to Central Asia (Sergienko, 2008; Karpun, 2012; Preston, 1953; McKean, Cann, 2011).

Incarvillea grandiflora (*Incarvillea grandiflora* Bureau & Franch.) is a summer-green plant, vegetation begins in early spring, leaves are in a root rosette, non-pinnately palmately tomentose, the margin of leaflets sometimes finely toothed. Inflorescence is a brush with bracts and bracteoles. Flowers are large, five-divided, calyx bell-shaped, corolla tubular bilaterally symmetrical. Stamens 4, pistil with bipartite stigma, naked. Colouring is white or deep pink, depending on the variety. Blooms in May-June. The fruit is a boll, the seeds are pubescent (Fig. 2). Plant height is 25-30 cm. It prefers open sunny places, however, it can grow in partial shade.

Period of ornamentation

month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
leaves												
blossoms												

Figure 2. *Incarvillea grandiflora. General view. Fruit. Seeds*

Rehmannia (*Rehmannia Libosch* ex Fisch. & Mey.) fam. *Scrophulariaceae*. 11 species of herbaceous plants from Southeast Asia (Karpun, 2012; Good, 1965).

Rehmannia elata (*Rehmannia elata* N.E.Brown) - native to China, perennial herbaceous plant, 40-60 cm tall, compact, beautifully shaped, densely branched. Leaves are dark green, acuminate-ovate or broadly triangular, toothed and notched. Flowers are rather large, funnel-shaped, 5-divided on a bend, pharynx light with small spots, tube length 7-8 cm, dia. 4.5-5 cm. Inflorescence has 7-8 flowers of dense pink colour (Fig. 3). Flowering is abundant, long-lasting (May-September). It is propagated by seeds and division. It is undemanding to light.

Figure 3. *Rehmannia elata*

Period of ornamentation

month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
leaves												
blossoms												

Based on the ornamental value of these plants, we can recommend them for expanding the existing green areas in Abkhazia and creating new ones. Work with the selected crops has shown their universal possibilities for use in flower beds for various purposes.

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DOI 10.34660/INF.2023.88.42.160

在阴影区域的花卉和装饰设计中使用阿布哈兹植物代表的可能性
POSSIBILITIES OF USING REPRESENTATIVES OF ABKHAZIAN FLORA IN FLORAL AND DECORATIVE DESIGN OF SHADED AREAS

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抽象的。 本文介绍了阿布哈兹植物区系的五种代表，它们很好地适应了阿布哈兹黑海沿岸的低地部分。 由于观赏价值高且开花时间长，可建议用于阴影区域的景观美化。

关键词：阿布哈兹黑海沿岸、Coronilla varia、Ajuga reptans、碎米荠、Trachystemon orientale、天竺葵、阴凉地区景观。

Abstract. *The article presents five representatives of the flora of Abkhazia, which are well adapted in the lowland part of the Black Sea coast of Abkhazia. Due to high ornamental value and duration of flowering can be recommended for landscaping of shaded areas.*

Keywords: *Black Sea coast of Abkhazia, Coronilla varia, Ajuga reptans, Cardamine bulbifera, Trachystemon orientale, Geranium robertianum, landscaping of shady areas.*

The Republic of Abkhazia is located on the coast of the Black Sea and is practically a year-round resort, which makes the issue of landscaping landscape and park areas and especially shady areas very relevant.

The study of literature sources available to us shows that almost all authors suggest using forest perennials in landscaping shady areas (Bilibina, 1990; Karpisonova, 2015; Lunina, 2011). Since Abkhazia is a mountainous country, most herbaceous perennials are distributed in the forest zone from 1800 to 2500 m. altitude. Many of them are highly ornamental, long and abundant flowering, it would be desirable to attract them for landscaping of the seaside strip, but as a rule, most of them are poorly adapted in the conditions of the lowland zone. However, we have studied and can offer 5 highly decorative plants of local flora of Abkhazia - Coronilla varia (*Coronilla varia* L.), Geranium robertianum (*Geranium rober-*

tianum L.), Ajuga reptans (*Ajuga reptans* L.), Cardamine bulbifera (*Cardamine bulbifera* (L.) Grantz), Trachystemon orientale (*Trachystemon orientale* (L.) D. Don), which can be used in landscaping on the coast.

We give a description of these species on the territory of the Sukhum Botanical Garden, located at an altitude of 23 m above sea level.

Coronilla varia fam. *Papilionaceae*, native to Southern Europe, Southwest Asia and North Africa, naturalised in the Caucasus (Yabrova-Kolakovskaya, 1959).

Perennial herbaceous plant, 30-40 cm tall. Stems lobed, branched to 60 cm. Bracts are small, lanceolate, free, 2-3 mm long. Leaves are regular, unpaired, 4-16 cm long. Inflorescence is umbrella-shaped, 5-6 cm in diameter, flowers are pink, drooping, 12-20 in inflorescence (Fig.1). The fruit is a bean (Kolakowski, 1982). Blooms from May to September.

It is not damaged by diseases and pests.

Propagated by seeds and vegetatively.

Figure 1. *Coronilla varia*

Geranium robertianum fam. *Geraniaceae*. It grows throughout the forest belt of the Caucasus up to 2000 m (Kolakowski, 1982).

A very common plant found in all types of forests, where it usually grows on suede stones (Kolakovsky, 1982). Stem erect, glandularly pubescent, 20-35 cm tall. Leaves (3-4 cm long and 4-6 cm wide) are ovate or elongate-pentagonal, divided to the base into almost rhombic, pinnately dissected, sharply or obtusely toothed lobes, of which the middle one on a long petiole, the lateral ones on short ones, or sessile. Sepals are ovate-lanceolate, ovate-lanceolate, long pubescent, with a long pointed tip. Flowers are pink, 3-4 cm in diameter. Seeds are wrinkled

or roughly veined. Blooms from the first decade of May to the second decade of July (Fig. 2).

It is propagated by seeds and vegetatively.

It is not damaged by diseases and pests.

Figure 2. *Geranium robertianum*

Ajuga reptans fam. *Lamiaceae*. The species' range covers practically the whole of Europe, including the European part of Russia and the Caucasus. It is also found in Iran and Turkey, and in North Africa in Algeria and Tunisia (Kolakowski, 1982).

The rhizome is short. Leaves are soft, oval, with wavy notched and shortly toothed margins; shortly pubescent. Root leaves are gathered in rosettes up to 8 cm high, long creeping rooting shoots emerge from the rosettes. Rosette leaves of creeping creeper, unlike some other species of this genus, are preserved during flowering. Flower stalks are up to 35 cm tall. Inflorescences are spike-like, gathered in whorls of 6-8 pieces. Calyx is pubescent, up to 7 mm long, bell-shaped, with five triangular teeth, corolla length 1.2-1.7 cm, colour blue (Fig. 3). The fruit is a rounded, light-brown polycarp. Flowering period is May-September.

Propagated by seeds and vegetatively.

It is not damaged by diseases and pests.

Figure 3. *Ajuga reptans*

Cardamine bulbifera fam. *Cruciferae*. Grows in broad-leaved and mixed forests of European Russia and the Caucasus (Gubanov, 1976; Kolakovsky, 1982).

Perennial herbaceous plant with a fleshy creeping rhizome. Stems are erect, 30-50 cm tall, leaf arrangement is spiral, the lower ones are unpaired, with 3-5 oblong-lanceolate, bluntly toothed segments, the upper ones are oblong, entire. Inflorescences are shield-shaped small-flowered brushes. Flowers are pink, 1-1.5 cm in diameter (Fig. 4). The fruit is narrow-linear pods. Blooms from March to May.

Propagated by seeds and vegetatively.

It is not damaged by diseases and pests.

Figure 4. *Cardamine bulbifera: general view, inflorescence*

Trachystemon orientale family *Boraginaceae*. In nature it is found in Europe and Asia Minor. In Abkhazia in the forest belt, up to the upper forest edge. It is often found in deciduous and fir forests, where it forms a characteristic tier and determines forest types (Kolakovsky, 1982).

The rhizome is thick, with a large number of cord-like adventitious roots. The stem is solitary, erect, succulent, 10-30 cm tall, pubescent with stiff hairs, glandular on the inflorescence. Root leaves are long-petiolate, broadly ovate or heart-shaped, small during flowering, then increasing to 30 cm long and 22 cm wide, scatteredly pubescent on both sides. Stem leaves are oblong, narrowed at the base, up to 3 cm long and 2 cm wide. Flowers in axillary whorls forming a paniculate inflorescence, developing before the lower leaves appear. The calyx is up to 4 mm long, long-bristly pubescent on the outside, divided almost to the base. Corolla is light bluish-purple, long-bristly pubescent on the outside, with narrowly linear spirally twisted lobes. Leaves are decorative almost all year round (Figure 5). Blooms from the third decade of March to the third decade of April.

Propagates by seeds and vegetatively.

It is not damaged by diseases and pests.

Figure 5. *Trachystemon orientale: general view, inflorescence*

The proposed plants can be widely used in landscape design of shady and heavily shaded areas in all types of landscaping in pure and mixed plantings, in large masses, in groups and as lawns. Robert's Geraniums can also be planted in flowerbeds, rambarts and borders.

Also all these plants look good in vases and containers. When decorating shaded areas, first of all you should pay attention to the colour of the flowers, because not all colours look good in the shade. All plants considered by us have colour of flowers from light pink to bright blue, which allows them to stand out in conditions of low light.

These characteristics of the studied plants make it possible to create a "non-conflict garden", the concept of which implies the selection of plants according to the conditions and not vice versa.

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DOI 10.34660/INF.2023.54.80.161

同时接触焊接气溶胶和烟草烟雾会增加患呼吸道疾病的风险

COMBINED EXPOSURE TO WELDING AEROSOL AND TOBACCO SMOKE INCREASES THE RISK OF DEVELOPING RESPIRATORY DISEASES

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注解。 焊接气溶胶是最常见的工业烟雾之一，而烟草烟雾是最常见的家庭健康危险因素。 该研究的目的是研究焊接气溶胶和烟草烟雾单独和综合影响下呼吸系统疾病的结构和患病率。 材料与方法。 研究了地下矿山矿工的体检数据以及对这些企业工作条件的专门评估。 结果。 550 名焊工中有 176 名 (32.0%) 检测出呼吸道疾病，吸烟者比不吸烟者更常见：39.8% 和 19.9%，p<0.001。 吸烟会增加鼻中隔偏曲导致呼吸功能障碍的风险（相对风险 (RR)=1.78；置信区间 (CI) 1.10-2.88；p=0.016）、慢性支气管炎（RR=3.33；CI 1.51-7.34；p= 0.001）和慢性阻塞性肺疾病（RR=6.47；CI 0.83-50.2；p=0.039）。 与非吸烟者的差异在吸烟指数为 10-19.9 包/年时出现，并且随着吸烟指数每 10 包/年增加，发生呼吸系统疾病的风险也会增加。 结论。 戒烟应成为保护接触焊接烟雾的工人健康计划的强制性内容。

关键词：工作条件； 焊接气雾剂； 吸烟； 呼吸疾病。

Annotation. *Welding aerosol is one of the most common industrial, and tobacco smoke is the most common household health risk factor. The aim of the study was to study the structure and prevalence of respiratory diseases under separate and combined effects of welding aerosol and tobacco smoke. Material and methods. The data of medical examinations of miners of underground mines and a special assessment of working conditions at these enterprises were studied. Results. Respiratory diseases were detected in 176 (32.0%) out of 550 welders, more often in smokers than in non-smokers: 39.8% and 19.9%, p<0.001. Smoking increased the risk of developing respiratory dysfunction due to deviated nasal*

septum (relative risk (RR)=1.78; confidence interval (CI) 1.10-2.88; p=0.016), chronic bronchitis (RR=3.33 ; CI 1.51-7.34; p=0.001) and chronic obstructive pulmonary disease (RR=6.47; CI 0.83-50.2; p=0.039). Differences with non-smokers arose at a smoking index of 10-19.9 pack/years, and the risk of developing respiratory pathology increased with an increase in the smoking index for every 10 pack/years. Conclusion. Smoking cessation should be a mandatory element of programs to protect the health of workers exposed to welding fumes.

Keywords: *working conditions; welding aerosol; tobacco smoking; respiratory diseases.*

Introduction. Welder is one of the most common modern professions. According to WHO experts, about 11 million people in the world have this profession, and about 110 million more people are regularly exposed to welding fumes at their workplaces [1]. Their impact may be associated with the development of acute and chronic diseases of the upper and lower respiratory tract, damage to the alveoli and other lung structures [2]. Respiratory diseases diagnosed in welders include chronic pharyngitis, laryngitis, bronchitis, chronic obstructive pulmonary disease, bronchial asthma, cancer of the lungs and bronchi, pneumoconiosis [3, 4].

In recent decades, it has been proven that in the form of suspended particles in the vapor phase of tobacco smoke there are more than 4 thousand different chemical compounds that have toxic, carcinogenic and other negative effects on the human body. The etiological role of tobacco smoking in the development of respiratory diseases is beyond doubt [5]. The problem of smoking among workers exposed to aerosols of harmful industrial chemicals deserves special attention. It is known that 47.7% of pyrometallurgical workers and 54.1% of workers in rough copper production, 58.0% of underground electricians, and 63.4% of underground miners smoke [6, 7]. Given the scale of the problem, new knowledge about the causes of development, structure and prevalence of respiratory diseases in these categories of workers is of scientific and practical interest.

The purpose of the study: to study the structure and prevalence of respiratory diseases under separate and combined effects of welding aerosol and tobacco smoke.

Material and methods. The results of periodic medical examinations of workers in underground apatite-nepheline and copper-nickel mines in the Murmansk region (Russia), as well as certification data (special assessment of working conditions) of workplaces at these enterprises, were studied. The main group consisted of 550 welders and electricians, whose functional duties included manual arc welding. The control group included 443 drivers of an underground electric locomotive (brands K-10 and K-14) and a freight electric locomotive (brands VL10, VL22m). The difference between the control group and the main one was

the absence of exposure to welding aerosol. To assess the effect of duration and intensity of smoking, the smoking index (SI) was calculated.

Statistical processing of the study results was carried out using Microsoft Excel 2016 and Epi Info, v. 7.0. Student's t-test, chi-square test, relative risk (RR), and 95% confidence interval (CI) were calculated. Numerical data are presented as absolute values, percentage, arithmetic mean and standard error of the arithmetic mean (M±m). The critical significance level of the null hypothesis was 0.05.

Results. The hygienic assessment of working conditions showed that the workers of the main group had the most significant exposure to harmful chemical factors. It was mainly determined by the influence of welding aerosol components (manganese, chromium trioxide, carbon monoxide). In the control group, only the maximum levels of trinitrotoluene and nitric oxide exceeded the allowable values within class 3.1. The drivers of a freight electric locomotive also had a class 3.1 level of nitric oxide. Of the other factors that could be associated with the formation of pathology of the respiratory system, only the maximum level of dust among the drivers of the underground electric locomotive exceeded the hygienic standards. The final assessment of working conditions for workers in the main and control groups met the criteria of class 3.2. For welders, it was determined mainly by the chemical factor, for drivers of an underground electric locomotive - by noise, and for a freight electric locomotive - by labor intensity (Table 1).

Table 1

Hygienic assessment of working conditions of workers of the main and control groups

Harmful factor	Welder electrician	Underground locomotive driver	Freight locomotive driver
1. The severity of labor	Class 3.1	Class 3.1	Class 2
2. Labor intensity	Class 2	Class 2	Class 3.2
3.Noise, dbA (equivalent noise level)	Class 3.1 (83)	Class 3.2 (86)	Class 3.1 (83)
4. Infrasound, db	Absence	Absence	Class 3.1 (103)
Non-ionizing radiation (ultraviolet irradiation)	Class 3.1	Absence	Absence
5. Trinitrotoluene, mg/m3 Maximum concentration Average per shift concentration	Class 2 (0,39) Class 2 (0,31)	Class 3.1 (0,81) Class 2 (0,33)	Class 2 (0,16)
6. Manganese, mg/m3 Maximum concentration Average per shift concentration	Class 3.1 (0,5) Class 2 (0,08)	Absence	Absence

7. Carbon monoxide, mg/m3 Maximum concentration Average per shift concentration	Class 3.1 (37,5) Class 2 (7,3)	Class 2 (10,2) Class 2 (6,0)	Класс 2 (18,4)
8. Nitrogen oxides, mg/m3 Maximum concentration Average per shift concentration	Class 3.1 (14,4) Class 2 (2,5)	Class 3.1 (6,7) Class 2 (0,3)	Класс 3.1 (11,4)
9. Chromium trioxide, mg/m3 Maximum concentration Average per shift concentration	Class 3.1 (0,015) Class 2 (0,009)	Absence	Absence
10. Dust, mg/m3 Maximum concentration Average per shift concentration	Class 2 (5.4) Class 2 (2.5)	Class 3.1 (7,9) Class 2 (2,5)	Class 2 (4,1) Class 2 (1,2)
11. Final assessment of working conditions	Class 3.2	Class 3.2	Class 3.2

The results of clinical trials were analyzed in 993 workers. All of them were men, the average age of which was from 37.0±0.6 to 38.8±0.8 years, and the length of service was from 11.6±0.4 to 12.8±0.7 years. In smokers, SI was 11.8±0.5 (main group) and 12.5±0.5 (control group) pack-years. The proportion of regular smokers in the main and control groups was 60.7% and 57.5%, respectively. There were no significant age-experience differences and differences in the degree of exposure to tobacco smoke between the two groups. Respiratory diseases were diagnosed in 32.0% of workers in the main group and in 28.9% of workers in the control group (p=0.147). In the structure of respiratory pathology, the first place was occupied by the curvature of the nasal septum with impaired respiratory function. The second or third places were occupied by chronic diseases of the upper respiratory tract (chronic rhinitis, chronic tonsillitis, chronic laryngitis, etc.) and chronic bronchitis. Differences between the two groups were only in a higher proportion of chronic obstructive pulmonary disease (p=0.033) and bronchial asthma (p=0.043) in workers exposed to welding fumes.

The effect of smoking was more pronounced in the main group (Table 2), manifested by an increased risk of developing respiratory dysfunction in case of deviated septum (RR=1.78; CI 1.10-2.88; p=0.016), chronic bronchitis (RR =3.33; CI 1.51-7.34; p=0.001) and chronic obstructive pulmonary disease (RR=6.47; CI 0.83-50.2; p=0.039). In the control group, smoking increased the risk of developing only chronic bronchitis (RR=2.92; CI 1.12-7.64; p=0.021). The overall risk determined for the occurrence of all five studied diseases of the respiratory system

in smokers was increased both in the main (RR=2.00; CI 1.48-2.70; p<0.001) and control (RR=1 .61; CI 1.16-2.22; p=0.003) group.

Table 2

Structure and prevalence of respiratory diseases in the main and control groups, cases (%)

Respiratory diseases	Main group			Control group		
	Smokers (n=334)	Non-smokers (n=216)	Total (n=550)	Smokers (n=256)	Non-smokers (n=187)	Total (n=443)
Deviated septum of the nose with impaired respiratory function	55 (16,5)	20 (9,3)*	75(13,6)	42(16,4)	23 (12,3)	65 (14,7)
Chronic diseases of the upper respiratory tract	27 (8,1)	12 (5,6)	39 (7,1)	23 (9,0)	12 (6,4)	35 (7,9)
Chronical bronchitis	36 (10,8)	7 (3,2)*	43 (7,8)	20 (7,8)	5 (2,7)*	25 (5,6)
Chronic obstructive pulmonary disease	10 (3,0)	1 (0,5)*	11 (2,0)	2 (0,8)	-	2 (0,5)#
Bronchial asthma	5 (1,5)	3 (1,4)	8(1,5)	1 (0,4)	-	1 (0,2)#
Total:	133 (39,8)	43 (19,9)*	176(32,0)	88 (34,4)	40 (21,4)*	128(28,9)

Note. * - statistically significant differences (p<0.05) between smokers and non-smokers; # - differences between the main and control groups.

In both groups, the influence of the degree of exposure to tobacco smoke on the occurrence of respiratory diseases was studied (Table 3). In the main group (against the background of exposure to welding aerosol) with SI <10 pack/year, there was no increase in the risk of developing pathology compared to non-smokers. With an SI of 10 – 19.9 pack/year, there was an increase in the risk of developing respiratory dysfunction (RR=1.96; CI 1.10-3.49; p=0.020), chronic bronchitis (RR=4.21; CI 1, 77-10.0; p<0.001) and chronic obstructive pulmonary disease (RR=7.85; CI 0.89-69.4; p=0.028) compared with non-smokers. An increase in SI to 20 or more pack/years was accompanied by a further increase in the risk of developing respiratory dysfunction in case of nasal septal deformity (RR=2.61; CI 1.42-4.79; p=0.002), chronic bronchitis (RR=4.48 ; CI 1.74-11.54; p<0.001) and chronic obstructive pulmonary disease (RR=17.4; CI 2.07-146.4; p=0.0003), as well as the appearance of an increased likelihood of chronic diseases upper respiratory tract (RR=2.59; CI 1.14-5.86; p=0.020). It is important to note that the risk of developing respiratory dysfunction with deviated septum and chronic bronchitis increased with each increase in EC by 10 pack/year.

In the control group, the effect of changes in the degree of exposure to tobacco smoke on the development of respiratory pathology was less pronounced. With an SI of 10–19.9 pack/year, there was only an increased risk of developing chronic bronchitis (RR=3.08; CI 1.04–9.18; p=0.033). With an SI of 20 or

more pack/years, the risk of developing chronic bronchitis continued to increase (RR=5.45; CI 2.13-13.9; p<0.001), and there was also an increased risk of developing respiratory dysfunction in case of deviated nasal septum (RR =1.91; CI 1.02-5.58; p=0.045) and chronic diseases of the upper respiratory tract (RR=2.75; CI 1.23-6.16; p=0.012). The cumulative risk determined for the occurrence of all five respiratory diseases studied in the main group increased with an increase in SI for every 10 pack/years: with an increase from <9 to 10-19.9 pack/years (RR = 1.99; CI 1 .40-2.81; p<0.001) and with an increase from 10-19.9 to ≥ 20 pack/year (RR=1.66; CI 1.28-2.16; p<0.001). In the control group, the overall risk of developing five respiratory diseases increased only with an increase in SI from 10-19.9 to ≥ 20 pack/year (RR=1.90; CI 1.34-2.71; p=0.0005).

Table 3

Influence of the smoking index value (pack/years) on the structure and prevalence of respiratory diseases in smokers of the main and control groups, cases (%)

Respiratory diseases	Main group				Control group			
	Non-smokers (n=216)	< 10 (n=182)	10-19,9 (n=110)	≥ 20 (n=62)	Non-smokers (n=187)	< 10 (n=108)	10-19,9 (n=97)	≥ 20 (n=51)
Deviated septum of the nose with impaired respiratory function	20 (9,3)	20 (11,0)	20[1,3] (18,2)	15[2,4,5] (24,2)	23 (12,8)	13 (12,0)	17 (17,5)	12[2](21,6)
Chronic diseases of the upper respiratory tract	12 (5,6)	10 (5,5)	8 (7,3)	9[2,4,5] (14,5)	12 (6,4)	7 (6,5)	7 (7,2)	9[2,4,5](17,6)
Chronical bronchitis	7 (3,2)	7(3,8)	15[1,3] (13,6)	14[2,4,5] (22,6)	5(2,7)	3 (2,8)	8[1] (8,2)	9[2,5](17,6)
Chronic obstructive pulmonary disease	10,5)	1(0,5)	4[1] (3,6)	5[2](8,1)	-	-	-	2 (3,9)
Bronchial asthma	3 (1,4)	2 (1,1)	1 (0,9)	2 (3,2)	-	1 (0,9)	-	-
Total:	43 (19,9)	40 (22,0)	48[1,3] (43,6)	45[2,4,5] (72,6)	40 (21,4)	24 (22,2)	32[1, 3] (33,0)	32[2,4,5] (62,7)

Note. 1 - statistically significant differences (p<0.05) between non-smokers and smokers with SI 10-19.9 pack/year; 2- between non-smokers and smokers with SI ≥ 20 pack/year; 3- between smokers with SI<10 pack/years and smokers with SI 10-19.9 pack/years; 4- between smokers with SI <10 pack/years and smokers with SI ≥ 20 pack/years; 5- between smokers with SI 10-19.9 pack/year and smokers with SI ≥ 20 pack/year.

The influence on the nature of chronic pathology of the respiratory organs of various durations of exposure to harmful production factors (experience) was studied. For this, 3 work periods were allocated: up to 10 years, 10-19 years and 20 years or more. In order to exclude the effects of smoking, only non-smokers were included in these studies. It was established that neither in the main nor in the control group did any significant changes in the structure and prevalence of respiratory pathology occur with different durations of exposure to harmful production factors.

Discussion. A number of facts deserving attention and discussion have been established. Firstly, it was found that non-smoking welders and electric locomotive drivers had a similar structure and prevalence of respiratory diseases. The experience did not significantly affect them, although the exposure to harmful industrial chemicals, which included welding aerosols, was significantly higher among welders. A likely explanation is the effectiveness of personal respiratory protection equipment during welding.

The data obtained contradict the results of the study, which showed that with the increase in experience, the number of welders suffering from respiratory diseases increases [8]. However, it should be noted that this work did not take into account the influence of either the fact of smoking or the degree of exposure to tobacco smoke. At the same time, our results are consistent with the data that in miners smoking significantly increases the frequency and severity of chronic obstructive pulmonary disease and silicosis [9], and also that the contribution of smoking to the development of chronic obstructive pulmonary disease in metallurgical workers is 5 times higher than the contribution industrial aerosols [10].

It is important to note a more pronounced effect of smoking on the risk of respiratory diseases in welders than harmful working conditions. Moreover, the degree of its negative impact progressively increased with increasing exposure to tobacco smoke and was more significant (with the same exposure indicators) than that of electric locomotive drivers. Exposure to harmful production factors (estimated by experience) did not have such an effect. Probably, this may be a consequence of the mutual potentiation of the negative effect of the components of welding aerosol and tobacco smoke, leading to more frequent formation of respiratory diseases.

One explanation for the difference in the effects of welding aerosols and tobacco smoke may be that personal protective equipment largely prevents the chemicals generated during welding from entering the respiratory system. On the contrary, tobacco smoke freely penetrates the respiratory tract and alveolar tissue of a smoker. Especially dangerous is smoking in the workplace, when, due to the lack of personal protective equipment, the combined effect of the components of welding and tobacco aerosols on the respiratory system becomes possible.

The phenomenon of potentiation of the action of a harmful production factor (water-soluble salts of nickel) and tobacco smoke was previously revealed among workers in the nickel electrolysis process. The combined effect of smoking and occupational hazards increased the risk of developing chronic bronchitis compared to exposure to occupational factors alone (RR=3.92; p<0.001) and smoking alone (RR=1.58; p=0.013). When exposed to nickel aerosols, an increased risk of developing chronic bronchitis occurred at an SI of 4.79±0.06 pack/year, while in auxiliary workshop workers it was at an SI of 6.07±0.23 pack/year [11].

Conclusion. In welders, smoking increases the risk of nasal breathing disorders, chronic bronchitis and chronic obstructive pulmonary disease. The negative impact of smoking is manifested at SI≥10 pack/years, and at SI≥20 pack/years there is an additional increased risk of chronic diseases of the upper respiratory tract. In the development of respiratory pathology, smoking and the degree of exposure to tobacco smoke are more important than the effect of welding aerosol. The obtained data show that smoking cessation should be an obligatory element of health protection programs for workers exposed to welding fumes.

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DOI 10.34660/INF.2023.55.82.162

带牙套受试者的现代口腔卫生分析方法
MODERN ORAL HYGIENE ANALYSIS METHODS AMONG SUBJECTS WITH BRACES

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注解。 现代牙科科学正在积极研究医源性病理学问题，以防止其发展并尽量减少可能的后果。 由于正畸患者使用固定矫治器进行治疗会导致这种病理的发生和发展，因此研究其预防方法是一项重要的任务。

关键词：正畸，口腔重大疾病的预防，卫生指标，固定正畸矫治器。

Annotation*. Modern dental science is actively investigating the problem of iatrogenic pathology in order to prevent its development and minimize possible consequences. Since the treatment of orthodontic patients with fixed appliances can cause the occurrence and development of this pathology, the study of methods for its prevention is an important task.*

Keywords: *orthodontics, prevention of major dental diseases, hygiene index, fixed orthodontic appliance.*

Introduction.

Recently, there has been a significant increase in the use of fixed orthodontic structures in the correction of malocclusion [1, 3, 4, 5, 6, 9]. Therefore, there is a need to explain to the patient the role and importance of oral hygiene procedures in order to visually assess the change in the hygienic state of the oral cavity in orthodontic patients [2, 3, 5, 7, 9]. For this, the Index of Hygiene of Fixed Orthodontic Construction (IH FOC) was developed, the indicators of the index are shown in Table 1.

Study population and methodology.

For the clearest assessment of the hygienic state of the oral cavity in a patient with fixed orthodontic appliances, without evaluating each tooth, teeth from the

four quadrants were selected: 1.6, 1.1, 2.4, 3.5, 4.2, 4.7. This indicator allows you to track changes in oral hygiene in patients with fixed orthodontic appliances.

Table 1.

Parameters of the hygiene index of a fixed orthodontic construction

№	Indicator name	Indicator characteristics	Points
1	available/not available brace	no	0
		yes	1
2	available/not available plaque on the vestibular surface of tooth 11 and brace	no	0
		yes	1
3	available/not available plaque on the oral (palatal) surface of 16th tooth and braces (if there are internal braces)	no	0
		yes	1
4	available/not available plaque on the mesial-vestibular surface of 24th tooth and braces	no	0
		yes	1
5	available/not available plaque on the distal-vestibular surface of 35th tooth and brace	no	0
		yes	1
6	available/not available plaque on the mesial-vestibular surface of the 42th tooth and braces	no	0
		yes	1
7	available/not available plaque on the distal-oral surface of the 47th tooth and braces (in the presence of internal braces)	no	0
		yes	1

In the absence of a tooth, indices were calculated for only the indicated teeth. To facilitate plaque detection, dissolution indicator tablets can be used.

Thus, the Hygiene Index of a fixed orthodontic structure is the sum of the scores obtained for all the criteria described, divided by the number of criteria.

Formula:

$$\text{IH FOC} = \frac{\sum(a_1+\ldots+a_n)}{n}$$

where $\sum$ - a sum of quantitative indicator assessments;

a_1 – a value for the first indicator;

a_n – a value for the n-indicator;

n – number of indicators used in the index.

In our index, the number of indicators is equal to 7, so the formula for the index will look like this:

$$\text{IH FOC} = \frac{\sum(a_1+\ldots+a_7)}{7}$$

In the numerator, the value of the sum of the indicators fluctuates within:

$0 \leq \sum(a_1 + \cdots + a_n) \leq 7$, and the limits of the index range are:

$0 \leq$ IH FOC ≤ 1.

Evaluation criteria:

0,00 - 0,17 - very good oral hygiene and braces;

0,18 - 0,35 - good oral hygiene and braces;
0,36 - 0,53 - satisfactory oral hygiene and braces;
0,54 - 0,71 - poor oral hygiene and braces;
0,72 - 0,89 - poor oral hygiene and braces;
0,90 - 1,00 - very poor oral hygiene and braces.

Efficiency mark:

To calculate the cleaning a fixed orthodontic appliance efficiency, the Hygiene Index of a fixed orthodontic construction was used.

Based on the obtained index data, the efficiency was determined by the formula:

Efficiency (%) = [100% × (IH FOC_0 – IH FOC_n)]/ IH FOC_0

IH FOC_0 – digital index at the beginning of the examination, prior to a hygienic procedure;

IH FOC_n – digital index after the examination lasting n-number of weeks, at the last examination, prior to a hygienic procedure.

Using the index above it is easy to determine the quality of oral hygiene in patients undergoing orthodontic treatment for malocclusion.

The index was developed to objectify understanding of oral hygienic condition dynamics during the period of using a fixed orthodontic structure, and in order to monitor the oral hygienic condition of those patients.

A patent was obtained for the methodology of calculating an index of oral hygiene and orthodontic fixed structures [8, 9].

The study involved 85 orthodontic patients. They are observed throughout the year. The distribution by age in the focus groups is shown in Table 2.

Table 2.

Distribution of the studied groups by age

Distribution by groups	Age (years)	Absolute number	Relative number (in % of total)
Group 1	15-20	5	22,72
	21-25	6	27,28
	26-30	6	27,28
	31-35	5	22,72
	Total	22	100,00
Group 2	15-20	5	23,80
	21-25	6	28,60
	26-30	5	23,80
	31-35	5	23,80
	Total	21	100,00

Group 3	15-20	6	28,57
	21-25	6	28,57
	26-30	5	23,80
	31-35	4	19,06
	Total	21	100,00
Group 4	15-20	6	28,57
	21-25	6	28,57
	26-30	4	19,06
	31-35	5	23,80
	Total	21	100,00

The object of the study were orthodontic patients with parameters that met the inclusion criteria presented in Table 3.

Table 3.

Parameters of focus group inclusion/exclusion

№ parameter	**Parameters**	
	Included in the research	**Excluded from the research**
1	People aged 15-35 лет	Out of age limit
2	Brace-system	Removal of brace-system, completion/suspence of orthodontic treatment
3	Missing heavy somatic diseases	The occurrence of severe somatic diseases during the study
4	Availability no less than 20 teeth	Loss of a number of teeth while undergoing orthodontic treatment
5	The oral cavity should be sanitized: missing carious cavities and inflammatory periodontal diseases in the exacerbation phase	availability of multiple caries, the development of acute inflammatory periodontal diseases of moderate and high severity
6	No pregnancy	Pregnancy
7	Patient's consent to follow prescribed personal hygiene measures and to see a doctor on a set schedule	Violation of prescribed conditions

Of the patients undergoing orthodontic treatment, 4 groups were formed:

The 1st group included those patients for whom the "Individual hygienic program for the prevention of dental diseases in orthodontic patients" was developed based on the use of prophylactic toothpaste A1 (Splat Ultracomplex) with active

ingredients - polyvinylpyrrolidone, hydroxyapatite, calcis, papain, alpha-bisabolol, potassium and zinc salts, cleansing foam "A1" ("Splat Raspberry"), prophylactic rinse "A1" ("Splat Healing Herbs") with geranium essential oil, extracts of sea buckthorn, hawthorn, chamomile and sage, super-floss ("Oral-B Super Floss"), an interdental brush ("Oral-B Pro-Expert Clinic Line Interdental"), a special toothbrush ("Oral-b Pro-Expert Clinic Line Ortho"), in the center of the brush field of which there is V -shaped deepening, manual prophylactic brush "A1" ("Oral-B Pro-Expert 3D Whites");

The 2nd group included patients who underwent an "Individual hygienic program for the prevention of dental diseases in orthodontic patients" using the prophylactic toothpaste A2 (Colgate Pro Gum Health) that contained arginine and sodium fluoride as active ingredients, preventive rinse A2 (Colgate Total Pro-Protection) for the oral cavity with cetylperidinium chloride and sodium fluoride, interdental brush (Oral-B Pro-Expert Clinic Line Interdental), manual preventive brush A2 (Reach Access ");

The 3rd group included patients who underwent an "Individual hygiene program for the prevention of dental diseases in orthodontic patients" using a prophylactic toothpaste "A3" ("Blend-a-med Pro expert") containing stannous fluoride as an active component, interdental brush ("Oral-B Pro-Expert Clinic Line Interdental"), manual prophylactic brush "A3" ("Colgate Health Classics");

4th group a control group, in which patients performed hygienic activities following their usual approach.

Results.

A study of the index of fixed orthodontic structure hygiene dynamics among the studied groups was performed. The results of changing the parameters of this index are presented in Table 4.

Table 4.

Changes in Hygiene Index indicators of a fixed orthodontic construction (HIFOC)

Distribution by group	Indicators of the hygiene index of a fixed orthodontic construction								
	Period of investigation								
	Beginning	1-st week	2-nd week	3-rd week	4-th week	3- rd month	6-th month	12-th month	p-value*
1 group	0,74±0,14	0,66±0,16	0,63±0,16	0,60±0,14	0,55±0,10	0,45±0,10	0,39±0,14	0,33±0,07	0,02
2 group	0,71±0,20	0,64±0,17	0,63±0,08	0,61±0,16	0,58±0,12	0,50±0,14	0,46±0,08	0,37±0,09	0,02
3 group	0,73±0,12	0,66±0,17	0,64±0,14	0,63±0,21	0,62±0,16	0,58±0,16	0,53±0,13	0,46±0,11	0,03
4 group	0,75±0,15	0,72±0,12	0,71±0,11	0,69±0,09	0,67±0,18	0,64±0,15	0,61±0,12	0,54±0,11	0,05

Data in the table are specified as a mean value ± standard deviation. * - the degree of statistical significance was identified using analysis of variance (ANOVA) for repeated measurements.

At the beginning the hygiene index value of fixed orthodontic construction displayed no difference between the examined groups (p = 0,8), a statistically significant difference appeared by the third month (p = 0,04) and stayed unchanged by the 12th month (p = 0,02).

The data in Figure 1 enabled tracing a decrease in the oral hygiene and brace indices of in all examined groups. The study has revealed the hygiene index decreasing from 0,74 ± 0,14 to 0,33 ± 0,07 in the 1st group, in the 2nd group - from 0,71 ± 0,20 to 0, 37 ± 0,09, in the 3rd group from 0,73 ± 0,12 to 0,46 ± 0,11, and in the 4th group from 0,75 ± 0,15 to 0,54 ± 0,11.

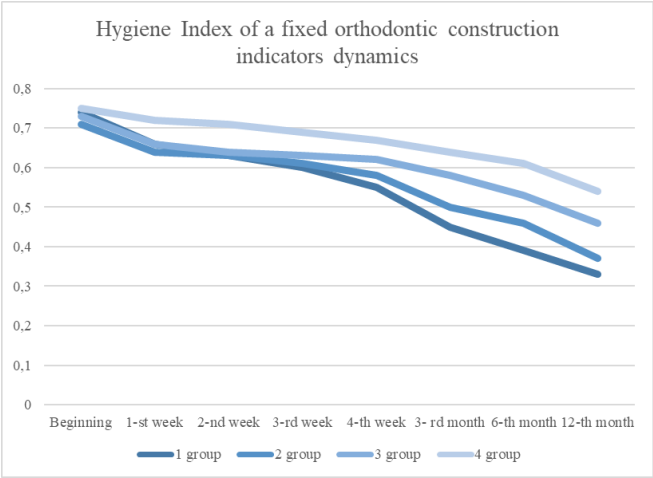

Figure 1. *Hygiene Index indicators of a fixed orthodontic construction (HIFOC) shifting during the year amond patients.*

Conclusion.

Based on the available data, a hygiene "Index of hygiene of a fixed orthodontic structure" was formulated, for which a patent was issued No. 2735987 dated 29.05.2020. It was used to dynamically monitor the orthodontic patients hygiene. So in group 1, it changed from 0.74 ± 0.14 to 0.33 ± 0.07, which indicates a good quality of hygiene. In the 2nd group - from 0.71 ± 0.20 to 0.37 ± 0.09, which indicates a satisfactory quality of hygiene among these orthodontic patients. In group 3, the index decreased from 0.73 ± 0.12 to 0.46 ± 0.11, which also corresponds to satisfactory oral hygiene and braces.

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DOI 10.34660/INF.2023.67.39.163
UDC 618.431.33-007(574)

妇产科医生实践中的勒琼综合征
LEJEUNE'S SYNDROME IN THE PRACTICE OF AN OBSTETRICIAN-GYNECOLOGIST

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注解。 文章描述了一名新生儿的罕见染色体疾病，Cri du chat 综合征，出生于地区第二综合医院。 临床描述的病例显示了新生儿罕见染色体疾病——猫叫综合症的治疗、检查和诊断的困难。

关键词：怀孕、分娩、手术、新生儿、遗传学研究、染色体疾病、尖叫综合症。

Annotation. *The article describes a rare chromosomal disorder in a newborn infant, Cri du chat syndrome, which was born in the multidisciplinary regional hospital №2. The clinically described case showed the difficulties of management, examination and diagnosis of a rare chromosomal disorder in a newborn - Cri du chat syndrome.*

Keywords: *pregnancy, delivery, surgery, newborn, genetic study, chromosomal disorder, Cri du chat syndrome.*

Relevance. Chromosomal abnormality is any change in the number or structure of chromosomes. A child with such pathology can be born in any family - a young healthy without bad habits, with a normal pregnancy. The problem of congenital malformations and anomalies of foetal development is very diverse, the study of this issue is engaged in by various specialists - geneticists, neonatologists, embryologists, specialists in prenatal (prenatal) diagnosis. It is always difficult to understand the causes{1}.

Objective. To study the peculiarities of introduction of a rare chromosomal disorder in a newborn - Cri du chat syndrome in the conditions of a multidisciplinary hospital.

Material and method of the study. The object of the study was a child born in a multidisciplinary regional hospital (MRH) №2 of Akmola region in 2022. A retrospective analysis was used to find out the circumstances of the child born with a rare type of chromosomal disorder in a newborn with Cri du chat syndrome.

Results and Discussion.

A 21 year old repeat female, housewife, was admitted on 24/08/22 at 7:40 am through the portal of the hospitalisation bureau to the maternity ward of MRH №2. Complaints of contraction-like pains in the lower abdomen since 05:00 hours. From anamnesis: menstrual function - menarche since 14 years old, 3-4 days, regular, painless. Sexual life since the age of 16. Gynaecological diseases: denies. Marriage 1, registered. Contraception - barrier method. This pregnancy is the 3rd. Previously 2 girls were born (in 2008 and 2020, premature, healthy). Registered for pregnancy since 11-12 weeks. Pregnancy against the background of anaemia of medium degree, Nv from 18/07/22 : 98 g / l.

Cardiotachography of the foetus was performed - satisfactory condition. Obstetric situation was clarified.

Diagnosis: Pregnancy of 41 weeks. 1st period of labour. Foetal presentation. Mild anaemia.

Labour plan: Considering the 1st period of labour, foetal foot presentation, operative delivery. Consent for surgery was obtained. Classical caesarean section under spinal anaesthesia was performed. Duration of the operation: 30 minutes. At the 4th minute by the legs, without technical difficulties, a live preterm foetus was extracted, male, with a tight fourfold cord wrapping around the neck of the foetus, weighing 3520 grams, height 52 cm without visible malformations. Posterior waters are light coloured, in moderate quantity. Transferred to a neonatologist. Apgar score 7/8 points.

Initial examination by a neonatologist. In the operating theatre, the newborn screamed immediately and was transferred to the "Mother and Child" mode. After 6 hours from the moment of transfer, lethargy, breast refusal, drowsiness appeared. The child has stigmas and microanomalies of facial structures. The condition is severe due to respiratory disorders, intoxication. He reacts sluggishly to examinations. Hypotonia of muscles, hyporeflexia, physiological reflexes are evoked, but quickly fade. Umbilical cord remnant in the staple. Correct build, moderate nutrition, face stigmatised: wide-set eyes, high gothic palate. Respiratory support: humidified oxygen via nasal cannulae. Skin and visible mucous membranes clear pink, cyanosis of the nasolabial triangle, acrocyanosis. The head is rounded. Large fontanelle 2.0*2.0 at the level of the skull bones, not tense.

The thorax is cylindrical in shape. Respiration is spontaneous. RR-52 per minute. Auscultated in all fields, weakened, no rales. Heart tones are clear, rhythmic. HR 150 beats per minute. The abdomen is soft, accessible to palpation, not tense, not bloated, liver and spleen are not enlarged. Peristalsis is audible. Hip extension is complete. Anus is present. Sexual organs are of the male type. Stool - meconium. Transferred in compliance with the heat chain accompanied by a neonatologist to the neonatal intensive care unit. In the cuvée the child periodically makes unusual sounds - "meows'' when crying. Genetic counselling was appointed, taking into account microstigmas and unusual crying. Received O2 therapy masked, tube feeding. Examination: CBC, general urine test, chest radiography (CXR). On the 2nd day a convulsive syndrome appeared, anticonvulsant therapy was performed, the convulsions were controlled.

Instrumental investigations: Registration of delayed evoked otoacoustic emission (05.09.2022 12:15. Conclusion: passed. Registration of short-latency auditory evoked potentials 05/09/2022 12:15). Conclusion: passed.

Specialist advice:

1. Consultation with a neurologist 06/09/2022 - conclusion perinatal CNS lesion convulsive syndrome in the anamnesis observation at the place of residence.

2. Geneticist consultation 05/09/2022. Conclusion: microanomalies, cytogenetic study recommended, repeated consultation with analyses - outpatient.

No pathology was detected on CXR. Subsequently, normalisation of laboratory tests - decrease in leukocytosis. On the 8th day of life with stabilisation of the condition the newborn was transferred to the Mother and Child ward, antibiotic therapy was continued. On the 9th day of life breastfeeding started. Condition at the time of discharge: satisfactory, suckles actively, weight gain, neurological status: half-flexion posture, tone preserved, cranial nerves - without pathology, physiological reflexes are evoked - reduced. The umbilical wound is dry, stool and diuresis are normal. Karyotyping result was obtained - Conclusion: Deletion of the short arm of the 5th chromosome in the segment (p14,1). Vaccinated - no BCG reaction.

At discharge (10th day of life), the mother was explained that there is a rare chromosomal disorder in the newborn - Cri du chat syndrome (Lejeune syndrome). Lejeune syndrome is a partial monosomy associated with a disruption of the structure of the short arm of the 5th chromosome (loss of 1/3 to 1/2 of its length, or, more rarely, complete loss of the short arm), which was verified at the Mother and Child Unit (karyotyping result). Cri du chat syndrome is one of the rare chromosomal diseases with a population frequency of 1:45-60 thousand. Among newborns with Cri du chat syndrome there is a predominance of girls over boys in the ratio of 4:3. In our case in this family, the previous girl children are healthy. The boy born has this rare pathology. From the literature, this pathology

is given a figurative name associated with a specific feature - crying of newborns, resembling a cat cry. The development of Cri du chat syndrome is associated with the loss of a fragment of the 5th chromosome and, consequently, the genetic information stored on this site. In 85-90% of cases, the short arm deletion is formed as a result of an accidental mutation, in 10-15% of cases it is inherited from parents who are carriers of a balanced translocation. The direct cause of mutation can be various damaging factors affecting the germ cells of the parents or the zygote (alcohol, smoking, drugs, ionising radiation, drugs, chemicals, etc.). A detailed interview with the parents showed that the above-mentioned conditions did not occur in this case.

Prognosis and prevention of Cri du chat syndrome

The severity of Cri du chat syndrome and associated birth defects, as well as the level of medical and psycho-educational care, influence the duration and quality of life of patients.

Prevention of Cri du chat syndrome consists in careful preparation for pregnancy and exclusion of possible unfavourable effects on the parents' organism long before conception. When a child with Cri du chat syndrome is born in a family, the parents must undergo cytogenetic examination to exclude carriage of reciprocal balanced translocation {2}.

Conclusions. Our observation corresponds completely in clinical features to the generally accepted standard for the management of genetic pathology. Parents were given recommendations for the management of the newborn. Psychological and genetic counselling in outpatient settings was prescribed. When planning the next pregnancy it is necessary to take into account this situation - the birth of a child with Cri du chat syndrome. The clinically described case showed the difficulties of management, examination and diagnosis of a rare chromosomal disorder in a newborn - Cri du chat syndrome

Thus, when unusual symptoms are detected in newborns, medical and genetic investigation is necessary for timely diagnosis, which contributes to the correct management of the child. And gives an opportunity to inform parents about the prognosis of the disease.

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DOI 10.34660/INF.2023.49.62.164

冠状动脉旁路移植术治疗右心慌及内脏完全倒转患者

案例报告

CORONARY ARTERY BYPASS GRAFTING IN A PATIENT WITH DEXTROCORDIA AND TOTAL INVERSION OF INTERNAL ORGANS

Case report

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抽象的。 逆位右心症是一种罕见的先天性异常，其中心脏和腹部器官以与正常解剖结构镜像反转的方式自行定位。 冠状动脉疾病的发病率与正常人群相似。 在这部分人群中进行冠状动脉旁路移植术几乎没有困难。 这些限制可以通过外科医生和团队的一些技术调整来克服，这将在我们的文章中讨论。 右位心逆位患者的冠状动脉搭桥手术 (CABG) 文献报道较少。 由于异常循环和相关的其他先天性异常，这些患者的麻醉影响和手术困难变得具有挑战性。 本文介绍了一名右位心和全反位患者进行多处冠状动脉旁路移植术的成功案例。

关键词：右位心、逆位、冠状动脉旁路移植术。

Abstract. *Dextrocardia with situs inversus is a rare congenital anomaly in which the heart and the abdominal organs orient themselves in a mirror-image reversal of the normal anatomy. Coronary artery disease incidence is similar to that of the normal population. Performing coronary artery bypass grafting in this subset of the population poses few difficulties. These limitations can be overcome by few technical adjustments by the surgeon and the team which will be discussed in our article. Coronary artery bypass surgery (CABG) in dextrocardia with situs inversus patients is reported less in literature. Due to abnormal looping and associated other congenital anomalies, anesthetic implications and surgical difficulties become challenging in these patients. The article presents a successful*

case of multiple coronary artery bypass grafting in a patient with dextrocardia and situs inversus totalis.

Keywords: *dextrocardia, situs inversus, coronary artery bypass grafting.*

Dextrocardia is an intrauterine anomaly when the major part of the heart is located in the right part of the thorax. Dextrocardia belongs to rare anomalies: the incidence rate varies in different regions from 1:8000 to 1:25000 newborns. In Russia, the prevalence of dextrocardia is 3.3% of all anomalies concerning the position of the organ.

Situs viscerus inversus is a rare abnormal development resulting from disorders of fetal egg differentiation and manifesting itself in mirrored, in relation to the normal, arrangement of internal organs. The incidence rate varies from 1:5000 to 1:20000. Such position of inner organs is observed in one case per 10 million births [1]. The specific genetic cause of dextrocardia with situs inversus was not identified, so patterns of inheritance were not confirmed in the majority of cases, but the condition results from disorders of the implementation of left-right-sided asymmetry in the prenatal period [1.].

Dextrocardia combined with situs viscerus inversus is a rare congenital anomaly with the incidence 1:10000 [2, 3]. Patients with SIT rarely have cardiac disorders, meanwhile, disorders related to isolated dextrocardia are observed more often. The incidence of coronary artery disease in these patients is relevant to the incidence across the population. Coronary artery bypass grafting in this group of patients is complicated by some difficulties and peculiarities. Hieronymus Facius, an Italian anatomist and surgeon, was the first to describe heart misplacement in the thorax in 1606. Marco Aurelio Severino used the term “dextrocardia” in 1643 for the description of internal organs reversed position in a patient. The first operation of coronary artery bypass grafting in a patient with dextrocardia was performed and described by Irvin RG et al in 1980[3, 4].

Case report

Patient A., aged 62, with the diagnosis of CAD, PICS (2011) was admitted to the department of CAD surgical treatment and minimally invasive coronary surgery of A.N. Bakulev NMRC CVS. The patient underwent PCI with RCA stenting in 2011 and 2017. Angina pectoris 3 FC. CD 2 A degree. CHF NYHA 2 FC. Dextrocardia. Hypertension 2 stage, 3 risk of cardiovascular complications. Chronic tubulo-interstitial nephritis. Hypertensive nephrosclerosis (GFR 41 ml/min /1.73 м2); CKD 3 B st. hyperuricemia. Non-acute chronic smoker bronchitis. Chronic erosive gastritis, remission.

According to the patient’s history, he has been suffering for a long time from arterial hypertension with max 160/100 mm Hg, adapted to 120/80 mm Hg. The patient was diagnosed with dextrocardia (situs inversus) during army conscription

commission. CAD manifested in 2008 by angina pectoris presentation. He was followed as an outpatient at his place of residence. The patient received all the time cardiotropic and antihypertensive therapy. He had left ventricle (LV) posterior wall acute myocardial infarction (AMI) in 2011, on this account coronary angiography (CA) was performed and followed with percutaneous intervention (PI) alongside with right coronary artery (RCA) stenting achieving satisfactory angiographic and clinical effect. The patient felt quite well later on, he regularly took prescribed drugs. In April 2017, he experienced angina again, underwent on this account second coronary angiography with single-step PI with RCA stenting. He was then followed as an outpatient at his place of residence. The patient started feeling worse in March 2021, angina symptoms progressed gradually with decreased exercise tolerance. He was admitted to the hospital at his place of residence in November 2021, where he underwent coronary angiography. CA results showed RCA dominance. Left main coronary artery (LCA) had no changes. Anterior interventricular artery (AIVA) had 85-90% stenosis in the middle third. Diagonal artery (DA) had up to 90% stenosis in the proximal third. Circumflex branch (CB) was occluded in the middle third, the distal third was filled through collaterals. Obtuse marginal branch (OMB) had 75-80% ostium stenosis, no changes further on. RCA was occluded in the middle third, the distal third was filled through collaterals. Posterior interventricular branch from right coronary artery (PIVB RCA) and posterolateral branch from right coronary artery (PLB RCA) were filled through collaterals. SYNTAX Score II was 13,6.

Data obtained during patient's examination at the department: ECG: sinus rhythm, normal, with heart rate 61 bpm. No cicatricial or ischemic lesions were observed.

LV hypertrophy. Echocardiography: heart is located in the right part of thoracic cavity with mirror position of cavities and main vessels. Ascending aorta 37 mm, left atrium (LA) apically 46 x 57 mm, right ventricle (RV) 3,4 cm, end systolic volume (ESV) 41.0 ml, end diastolic volume (EDV) 94.0 ml; stroke volume (SV) 53.0 ml; LV ejection fraction (EF) 56.4 %, thickness of the interventricular septum (TIVS) 13 mm, LV posterior wall thickness (LVPWT) 12 mm, right atrium (RA) 40 mm. Signs of initial pulmonary hypertension were observed - systolic pressure in the pulmonary artery 35 mm Hg. Mitral (MV) and tricuspid valve (TV) insufficiency of 1,5 degree.

Multislice computed tomography (MSCT) data: Heart: left-formed, right heart, enlarged moderately. The heart structures are mirrored. The pericardium with clear, even contours, the fluid in its cavity is not defined. Aortic valve: tricuspid, leaflets thickened. Coronary arteries: originate mirror-like, walls with combined atherosclerotic plaques (ASP) with calcium inclusions. The stent is viewed in RCA middle third. Vena cava are located on the left, go into RA mirror-like:

SVC 21x23 mm, IVC - 25x28 mm. Atria: RA 50x55mm, LA up to 41x53x68 mm. Pulmonary veins are drained into left atrium. On the right PV end by a common trunk into the LA, diameter 25 mm, length 26 mm. Ventricles: RV – cavity dimensions during diastole (anterior-posterior dimension at the middle) up to 45 mm; LV - cavity dimensions during diastole at the middle 61 mm. LVOT up to 27 mm, interventricular septum thickness during diastole at the middle (at average diastole) up to 10 mm. VSD is not detected.

Aorta originates mirror-like from LV: AAo at the level of FR 20x26 mm, at the level of Valsalva sinuses – 38 mm, at the level of sinotubular junction – 30 mm, at the level of PT bifurcation 36 mm. Ao arch is right, at the cross-section 29 mm. Descending aorta is located to the right of the spine, at the level of PA trunk – 26 mm, at the level of LA – 25 mm, at the level of diaphragm 24,5 mm. BCA: originate mirror-like from Ao arch, BCT and RCCA originate with common trunk with the diameter of 16 mm, right subclavian artery – 12 mm. Pulmonary artery originates from RV, located mirror-like on the right: PT is not dilatated, diameter 25 mm, RPA – 23 mm, LPA – 23 mm. According to the examination level: situs inversus of abdominal organs (liver, spleen, stomach).

Direct myocardial revascularization was performed 17 January 2022. It included mammary coronary bypass by anterior interventricular artery, coronary artery bypass grafting by autovenous grafts of diagonal artery and obtuse marginal branch, coronary artery sequential bypass grafting by autovenous graft of acute marginal branch and right coronary artery under parallel perfusion and normothermia. Total cardiopulmonary bypass (CPB) time was 168 min.

Bypass angiography was performed intraoperatively: bypasses are patent all through, anastomoses are secure

The patient was transferred to intensive care unit. Mechanical ventilation lasted for 7.5 hours. The patient was transferred to the department the next day. Early postoperative period was fine, no complications were observed. Haemodynamics was stable. Postoperative clinical data as well as instrumental and laboratory tests results related to the severity of operation which the patient underwent. EchoCG data demonstrated no negative changes: LA – 40 mm; ESV 39.0 ml EDV 92.0 ml SV 53.0 ml EF 57.6 %. Heart cavities were not dilatated. LV myocardium contractility was satisfactory. There were no signs of free fluid in pericardium and pleural cavities. Chest X-ray showed that the lungs were expanded. There was no free fluid in pleural cavities. Heart sizes were stable. The patient was discharged on the 10th day after the operation in a good condition.

Discussion

Dextrocardia is an anomaly associated with gene defect; HAND, ZIC3Shh, ACVR2, Pitxz gene mutations which develop because of disorders of embryogenesis processes at the early stages of intrauterine development. Situs viscerum

inversus totalis means total or partial mirror-like position of organs in chest and abdomen. Dextrocardia is one of transposition variants which was first described by an Italian surgeon and anatomist Marco Aurelio Severino in 1643 [5, 6, 7, 8].

There are 4 types of transposition:

1. situs inversus cordis —simple dextrocardia, only heart is located atypically in the right of the thorax;
2. situs viscerum inversus partialis — partial inversion, heart and some organs of gastrointestinal tract and respiratory system are mirrored;
3. situs viscerum inversus totalis — all gastrointestinal tract and respiratory system organs are mirrored;
4. situs ambiguous (heterotaxy) — a rare variant with ambiguous location, liver is usually in the middle of the body, spleen is absent.

The patient in our case had 3 type (situs viscerum inversus totalis). During intraoperative exploration left-formed, right heart was found. Taking into account heart transposition, right internal thoracic artery (RITA) was used as a conduit for anterior interventricular artery (AIVA), autovenous anastomoses were used as well.

There is a limited number of reports about myocardium revascularizтion in such patients in the literature [9].

Dextrocardia is a rare congenital malformation of the cardiovascular system, in which the heart is located in the chest on the right, in a manner similar to the normal location. Separate descriptions of surgical treatment of ischemic heart disease in patients with SIT are given in the relevant literature. Most surgeons in these operations stand on the left side of the patient [3]. Saad RA at all conducted an analysis of the available literature. The question addressed was which side of the operating table you should stand on when carrying out surgical revascularization on a patient with dextrocardia. Altogether 40 papers were found using the reported search, of which 19 represented the best evidence to answer the clinical question. The authors, journal, date and country of publication, patient group studied, study type, relevant outcomes, and results of these papers are tabulated. The side on which the operating surgeon stood was mentioned in 20 out of the 24 cases. Surgery was carried out from the conventional right side of the patient in 5 cases, while in 10 cases, it was carried out from the left side. The surgeon needed to switch sides to facilitate surgery in three cases. In addition, the right internal mammary artery (RIMA) was anastomosed to the left anterior descending artery (LAD) in 16 cases. Of these, surgery was carried out from the left side in 11 cases. The left internal mammary artery (LIMA) to LAD anastomosis was carried out in two cases, one of which was a free LIMA graft. In six cases, only vein grafts were used. Fourteen cases were carried out using cardiopulmonary bypass while 10 cases were carried out as off-pump cases with one conversion. The majority of

patients were operated on from the left of the table. More cases were performed with the RIMA as the conduit of choice to the LAD [10].

This operation can be performed either on off-pump or on-pump. Murtuza B, et al. We analyzed 32 cases of patients with SIT who underwent CABG surgery in the period from 1981 to 2009. A total of 20 patients underwent CABG on-pump, 11 off-pump (one patient had a conversion, i.e. switching to a heart—lung machine during surgery) and in one case it was not reported. Large subcutaneous veins were used as conduits in 6 cases, arterial grafts in 7 cases, and both types of grafts were used in 19 cases. The exposure of surgical targets for CABG in dextrocardia patients may be difficult with a conventional operative arrangement. Most reported operations were performed while the surgeon stood on the left side of the operating table. This position facilitates grafting to vessels in both coronary artery distributions and particularly to the circumflex region, which is exposed by retracting the heart toward the surgeon on the left side of the table. The LAD anastomosis can probably be performed with similar ease from either side of the table. Because the right ventricle (RV) is on the left and anterior to the LV, exposure of the right coronary branches is perhaps easier from the left side. If the surgeon stands on the left side, the position of the stabilizer/retractor device for OPCAB grafting may also need to be modified [8, 11, 12, 13, 14].

The anatomy of this condition requires few adjustments during the conduct of surgery. In dextrocardia, the surgeon will operate from the left side of the patient in most centers. However, surgery can also be performed by the surgeon in the conventional position. [15]

Despite the fact that most surgeons prefer to stand to the left of the patient when applying an anastomosis in patients with dextrocardia due to the position of the heart. However, there are reports showing that surgeons operate in a normal position. The presence of a bilateral superior vena cava should be checked before vein catheterization. Ravikumar MS and all showed - RIMA is usually harvested instead of the left internal mammary artery (LIMA) in these cases. In our case, the only time the surgeon positioned himself to the left of the patient was while harvesting RIMA. LIMA is usually avoided since the length of the graft will not be adequate to anastomose to the LAD resulting in the stretch of the graft and inadequate flow. The LIMA will have to cross the midline exposing it to high chances of injury during the re-do surgery. The LIMA flow may get compromised due to marked angulation at its origin leading to a dismal result of surgery. These limitations are avoided by using RIMA. Other considerations before incision include placement of electrocardiogram electrodes over the right hemithorax and placement of a central venous catheter in the left-sided internal jugular vein which will be monitored by the cardiac anesthetist. [15]

The majority of surgeons when operating a patient with dextrocardia prefer to stand next to the left side of the patient due to the heart position. In our case, the

surgical team stood contralaterally as well. According to the majority of authors [3, 8], surgeon's position next to the left side of the patient during the intervention is the best in such patients.

Conclusion

The described clinical case is interesting because of a rare congenital anomaly. The surgical team must have certain skills to conduct coronary artery bypass grafting in a patient with dextrocardia and SIT. Surgeons face some problems and questions: patient's preoperative preparation, surgeon's position at the left or at the right during the operation, conduit choice for anastomosis. This particular clinical case presents research interest because dextrocardia combined with situs viscerus inversus totalis are rarely met. In our opinion, surgeon's position next to the left side of the patient during the operation is the best in such patients. Besides, it is more preferable to use right internal thoracic artery for creating anastomosis with anterior descending artery. Thorough patient's examination, taking into account different types of dextrocardia, is necessary. Coronary artery bypass grafting can be successfully performed in patients with dextrocardia.

Relationships and activities: the authors declare no potential conflicts of interest requiring disclosure in this article.

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DOI 10.34660/INF.2023.19.71.165

自闭症和智力低下儿童催产素水平指标
INDICATORS OF OXYTOCIN LEVELS IN CHILDREN WITH AUTISTIC DISORDERS AND MENTAL RETARDATION

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抽象的。 我们研究了自闭症和智力低下（ASD）儿童以及单纯智力低下（MR）儿童唾液中催产素的水平。 与 MR 61.88 ± 4.8 pg/ml 患者组相比，ASD 组催产素水平较低（41.51 ± 7.29 pg/ml）。 同时，根据主组ASD的相关分析结果，与对照组MR相比，催产素浓度与自闭症特征指标之间建立了更显着的依赖性（rs=0.499）。 （rs=0.097）； 随着年龄的增长，自闭症主要群体的自闭症行为模式严重程度（rs=-0.003）和唾液中催产素浓度（rs=-0.045）呈下降趋势。 MR组患者的自闭症评分随着年龄的增长而略有下降（rs=-0.0001），而催产素水平则显着增加（rs=-0.133）。 结论。 结论是，自闭症儿童更严重的自闭症变异与高水平催产素之间存在显着关系。 此外，该组患者唾液中催产素的浓度随着年龄的增长而有所下降，与智力障碍的程度关系不大。

关键词：自闭症谱系障碍、智力障碍、儿童年龄、行为、智力、催产素。

Abstract. *We studied the level of oxytocin in the saliva of children with autism and mental retardation (ASD) and of children only mental retardation (MR). Data were obtained on a lower level of oxytocin in the group ASD 41.51 ± 7.29 pg/ml compared with the group of patients MR 61.88 ± 4.8 pg/ml. At the same time, according to the results of the correlation analysis in the main group ASD, a more significant level of dependence between the indicators of the concentration*

of oxytocin and autistic characteristics (rs=0.499) was established in comparison with the control group MR (rs=0.097); there was a trend towards a decrease in the severity of autistic behavioral patterns (rs=-0.003) and the concentration of oxytocin in saliva (rs=-0.045) with age in the main group ASD. Patients in the group MR showed a slight decrease in autism scores with age (rs=-0.0001) and a more marked increase in oxytocin levels (rs=-0.133). Conclusion. It is concluded that there is a significant relationship between more severe variants of autism disorders and high levels of oxytocin in children ASD. In addition, the concentration of oxytocin in the saliva of patients in this group decreases somewhat with age and little depends on the degree of intellectual impairment.

Keywords: *autism spectrum disorders, intellectual disability, childhood age, behaviour, intelligence, oxytocin.*

Introduction. Assessing the role of oxytocin in the regulation of social interaction is a promising area that opens up new opportunities for studying the mechanisms of developing autism spectrum disorders. Changes in the plasma levels of neuropeptides, including oxytocin and mRNA, have been reported in children with autism spectrum disorders, which correlate with the severity of the disorder; the importance of oxytocin receptor gene polymorphism is noted (1). Some studies report the ability of oxytocin to improve social interaction in a group of autistic patients with comorbid mental retardation (2).

Data on the baseline oxytocin level vary by gender, age and occupation. The concentration of the hormone in saliva in the amount of 45.96(33.27)–77.93(74.46) pg/ml was registered in 31 students before the start of the study (3); there was a difference in the level for different activities (individual and group ones) from 60 ± 8 to 234 ± 35 pg/ml in women and from 63 ± 15 to 207 ± 24 pg/ml in men (4).

Other authors showed that oxytocin levels (44.72 ± 36.1 μu/ml) in autistic patients were significantly lower ($p < 0.05$) than in child patients of approximately the same age (102.1 ± 34.31 μu/ml) and of the same gender (53.05 ± 38.38 pg/ml) in the control group. In the same study, a noticeable relationship was observed between the severity of developmental disorders and the concentration of the hormone in saliva: 59.22 ± 27.32 μu/ml for a mild degree, 47 ± 25.47 μu/ml for a moderate degree, 27.92 ± 10.23 μu/ml for a severe degree (5).

There is practically no information about the level of oxytocin in people with intellectual disability (MR). At the same time, a large number of people with autism spectrum disorders have intellectual disability (MR) (6). There is evidence that the functions of oxytocin differ in men and women with severe mental retardation and that oxytocin partially affects autism and is associated

with some repetitive actions and nonverbal communication in patients with autism spectrum disorders with severe mental retardation (7).

Some research results show that oxytocin can improve social interaction in a group of patients suffering from autism spectrum disorders with concomitant intellectual disability (8). It remains unclear whether the presence of mental retardation affects the level of oxytocin in autism spectrum disorders. This is important to understand for the development and application of treatments for autism spectrum disorders based on changes in oxytocin levels.

The purpose of this study is to evaluate the relationship between the level of oxytocin in saliva and the age and psychopathological characteristics of children with autism and mental retardation (ASD) and of children only mental retardation (MR).

Materials and methods. Two groups of children, hospitalised for the first time in the Paediatric Department of the Krasnoyarsk Regional Psychoneurological Early Treatment Centre No.1, were examined. The first group ASD consisted of 34 patients (27 boys and 7 girls) with clinical signs of autism spectrum disorders and mental retardation. The average age is 7.65 ± 0.43 years. The second group included 87 people (66 boys and 21 girls) with intellectual disability (only mental retardation (MR), the average age was 8.47 ± 0.27 years. IQ scores of the children in both groups was below 70.

The clinical picture of mental disorders was assessed according to ICD-10 criteria. Specifics of intellectual development was identified with the human drawing test, allowing to correlate the degree of cognitive functions development with the 100-point system of the IQ test, since for some patients included in the study it was impossible to determine the level of intelligence by a standard method due to autistic characteristics or severe behavioural disturbances. The severity of autistic traits was rated using an adapted version of the CARS (9).

The level of oxytocin in saliva was determined by enzyme immunoassay. The collected saliva samples in a volume of 0.5–1.0 ml were stored at −80 °C. For testing, they were thawed and centrifuged at 4 °C at 1500gfor 15 minutes. The samples were kept at −20 °C till the time of testing. Salivary oxytocin levels were determined using a commercial 96-plate OT-ELISA kit. Recent studies have shown that OT values are reliable when measured in saliva by enzyme immunoassay (10). Samples (100 μl) were processed according to the manufacturer's instructions for ELISA kits (Cloud-Clone Corp., USA) for oxytocin.

Statistical processing was carried out in Microsoft Office Excel 2013. To assess parametric data, descriptive statistics methods were used, the mean values of the parameters M±m were calculated, the level of statistical significance was determined using the Student's t-test, Pearson's χ^2 test and Fisher's exact

test (two-sided). The relationship between the indicators was assessed using the Spearman's rank correlation coefficient (rs).

Research results. Both study groups were comparable in terms of gender, age and level of intellectual development. Demographic and psychological characteristics of both groups are presented in Table 1.

Table 1.

Demographic and psychological indicators of the participants

Indicators	Group 1 ASD n=34	Group 2 MR n=87	Pearson's χ^2 test	Critical value x^2	Fisher's exact test	Significance level
Age M±m	7.65±0.43	8.47±0.27	–	–	–	p>0.05 (p=0.108)
Sex M/F abs. (%)	27(79.41%)/ 7(20.59%)	66(75.86%)/ 21(24.14%)	0.173	3.841	–	p>0.05 (p=0.678)
Intellectual level M±m	58.23±2.05	58.54±1.07	–	–	–	p>0.05 (p=0.893)
Autism severity	48.74±1.44	32.27±0.92	–	–	–	p<0.001
Disability group abs. (%)	16(47.06%)	15(17.24%)	11.406	6.635	–	p<0.001
Orphancy abs. (%)	1 (2.94%)	26(29.89%)	4.832	3.841	0.001	p<0.05 (p=0.028)

Significant differences between the groups were found in terms of the CARS development indicators associated with autistic disorders (p<0.001) and in social status data. Paediatric patients ASD had some disability at the time of the first hospitalisation more often than patients MR (p<0.001). Children with intellectual disability (MR) showed more pronounced signs of social disadvantage due to a greater number of orphans in the group (p<0.05).

Analysis of salivary oxytocin concentration indicators showed lower levels in the group 1 (ASD) compared to the group 2 (MR), 41.51 ± 7.29 and 61.88 ± 4.8, respectively (Figure 1).

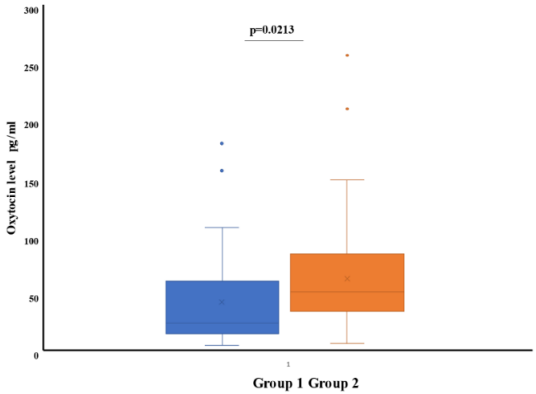

Figure 1. *Salivary oxytocin concentration*

The results of the correlation analysis showed certain differences between the patients of the main group ASD and the control group MR. In the group ASD, this association of high levels of oxytocin with severe autism is more intense than in patients MR (Fig. 2a, 2b). The presented data indicate that there is practically no relationship between the level of oxytocin concentration and the level of intelligence in the ASD group, while there is a relationship between a higher level of oxytocin and a higher level of intelligence in the MR group (Figure 2c, 2d).

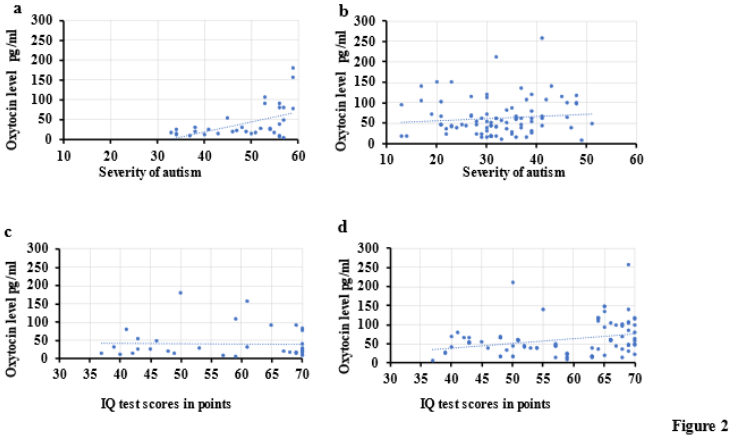

Figure 2. *Indicators of the oxytocin levels*

In addition, ASD patients showed a tendency of a decrease in the severity of autistic behaviour with age.

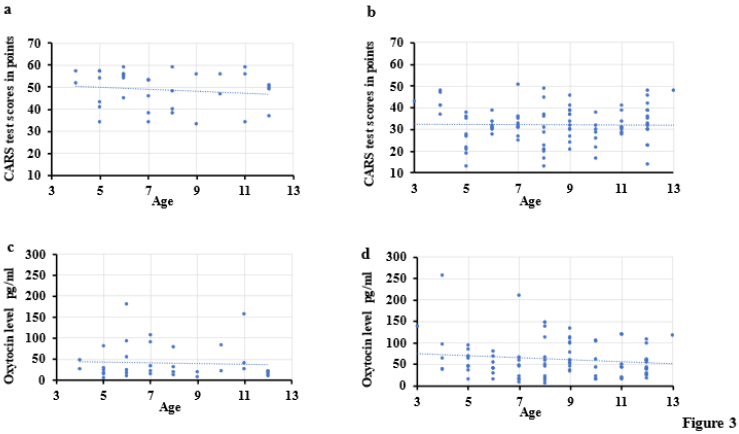

Figure 3. *Indicators of severity of autistic disorders, oxytocin levels and age*

Patients with signs of intellectual disability (MR)did not show such dynamics (Figure 3a, 3b). The data on assessing the relationship between oxytocin levels and age were very similar in both groups (Figure 3c, 3d).

The general trend of changes in indicators in both groups is a decrease in salivary oxytocin concentration in older patients. To clarify the degree of influence of the parameters, correlation coefficients were calculated (Table 2).

Table 2.

Correlation coefficients of indicators in both study groups

Group	**Correlation coefficients of indicators (rs)**			
	Autism severity / oxytocin levels	**Intellectual level / oxytocin levels**	**Age / oxytocin levels**	**Age / autism severity**
Group 1 ASD	0.499	−0.003	−0.045	−0.130
Group 2 MR	0.097	0.280	−0.133	−0.0002

The highest positive correlation coefficient that confirms a noticeable level of dependence was for oxytocin levels and the severity of autism in the main study group ASD. In the control group MR, the correlation for these indicators was significantly lesser. The lowest level of positive connection was found for the oxytocin concentration and the severity of autism in the data of the MR patients.

The greatest negative values of the correlation indicator were determined for the relationship between age and oxytocin levels in the control group MR and for the relationship between age and autism in the main group ASD.

The smallest negative correlation was found for the relationship between age and the severity of autism in the group of patients with intellectual disability (MR).

The data we have obtained require discussion and further study. The results of our work, which showed lower levels of oxytocin in children ASD, are consistent with the results of other studies on the nature of oxytocin system dysfunction in this pathology (11).

At the same time, the higher level of connection of high oxytocin levels with pronounced autism signs within the main study group ASD, established by us, does not agree with the materials of scientific publications on the reduced concentration of this hormone in autistic pathology (12). This result may be associated with a different level of patients' adaptive capabilities or perhaps with the specifics of stress response and a more significant (than expected) role of oxytocin in the regulation of response to emotional and intellectual load.

More favourable indicators of the social status of children ASD (2.94% of orphans in the autism group versus 29.89% in patients MR) and an increased level of oxytocin in their group with more severe developmental disorders also deserve attention and additional study (47.06% of disabled ASD versus 17.24% in the control group MR). One can assume that it is the increased levels of this hormone in the body that affects the stability of emotional bonds and significantly reduces the risk of parents abandoning a child with the disorder (13). The absence of relationship between intellectual level and autism in the main group ASD and the positive relationship of these indicators in the control group MR agree very well with the statement about the difference in the etiology and pathogenesis of autistic disorders and developmental disorders in the form of intellectual disability.

A slight decrease in the level of autism with age in the main group ASD, established by us, is confirmed by other studies on the change in some autistic characteristics in the process of growing up (14). Considering this fact and the clear relationship between autism and high oxytocin levels, it can be assumed that the decrease in the indicators of this hormone with age is the result of a decrease in signs of dysfunction of the oxytocin system.

Conclusion. Based on the results of the study it has been established that paediatric patients ASD admitted to hospital for the first time had lower levels of oxytocin compared to the group of patients MR.

Children ASD characteristics demonstrated a more pronounced tendency towards increased oxytocin levels in severe autistic disorders than children MR.

Moreover, in this group of patients ASD, the oxytocin concentration in saliva decreases with age and does not depend on the degree of intellectual disability.

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DOI 10.34660/INF.2023.48.91.166

重新审视吸烟问题并在最短的时间内永久消除这一现象
A NEW LOOK AT THE PROBLEM OF TOBACCO SMOKING AND ELIMINATING THIS PHENOMENON PERMANENTLY IN THE SHORTEST POSSIBLE TIME

Khazov Vladimir Sergeevich

"Tactics without strategy are mere vanity before defeat."
Chinese general Sun Tzu

概括。 吸烟现在被认为是全世界许多疾病的一个主要可改变危险因素（FR），并且被认为是有史以来影响人类的最严重的流行病。 我们认为吸烟是一种非常复杂的疾病。 它非常巧妙地将自己伪装成一种习惯，并通过制造一种很难放弃这种"习惯"的假象来欺骗全体民众。 不得不说，世界医学已经中了这一招。 结果发现，吸烟的深层本质不仅没有被阐明，而且实际上也没有进行必要方向的科学研究。 根据现代观念，治疗不可抗拒的吸烟欲望应该至少进行六个月，但没有人能保证有积极的结果。 作者再次证明这个世界级难题只有借助P.K.Anokhin院士的功能系统（FS）理论才能解决。 FS的理论可以找出这种现象的深层本质，并在短期的治疗过程中从根本上解决它。 在关于吸烟所向无敌的惨淡故事中，终于有一个真正的机会来摧毁这个神话了。 实验结果证实了这一点。

关键词：吸烟成瘾，多巴胺成瘾，该疾病的系统分析，学术P.K. Anokhin，针灸，统计结果。

Summary. *Tobacco smoking is now recognised as a major modifiable risk factor (FR) for a huge number of diseases worldwide and is considered the most severe pandemic ever to affect humanity. We believe that tobacco smoking is a very complex disease. It has very skilfully disguised itself as a habit and deceives the entire population by creating the illusion that it is extremely difficult to give up this "habit". It has to be stated that world medicine has fallen for this trick. As a result, it turned out that the deep essence of tobacco smoking is not only not clarified, but also scientific research in the necessary direction is practically not conducted. Treatment of irresistible craving for smoking tobacco according to modern ideas should be carried out for at least six months and no one guarantees a positive result. The author once again proves that this world-class problem can be solved only with the help of the theory of functional system (FS) of academician P.K.Anokhin. The theory of FS allows to find out the deep essence of this phenomenon and to solve it cardinally in a short course of treatment. In the bleak*

story about the invincibility of tobacco smoking, finally there is a real opportunity to destroy this myth. Experimental results confirm it.

Keywords: *tobacco smoking as an addiction, dopamine addiction, system analysis of this disease, academic P.K. Anokhin, acupuncture, statistical outcomes.*

Modern medicine is full of complex puzzles and riddles. It can be argued that the level of its development, achievements and failures, stunning successes in its various sections can be a benchmark, a litmus test of the stage of human progress in the progressive movement of civilisation towards perfection. However, so far the real achievements of medicine are, on the whole, insignificant. If we recall the ultimate goal of this science - complete elimination of all diseases and a significant increase in life expectancy in a sane and healthy body, everyone realises that, unfortunately, the real achievements of medicine are far from the designated end result. The whole world is mired in a huge number of non-infectious chronic diseases, such as ischaemic heart disease, atherosclerosis with its many masks, cerebrovascular diseases, cancer, chronic diseases of the lungs, gastrointestinal tract, genitourinary system and all other systems and organs. This includes the global tobacco pandemic. We believe that this state of affairs directly depends on the fact that science relies on the study of pathological processes on old concepts and theories of the past centuries, which do not allow us to get to the true aetiology and pathogenesis of any disease. [11, 19, 26, 29]. Carefully analysing the results of medical achievements, it turned out that all of them were obtained not due to the elucidation of causes and exact, single mechanisms of their development, but by means of correction, treatment of changes in the structure and function of organs under the action of unknown pathogenic factor. [19]. That is, the tools to find out in each case the only cause and pathogenesis of the disease have not been and are not yet available. The result of the above may be a banal, but certainly correct idea: a disease can be defeated only when its cause and the only correct pathogenesis are known.

Let us now turn to analysing the widespread prevalence and extreme difficulty of quitting tobacco smoking. Thanks to observations and research carried out all over the world, the unusually sinister essence of the structure of tobacco smoke [7, 8, 17, 24] and what problems tobacco smoking realises in the organism have become clear. [9, 10]. The insidiousness and deadly danger of smoking is not manifested at once, but delayed for years and even decades. Therefore, not seeing the immediate threat to life and health, imitating idols and authorities, women, adolescents and even children begin to smoke on a par with men. This has led to the fact that there are now about 1.3 billion active smokers in the world. According to The Lancet's Global Review of Tobacco Use (1990-2019), the top ten most "smoking" countries are China, India, Indonesia, USA, Russia, Bangladesh, Japan, Turkey,

Vietnam and the Philippines. Russia is at the top of the list of countries in terms of the number of smoking population and counts from 28.3% to 33% of people of all ages according to different estimates. The National Project "Health Care" sets a goal to significantly increase the average life expectancy of Russians and bring it to 76 years in 2024 and to 80 years by 2030. It is clear that the increase in life expectancy depends directly on the reduction of mortality. It is known that the main cause of mortality worldwide is cardiovascular diseases (CVD) or, in a more extended version, circulatory system diseases (CSD). What is the situation with mortality from CSD in Russia? In 2014, 654 people per 100,000 population died from BSC. In 2018, 583.1 people died. As a result, we see a decrease in mortality from these causes by 70.9 people per 100 thousand population. Then in 2022 567.8 people died, that is, mortality from CSD compared to 2018 still decreased by 15.3 people per 100 thousand population. But the state task to increase life expectancy has been set - to reach 76 years by the end of 2024. Accordingly, the Ministry of Health has set the task to reduce mortality from CSD in 2023 to 465 people, and in 2024 to 450 people per 100 thousand population, that is, compared to 2022 it is necessary to reduce mortality by 117.8 people per 100 thousand population. The goal is extremely important and noble, but the way to this goal, to such a stunning, one could say a giant leap, is blocked by the problem of tobacco smoking, which is practically not solved all over the world. More than 400 thousand people die annually in the Russian Federation as a result of smoking. Life expectancy of smokers is 10-15 years less than that of non-smokers. By general opinion the only direction in medicine capable of giving a quick effect in the form of reduction of morbidity and mortality from many diseases is elimination of tobacco smoking. It is necessary to intensify not repressive methods of struggle with smokers, but real help to the smoking population to stop using tobacco products in any form from ordinary cigarettes, to vape and other electronic systems of heating tobacco. So what is this morass called tobacco smoking? Why has it become the world's and the most dangerous pandemic in human history?

World medicine has two general points of view. The first point of view considers that smoking is harmful, but very quickly entangles a person in a destructive habit. They say that in the beginning a smoker foolishly, ignorantly takes an example from his film or real idols. In some cases it is usual curiosity, desire to try what is the charm of smoking. Sometimes it is a fear of seeming unmodern, "weak". Very quickly smoking becomes a part of the smoker's life. Without a cigarette it is already difficult to relax, it is difficult to concentrate. Smoking becomes a ritual, a second nature. This expression - habit, second nature, Consuetudo est altera natura, was already well known in ancient times. It means that it is as difficult to give up the habitual as it is to change one's character. So the view that the severity of quitting smoking depends on a deeply ingrained habit is not

new, it is well known and it gives the first point of view on the essence of tobacco smoking a special weight. The second general point of view on the problem of tobacco smoking states that smoking is a dopamine addiction. Nicotine in tobacco smoke activates the dopamine centre of pleasure, as a result of which the mood rises, life's hardships become irrelevant, and current life problems recede into the background. Therefore, without constant excitement of this pleasure centre on the background of quitting smoking there is a low mood up to a depressive state, the colours of the surrounding world fade, the usual small daily positive moments do not please, there is no desire to communicate with loved ones without a cigarette. Life is coloured in sad colours, in gloomy tones. That is why no arguments about the deadly harm of smoking can not drown out the irresistible craving for smoking due to dopamine addiction. The view of heavy attachment to smoking because of a deeply ingrained habit or because of dopamine addiction shows that if you are unlucky enough to fall into this nasty stuff, quitting smoking will take a lot of time and effort. Both viewpoints agree that treatment will be very difficult. According to leading tobacco elimination specialists, a full course of treatment takes at least six months. Sometimes one course of treatment is not enough and has to be repeated. What to do? Lives and the rest of your health are at stake. Both points of view on the problem of tobacco smoking agree on the methods of treatment of this vice. First of all, psychological preparation is necessary. Smokers should be thoroughly explained by examples that smoking is very harmful. They poison not only themselves, but also innocent people close to them. It should be widely advertised how good life is for those who quit smoking. How much money is needlessly spent daily on tobacco products. [32]. But, as practice shows, these techniques do not work at all. Further, both directions use the only basic method of treatment - nicotine replacement therapy (NRT). These are nicotine-containing and nicotine-like pills, gum, patches and inhalers. These products deliver nicotine in smaller amounts, and their effect on the body is smoother and longer lasting. Due to this, they do not allow the nicotine hunger syndrome, nicotine withdrawal, to develop in full force. The point of NST is not only to relieve withdrawal at the beginning of smoking cessation, but also to break the logical link between cigarettes and pleasure that exists in the mind. [12, 16]. Somewhat apart, but with exactly the same effect, the widely publicised drug varenicline (Champix), an agonist of one of the most sensitive to nicotine subreceptors j4b2 nicotinic acetylcholine receptors, synthesised in 2006 in the USA, is used. As already mentioned, treatment with these drugs takes six months or more, and even if a person quits smoking this way, there is no guarantee that he or she will not smoke again after a short period of time. This method of quitting smoking does not form any internal brakes, psychological barriers that help a smoker to abstain from tobacco smoking forever. On the contrary, having given up cigarettes with difficulty, a person believes that he has defeated

this addiction thanks to his sufficient willpower. And finding himself once again in a difficult life situation, a person takes up a cigarette, expecting that, as in the first time, he will be able to quit smoking again later. And this "later" in the overwhelming number of people does not happen. Smoking again on a full programme drags a person. As summarised by some experts, many people quit smoking, but few people manage to accomplish this feat. Dependence on tobacco is considered one of the most invincible. It is well known that quitting smoking is a truly difficult endeavour. [15].

We believe that both of these views, which are unfortunately generally accepted worldwide, are theoretically unfounded and incorrect. Treatment methods based on them are ineffective, excessively long and, as a consequence, have not found the desired response among smokers. We started studying this problem several years ago. The main method of research of the set problem was the all-penetrating functional system analysis, created on the basis of the ingenious theory of functional system (FS), developed by academician P.K.Anokhin. Studying the development of all living things in evolution, P.K.Anokhin discovered that the current vital activity of an organism at any moment of time is provided by the so-called functional systems (FS). Working elements of any FS are assembled from elements of standard anatomical systems of the organism, which are functionally united, and after fulfilment of the set task continue to remain in the structure of their anatomical formations. FS instantly react to any environmental influences. Their only goal is to satisfy emerging needs, which, in particular, include the elimination of threats from the outside world. The organisation and peculiarities of functioning of such structures, assembled for a specific task, were studied in detail by academician P.K.Anokhin and called them functional systems (FS). [2, 3, 4, 5, 6]. Thus, in reality, the organism consists of an unlimited number of different functional systems. Some, having fulfilled their task immediately disintegrate, others exist longer, some remain until the end of the life cycle. P.K.Anokhin established that any functional systems from the simplest to the most complex have the same standard structure and universal principle of operation. Along with ordinary but absolutely necessary elements, functional systems include critical elements. One of such critical elements of any functional system, which is as if in plain sight, is the instantaneous creation of afferent model of the necessary action, virtual parameters of the future result of activity of the working apparatus of the system, which is obliged to eliminate the arisen threat. It is he who in a fraction of a second assembles the working complex of this functional system. P.K.Anokhin labelled it as a system-forming factor or goal reflex. Another element that closes any functional system is called the action result acceptor (ARA). The ARA is a very important element. On the one hand, it is the controller of the system's fulfilment of the necessary action, i.e. creation of the real final result. On the other

hand, this element is a corrector of the entire system, if for some reason the required result was not achieved. In case the system fails to fulfil its basic function, the ARA gives an alarm signal, which contributes to strengthening the activity of the working apparatus or, if necessary, joining additional structures to obtain the required result. Only when the result obtained by a given functional system begins to correspond to the target reflex, the ARA calms down and excitation of the whole system stops. Thus, any process in the organism begins with the appearance of a certain need and necessarily passes through the standard chain of elements of the functional system, which is already familiar to us. [26, 27, 28, 29]. Tobacco smoking is not an exception. What happens when smoking tobacco? The main body structure affected by nicotine in tobacco smoking is nicotine sensitive cholinergic receptors (N-CHRs), which are widely distributed in all organs and body systems. [22]. In the environment in nature, nicotine has never been and is not present. So, in normal life N-CHRs are activated only under the influence of nerve centres. Under the influence of a nerve impulse, a certain amount of the secondary messenger, acetylcholine (ACh), is released from the presynaptic membrane of the N-ChR into the synaptic cleft. Depending on the characterisation of the ion channels in the postsynaptic membrane, the cell attenuates or enhances its function. ACh acts for milliseconds and is almost immediately inactivated, broken down to inactive constituents by acetylcholinesterase (AChE), an enzyme that is synthesised in the same cell. When N-ChR is affected not by an electrical impulse but by exogenous nicotine from a cigarette, there is a stressful, gigantic, catastrophic release of ACh. The synthesis of the ACh-degrading enzyme AChE at the initial moment is sharply lagging behind that required for inactivation of the suddenly arisen huge concentration of ACh. The situation arises as when the organophosphorus chemical warfare agents such as sarin, soman, vi-gas are applied to the organism. These chemical warfare agents also sharply raise the concentration of acetylcholine, blocking the production of acetylcholinesterase, causing poisoning incompatible with life. Therefore, the categorical statement of Professor J.B.Lehtman (1969) that a single cigarette is fatal to a person is quite true. [13]. Activation of N-ChR under the influence of a single cigarette provokes the release of such an amount of acetylcholine, which causes unconditional blockage, paralysis, complete stop of the work of these cells. And since N-ChRs are located in all key areas of the body, this would necessarily lead the body to death. But here the events described in the theory of functional systems (FS) of academician P.K.Anokhin begin. At the same moment, when under the influence of a smoked cigarette the release of ACh catastrophically jumped up, an anti-nicotine FS uniting all cells with N-ChR is formed. The only function of this FS was maximum stimulation of cell structures synthesising AChE. Under the influence of strategic antinicotinic FS, providing the very existence of the organism, AChE synthesis was sharply activated and the

concentration of this enzyme increased up to the level necessary in a given situation. The whole process took a fraction of a second, so that the organism did not have time to receive a severe toxic trauma. The power of AChE synthesis structures was rapidly increasing, as the antinicotinic FS was the main life-supporting system capable of using all energy and plastic resources of the cell for its needs. The system-forming factor of the antinicotinic FS, thus, is a high level of AChE concentration. The ARA receives information about sufficient AChE synthesis capacity, showing that the lethal threat has been eliminated. In this case, the motivational arousal of the antinicotinic FS ceased. The situation did not reach the conscious level. The organism continued to live a quiet life. From this moment any quantity of nicotine of smoked cigarettes was calmly processed by perfectly functioning antinicotine FS.

And everything would be fine, but under the influence of the appearance of "red flags" already developing in the body of diseases induced by tobacco smoke, active propaganda of extremely negative effects of smoking on the body there is a firm and confident desire to quit smoking. In the morning, having not received a portion of nicotine in a certain, very short period of time, the action result acceptor ("ARA'') detects a low concentration of AChE (the person does not smoke). We are now considering the work of the lowest, subcortical level of the antinicotine FS, which functions autonomously, without cortical, conscious control. And it does not care at all why the system-forming factor turned out to be inadequately low. For this level of organisation, the absence of a rise in AChE concentration shows that the vital antinicotine FS has not fulfilled its mission. ARA, as usual in such cases, induces an orientative-research reaction (ORR) and rearranges the activity of this FS in the direction of strengthening its activity. Any ORR has a specific peculiarity to have a powerful inhibitory effect on all activities occurring at that moment in the organism. The antinocotinic FS is an extremely important FS responsible for survival of the organism. OIR when excitation of the action result acceptor ("ARA '') of this FS acquires a dominant character, i.e. the primary, the most important state of the organism, which requires immediate gratification. A significant negative motivation arises, activating excitation of the subcortical neurovegetative apparatus of depriminating, depressing, depressive character. This manifests itself in the form of increased irritability, nervousness, deterioration of general well-being, a lingering feeling that "something is missing". Such sensations have happened many times in the life of a smoker, when for some reason there were periods when smoking for a certain time was impossible or nothing. At such times the arousal that arose unmistakably indicated the way out. It was necessary to get a cigarette as quickly as possible, as quickly as possible to inhale tobacco, nicotine smoke. After the first puffs, the excitement disappeared and the feeling immediately normalised. If a person continued to hold on and did not smoke,

the ARA of the antinicotine FS increasingly activated the subcortical centres. Internal excitement began to increase rapidly. The state described by different terms - nicotine withdrawal, nicotine hunger, vegetative storm in the form of very high nervousness, aggressiveness, inability to adequately contact with others, difficulty in fulfilling one's professional duties - began to occur. There is an irresistible, animal desire to smoke, which drowns out all the arguments of reason. At the same time, blood pressure, heart rate, and body temperature increases. There are attacks of sweating, disturbed appetite, and sleep. Often there are pains in different parts of the body. Life becomes unbearable. These phenomena can last 1.5 - 2 weeks and most smokers cannot overcome them. In addition to information from doctors and "knowledgeable" people that smoking is a habit accumulated over the years, smokers give up, believing that it is impossible for them to overcome, defeat such a deeply ingrained bad habit, sigh heavily and smoke. Now, thanks to physiological system analysis of processes in organisms, it becomes clear that all these extremely unpleasant processes and sensations are caused by sharp excitation of antinicotine FS. Absolutely all smokers after smoking their first cigarette fall into a standard physiological trap or snare. The life-saving subcortical anti-nicotine FS creates a vicious circle: no nicotine portion after a short period of time→occurrence of the orienting-research response (ORR)→appearance of a powerful negative motivation in subcortical structures with an irresistible, animal desire to get a dose of nicotine at any cost→receipt of this dose→decomposition of the critically increased amount of acetylcholine (ACh) caused by smoking by the specific enzyme acetylcholinesterase (AChE)→release of the cell from nicotine captivity→release of excitation of the antinicotine FS with the appearance of the most ancient nonspecific satisfaction reaction as a sign that the deadly agent has been destroyed and the organism is alive and free again. It is impossible to break out of the described vicious circle without some support. It becomes clear that it is almost impossible to "persuade" a smoker to stop smoking. It is equivalent to asking a sneezing person not to sneeze. Thus, the systemic analysis of tobacco smoking unambiguously states that the only option, the only way to stop smoking is inactivation, a complete reduction in the activity of the primary, subcortical antinicotine functional system (FS). Understanding the nature of the irresistible craving for nicotine, not only by the patient but also by the treating physician, makes it much easier to categorically stop smoking tobacco. To use a sporting term, treatment in this case is no longer a "shadow boxing", i.e. not a fight with I don't know what, not with vague concepts such as "harmful, pernicious habit", not with unscientific views about a super-powerful conditioned reflex or with unfounded suspicions of dopamine addiction. Final assimilation of the essence of tobacco addiction, full conscious understanding that an attempt to "smoke a little" in any amount of time will instantly unfold in full anti-nicotine FS and the whole process of smoking

with its attributes and sufferings will return to "business as usual". This firmly learnt fact gives a reliable psychological point of support, allowing never to touch tobacco products again. The quintessence of the problem has become crystal clear. We need to stop the unnecessary, meaningless, unphysiological hyperactivation of the action receptor (ARA). When there is no exogenous stimulation of N-ChR, because a person does not smoke, activation of the controller and corrector of the antinicotine FS of the primary, subcortical level of regulation is already dysadaptive, pathological in nature. A specific task has been outlined with the help of what tools and methods it is possible to quickly and relatively painlessly extinguish excessive activity of the ARA of the antinicotine FS.

Quitting smoking after a complete assimilation of the task before him acquires, or rather awakens in himself a great power. Eyes are opened, brain activity becomes clearer. The smoker realises that the problem from a huge, incomprehensible, formless essence, creating an irresistible craving for a cigarette, is narrowed down to the understanding of an elementary, clearly defined goal. It turns out that the whole gravity of quitting tobacco smoking lies in the inadequate, no longer needed at the moment excitation of the acceptor of the result of action (ARA) of the antinicotine functional system (FS). It is this "pimple" that turns on the subcortical systems of the body, our unconscious self. But what to do, how to be? A person does not smoke anymore! It is known from physiology that physiological processes in the organism do not work aimlessly, idly. It should be added, they do not work for a long time. Any physiological process, especially the one that is responsible for our life and ensures the safety of the organism, has inertia. But if the need in it is gone, if there is no reinforcement, no information about the continuing need for this physiological reaction, this process quickly fades away. The cessation of useless waste of energy is an obligatory rule of physiology, which is fulfilled in all spheres of the organism's vital activity unconditionally. This is what happens with the ARA of the antinicotine FS. It is physically impossible for this antinicotine FS corrector to constantly activate deep subcortical structures, which require huge energy expenditure, in conditions of unnecessary excitation. A person quitting smoking should realise that he/she is fighting one-on-one not with an incomprehensible, amorphous evil force, but with a frenzied ARA of the antinicotine system. A person should clearly understand that the ARA has enough strength for only 3-5 days. Having learnt this, at the moment of occurrence of signs of nicotine withdrawal, the majority of those who quit smoking have not irritability and depression, but sports excitement. To feel yourself the master of your life, to accept the challenge of the opponent, whose face and his capabilities are clearly visible, to know that the fight will be short, within 3-5 days and come out the winner, this is the fate of 90% of people who want to quit smoking. To win, and not to tail at the whim of some ARA, to end forever with the willless, criminal towards

themselves and their loved ones poisoning the body. This is within the power of any sane person. If for some reason you cannot quit smoking on your own, you should turn to other methods, for example, to acupuncture, which is aimed at blocking inadequately excited ARA at the subcortical level. For a long time now, this science has come out of the shadows and has been used with great success to treat many diseases. [14; 20; 21;25]. It has become clear to many researchers that acupuncture plays a very important role in the elimination of tobacco smoking. [1; 18].However, it should be clearly understood that acupuncture is one of the possible methods of rescuing the smoker from the tobacco physiological trap within the new concept of the essence of this disease. No doubt, other methods of treatment will be found, but strictly within the framework of the functional system analysis described above. The information that acupuncture actively affects all levels of organisation - cellular-organismal, emotional, mental and other levels - was taken into account. Experimentally, based on the results of pulse diagnostics, we came to the conclusion that in tobacco withdrawal the normal movement of energy through the channels of gallbladder (VB), large intestine (GI), spleen and pancreas (RP) and through the channel of pericardium (MC) is disturbed. Besides, we took the points of the channels influencing in the necessary direction on the patient's deformed mental characteristics: VB-originality (excessive), IG-desire (pathological), GI-volition (depressed), TR-ambition (overestimated), RP-consciousness (overshortened). In the end, we created an optimal treatment regimen that suited the vast majority of patients. One treatment session lasts 30-40 minutes, sessions are held strictly daily, without omissions. The duration of the course is 3-4 days. The assessment of the degree of nicotine dependence, the so-called Fagerström test, is completely irrelevant. All that matters is an active desire to quit smoking. Where did this 3-4 days treatment period come from? Experimentally we have established that during this period of time the inadequate activity of ARD antinicotine FS decreases to such a level, which no longer causes symptoms of nicotine withdrawal and the former smoker begins to live a full, healthy life. [30]. To determine statistical efficacy, we treated 131 individuals in a free sample. There were 88 men and 43 women from 22 to 69 years old. All had smoked one to two packets of cigarettes daily for 10 years or more (Fagerstrom score 7). All had tried repeatedly but unsuccessfully to quit smoking on their own. Within three days of treatment, 82 men quit smoking, i.e., more than 93% and 37 women, 86%. Six men and six women failed to quit smoking. [31]. We will analyse the reasons for the ineffectiveness of the treatment for these people later. For the time being, it is necessary to declare without false modesty that the treatment of tobacco smoking according to our methodology has no analogues in terms of treatment time and its results. According to the developed scheme, one month after the end of treatment we called the patients who quit smoking. Most of them continue to live confidently

without tobacco. Some patients needed a second treatment because for some minor reasons they forgot what the operator was talking to them about. But with such a short course of treatments, this annoying moment did not seem insurmountable. The patients had a real experience of the real effectiveness of the method and were eager to repeat the course. Analysing the reasons for the breakdown, they were convinced by their own mistakes that smoking a cigarette or two without consequences would not work. Immediately the antinicotine functional system (FS) was activated and it was impossible to abstain from smoking after that.

Smoking shortens the lives of all smokers. At the same time, tobacco smoke affects those around them, making them passive smokers. Almost all smokers realise that they have fallen into some incomprehensible trap from which it is very difficult to get out on their own. In this paper we have shown how it can be done very quickly. Acupuncture is only one of the possible methods. We have developed other effective options. However, as practice shows, treatment of tobacco and nicotine addiction is not an easy matter. But the way out has been found. Our conceptually exclusive understanding of this world problem is deeply enough scientifically grounded and experimentally proved. This allows us to start a real fight against tobacco smoking and guarantee to win.

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DOI 10.34660/INF.2023.30.46.167

R.M. 的健康水平（适应能力） 秋明州第二个童年的男孩巴耶夫斯基患有过敏性鼻炎，正在参加体育运动

LEVEL OF HEALTH (ADAPTIVE CAPACITY) BY R.M. BAYEVSKY IN BOYS OF THE SECOND CHILDHOOD IN TYUMEN WITH ALLERGIC RHINITIS, GOING IN SPORTS

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注解。 对患有轻度和中度临床病程的过敏性鼻炎（AR）、参与所选运动的第二个童年时期男孩的健康水平（适应潜力 - AP）进行了分析。 结果表明，2015年至2023年期间，男孩AP水平的指标没有变化，并保持对两个累积因素——AR疾病严重程度和护照年龄的显着依赖趋势。 结果表明，随着男孩通行年龄和AR疾病持续时间的增加，心血管系统（CVS）活动的压力变得更加明显，在12岁时普遍存在。AR临床表现的严重程度显着影响第二童年时期男孩AP的表现，在青少年体校进行训练时应考虑到这一点。 体育区中存在患有过敏性疾病的儿童，这要求教练需要与医疗和体育药房的专家一起纠正体育活动。

关键词：男孩，第二童年期，运动，过敏性鼻炎，适应潜力。

Annotation. *An analysis of the level of health (adaptive potential - AP) of boys of the period of the second childhood, suffering from allergic rhinitis (AR) of mild and moderate severity of the clinical course, involved in the chosen sport is given. It is shown that over the time period from 2015 to 2023, the indicators of the level of AP in boys have not changed and retain a significant trend of dependence on*

two cumulative factors - the severity of AR disease and passport age. It is shown that as the passport age of boys and the duration of AR disease increase, the stress in the activity of the cardiovascular system (CVS) becomes more pronounced, prevailing at the age of 12 years. The severity of clinical manifestations of AR significantly affects the performance of AP in boys of the period of the second childhood, which should be taken into account when conducting the training process in the Youth Sports School. The presence of children with allergic diseases in the sports sections dictates to the coach the need to correct physical activity together with a specialist in a medical and physical education dispensary.

Keywords: *boys, second childhood period, sports, allergic rhinitis, adaptive potential.*

The relevance of research. Allergic rhinitis (AR) is one of the most common human diseases on earth [4, 6, 7], the diagnosis and treatment of which is the subject of extensive specialized literature [2, 3, 5, 8]. It is alarming that as the passport age increases, the number of children and adolescents with allergic diseases, including AR, increases. The influence of the clinical course of AR on the adaptive capabilities of a growing child's body has been studied little and there is practically no information on the indicators of the level of AP in boys of the period of the second childhood, living in Siberia, who for the first time started regular sports.

The purpose of the study: at the initial stage of playing sports in boys of the period of the second childhood in Tyumen, suffering from allergic rhinitis of varying severity, using the method of R.M. Baevsky, to study the level of health (adaptive potential).

Material and research methods. The "Astra-Med" Medical Center in Tyumen has been conducting clinical and immunological examination and treatment of children with AR for many years. In this report, we present only the results of studying the level of AP for the period from 2015 to the present in 72 boys of the period of the second childhood (8–12 years old), who have been suffering from AR for a number of years, involved in various sports - martial arts, ice hockey, skiing. racing and biathlon, athletics. All the boys were residents of the city of Tyumen and studied in general education schools, while their parents had been permanent residents of the area for three generations.

Mild severity of clinical manifestations of AR was diagnosed in 43 (63.15%) boys, moderate severity of manifestations of the disease - in 29 (36.85%) people.

The level of health was studied using the so-called. AR, determined in points according to the formula [1]:

US \u003d 0.011HR + 0.014SBP + 0.008DBP + 0.014V + 0.009MT 0.009R 0.27

where: HR heart rate; SBP systolic blood pressure; DBP diastolic blood pressure; B - age; BW body weight; R body length.

AR values were characterized as follows: no more than 2.10 points - satisfactory, from 2.11 to 3.20 points - tension of CVS adaptation mechanisms, from 3.21 to 4.30 points - unsatisfactory; more than 4.30 points - failure of adaptation.

The data obtained as a result of the study were processed on a personal computer using mathematical analysis according to generally accepted methods of variation statistics. We determined: the arithmetic mean and the error of the arithmetic mean. The significance of age differences was judged by Student's parametric t-test. Differences were considered significant at a significance level of $p<0.05$.

The studies were performed in accordance with the Order of the Ministry of Health of the Russian Federation No. 226 of June 19, 2003 "Rules of Clinical Practice in the Russian Federation". The principles of voluntariness, the rights and freedoms of the individual, guaranteed by articles 21.2 and 22.1 of the Constitution of the Russian Federation, as well as the Order of the Ministry of Health and Social Development of Russia No. 774n dated August 31, 2010 "On the Council on Ethics" were observed. The study was conducted in accordance with the ethical standards set out in the Declaration of Helsinki and the Directives of the European Community (8/609EC) and with the oral consent of the boys.

Results of the study and their discussion. Calculations showed (Table 1) that in boys aged 8–11 years with a mild form of clinical manifestations of AR in the form of rhinorrhea, sneezing, itching in the nose and eyes, headache at three stages of the study, the numerical values characterizing the severity of AP did not go beyond satisfactory adaptation - 2.10 points.

Table 1

Indicators of the level of health of boys 8–12 years old in the city of Tyumen who are ill allergic rhinitis of varying severity of clinical manifestations

Disease severity	Age, years				
	8	9	10	11	12
I examination period – 2015-2016 г. n=21					
Light	1,89±	1,98±	1,99±	2,09±	2,190,14*
Medium	2,21±	2,29±	2,33±	2,42±	2,52±
II examination period – 2019-2020 г. n = 27					
Light	1,91±	1,93±	2,04±	2,06±	2,180,13*
Medium	2,27±	2,31±	2,40±	2,50±	2,50±
III examination period – 2023 г. n = 24					
Light	1,83±	1,88±	1,96±	2,08±	2,210,14*
Medium	2,30±	2,33±	2,38±	2,48±	2,58±

Note: * and ** difference is significant at $p<0.05$

As for the boys aged 12 years, their AP values exceeded the normative values and were in the range of 2.18-2.21 points, which we regard as the initial manifestations of the stress of the adaptation mechanisms in the activity of the CVS.

With moderate severity of AR at three stages of the study, expressed not only in the symptoms described by us above, but also in almost constant nasal congestion and often copious discharge from the nose, which makes the child breathe through the mouth, more pronounced itching in the nose, pain in the ear, the values AP always went beyond the normative values. Calculations showed that all boys had a significant ($p<0.05$) tension in the CVS adaptation mechanisms, because the AP values exceeded 2.10 points.

Attention is drawn to the fact that as the age of the boys increased, the tension in the activity of the CVS became more pronounced, and it depends on the severity of the course of the disease. The age-related increase (from 8 to 12 years) in the activity of the cardiovascular system in boys with a mild form of AR in absolute terms was: at stage I - 0.30 points, at stage II - 0.27 points, at stage III - 0.38 points. With an average severity of AR, the stress in the work of the cardiovascular system, respectively, amounted to 0.31; 0.23 and 0.28 points (Fig. 1).

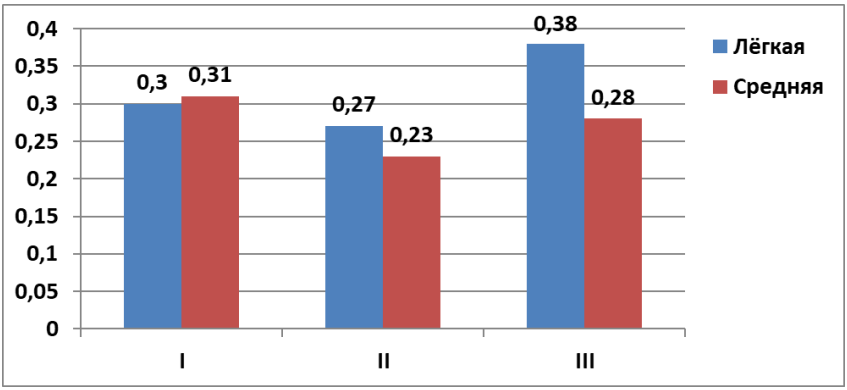

Figure 1. *Age-related stress in the activity of the cardiovascular system in boys of the period of the second childhood at three stages of the study, depending on the severity of the clinical course of AR.*

Of undoubted scientific interest is the question of age-related differences in AP values in boys, depending on the severity of the clinical course of AR (Fig. 2).

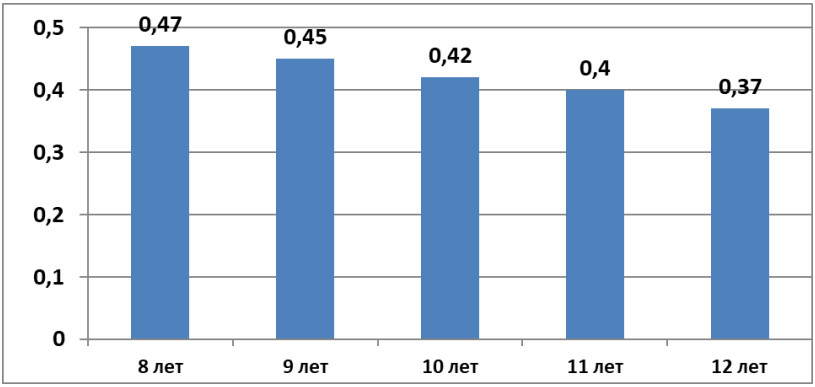

Figure 2. *Age differences in the level of adaptive potential in boys involved in sports, depending on the severity of the disease.*

As the passport age increases, the level of health of boys, despite AR, as a result of regular sports, tends to normalize adaptation.

Thus, based on the study, the following conclusions can be drawn.

1. The severity of the clinical manifestations of allergic rhinitis significantly affects the parameters of AP in boys of the period of the second childhood, which should be taken into account when conducting the training process in the Youth Sports School.

2. As the passport age of boys increases and the duration of AR disease, the tension in the activity of the CVS becomes more pronounced, prevailing at the age of 12 years, which is the beginning of puberty. As a result of regular exercise, tends to normalize adaptation.

3 The presence of children with allergic diseases in the sports sections dictates to the coach the need to correct physical activity together with a specialist in a medical and physical education dispensary.

4. Over the time period from 2015 to 2023, the indicators of the level of adaptive potential of boys in the period of second childhood have not changed and retain a significant trend of dependence on two cumulative factors - the severity of AR disease and passport age.

Conflict of interest. The authors of the article confirmed the absence of a conflict of interest, which must be reported.

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DOI 10.34660/INF.2023.66.55.168

基于地理信息系统收集和分析卫生和流行病学健康数据的数字平台
DIGITAL PLATFORM FOR COLLECTING AND ANALYZING DATA ON THE SANITARY AND EPIDEMIOLOGICAL WELL-BEING BASED ON GEOGRAPHIC INFORMATION SYSTEMS

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抽象的。 尽管人工智能算法在各个领域得到广泛应用，但其用于解决卫生和流行病学状况评估以及环境因素对公共卫生影响的问题仅限于少数科学研究，主要是在国外。

开发的地理信息门户“俄罗斯北极地区人口的卫生和流行病学福祉”是俄罗斯北极地区第一个解决此类问题的地理信息平台上的交互式信息和分析系统。2022年进行的测试使制定新的发展方向成为可能，主要是通过引入基于人工智能的分析算法。 借助这些用于分析大数据的工具，Geoportal 将使您能够重新审视卫生和流行病学状况的综合评估问题，同时考虑到多变量分析。

关键词：地理信息系统、公共卫生、环境因素、人口卫生和流行病学福祉、大数据、地理门户、俄罗斯北极、分析处理、统计分析、人工智能。

Abstract. *Despite the widespread use of artificial intelligence algorithms in various fields, its use for solving problems of assessing the state of sanitary and epidemiological well-being and the impact of environmental factors on public health is limited to only a few scientific studies, mainly abroad.*

The developed geoinformation portal “Sanitary and epidemiological well-being of the population of the Russian Arctic” is the first interactive information and analytical system on a geoinformation platform in the Russian Arctic to

solve such problems. The testing conducted in 2022 made it possible to formulate new directions for development, primarily through the introduction of analysis algorithms based on artificial intelligence. Thanks to these tools for analyzing big data, the Geoportal will allow you to take a fresh look at the problem of a comprehensive assessment of the state of sanitary and epidemiological well-being, taking into account multivariate analysis.

Keywords: *geoinformation systems, public health, environmental factors, sanitary and epidemiological well-being of the population, big data, geoportal, Russian Arctic, analytical processing, statistical analysis, artificial intelligence.*

Introduction. The prospects for the use of artificial intelligence in the field of preventive medicine and the assessment of sanitary and epidemiological well-being are quite extensive [1, 2, 3]. One of the urgent tasks is the analysis of big data with reference to the territory (map) [4, 5, 6], for which it is effective to use geoinformation systems based on server platforms [7, 8].

The created geoinformation portal "Sanitary and epidemiological well-being of the population of the Russian Arctic" (Geoportal) allows solving most of the above tasks, however, to improve the accuracy of forecasting and assessment, it needs to be equipped with artificial intelligence algorithms [9].

The concept of the Geoportal involves the implementation of the following features:

1. Formation of a unified database on the state of public health and environmental factors in the Russian Arctic.

2. The possibility of prompt access to the list of medical, hygienic and socio-economic information in the "online" mode through the Internet portal for a wide range of authorized organizations.

3. Improving the system of social and hygienic monitoring (SHM).

4. Creation of programs for the comprehensive improvement of territories and ensuring the hygienic and environmental safety of the population.

The main component of the entire system is the geographic information system ESRI ArcGIS for Server Advanced Enterprise v.10.7, which provides processing of all data, the ability to download and interact with the user.

The following priority indicators were chosen for the formation of databases:

1. Data from Rospotrebnadzor of the subjects included in the Russian Arctic;

2. Data of executive authorities and local self-government of the subjects of the Russian Arctic;

3. Forms of federal and sectoral statistical observation: forms of federal statistical observation;

4. Data from the federal information fund SGM:

5. Cartographic resources of Open Street MAP;

The architecture consists of 4 levels of data presentation: the Russian Arctic as a whole, the subjects of the Russian Federation as part of the Russian Arctic, the municipal districts of the subjects and the municipalities within the regions. The indicators are grouped in the form of 8 information layers: topographic base with administrative boundaries of territories of various levels, health indicators of the population, demographic indicators, socio-economic indicators, indicators characterizing the quality of drinking water supply, indicators of the quality of atmospheric air, drinking water, soil of populated areas. The Geoportal covers the entire territory of the Russian Arctic: 9 subjects and more than 60 municipal districts and currently contains information for a time period of 16 years - from 2007 to 2022. The Geoportal is implemented as a browser-based web application and is available at the Internet address https://rusarctic.com, where information content is posted on the subject of sanitary and epidemiological well-being in the Arctic zone. In the cartographic application, the user has access to a wide range of tools for working with map-related information: visualization of monitoring points, selective arrays of spatially related data in the context of districts and subjects with color indication of indicator variability using gradient fill (Figure 1), visualization of data in tabular form and in the format of graphs and histograms.

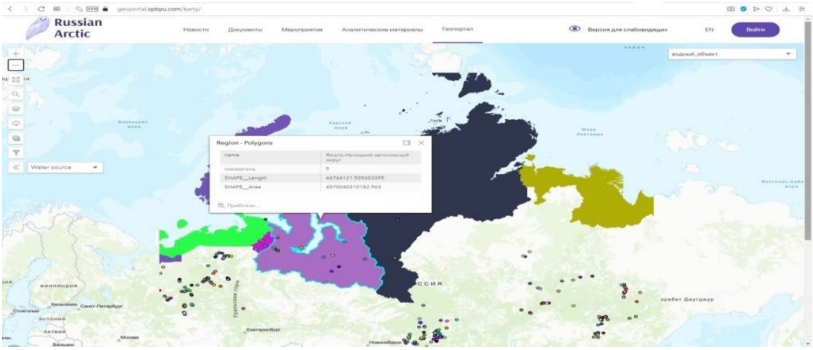

Figure 6. *Visualization of monitoring points and indicator variability using gradient fill*

In 2021, the creation of the basic version of the Geoportal with the listed tools was completed. In 2022, testing was carried out with the participation of specialists from bodies and institutions of Rospotrebnadzor, during which user experience, speed and efficiency were tested. As a result, a list of proposals for improvement and optimization was formulated. For more effective practical application, it is planned to expand the functionality and create tools for statistical data analysis - the Geoportal Analytical Module with artificial intelligence algorithms.

The purpose of creation is in-depth statistical data processing without the use of third-party specialized software products:

1. Establishing a mathematical relationship between the impact of environmental factors and indicators of public health in dynamics.

2. Comparison of indicators of the state of the environment or the state of health in one or more territories for one or more time periods, or in dynamics.

3. Building a mathematical model for changing the level of the indicator under study depending on the level of risk factors and predicting its dynamics.

4. Identification of areas of trouble for one or more indicators.

Conclusion. The geoportal "Sanitary and epidemiological well-being of the population of the Russian Arctic" is the first of its kind digital platform based on geographic information systems for assessing and analyzing the sanitary and epidemiological well-being in the context of the Arctic zone of Russia. Approbation in pilot subjects of the Arctic zone of Russia and showed its relevance for specialists of the practical level of Rospotrebnadzor. For more effective use of the Geoportal for practical and scientific purposes, it is necessary to optimize it and equip it with analytical algorithms based on artificial intelligence, which will significantly simplify the solution of problems of a comprehensive assessment of the impact of various environmental factors on the health of the population.

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

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DOI 10.34660/INF.2023.96.58.169

使用自动控制工具进行饮用水水质评估方案的论证

SUBSTANTIATION OF THE SCHEME FOR THE USE OF AUTOMATIC CONTROL TOOLS FOR DRINKING WATER QUALITY ASSESSMENT

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抽象的。 这项工作的相关性是因为需要创建一个单一的数字平台来收集、系统化和分析饮用水质量实验室研究的结果，从而使您能够快速处理大量数据。分析了集中供水系统中使用水浊度自动控制的实验室研究和测量结果。 已经制定了利用自动控制装置的测量结果来评估饮用水质量的方案，并为其选择提出了建议，并形成了测量指标清单。

关键词：数字化、自动控制系统、饮用水水质、浊度。

Abstract. *The relevance of the work is due to the need to create a single digital platform for collecting, systematizing and analyzing the results of laboratory studies of drinking water quality, which allows you to quickly process large amounts of data. The results of laboratory studies and measurements using automatic control of water turbidity in centralized water supply systems are analyzed. A scheme for using the results of measurements of automatic control devices for assessing the quality of drinking water has been developed, recommendations have been prepared for their selection, and the formation of a list of measured indicators.*

Keywords: *digitalization, automatic control system, drinking water quality, turbidity.*

Introduction. The disadvantage of laboratory control of the quality and safety of drinking water in centralized water supply systems is the time lag in making managerial decisions on intervention in the water treatment process in order to prevent undesirable developments in the situation [1]. A possible alternative may be control by means of automatic control, the reliability of which makes it possible to reduce the need for human intervention in the processes of water treatment and provide the possibility of automatic adjustment of technological regimes. SUE "Vodokanal of St. Petersburg", since 2004, has been implementing an automated water quality control system [2].

To justify the use of measurement results by means of automatic control for assessing the quality of drinking water, it is necessary to compare them with the results of laboratory studies [3]. One of the indicators of changes in the quality of drinking water, the integrity of water supply facilities and distribution networks, and the acceptability of water for consumers is turbidity, the elimination of which can significantly reduce the level of microbial contamination of treated water and the content of inorganic, organic substances that are likely to pose a threat to public health [4].

Materials and methods. Laboratory studies of turbidity in the water of the Neva River at the South Waterworks of the SUE "Vodokanal of St. Petersburg" were carried out in accordance with [5] with a sampling rate of 1 time per day, using the measurement of the automatic turbidity meter AquaScat NT [6] in 2019-2020. To justify the possibility of using the measurement results of the turbidity meter for assessing water quality, its readings were recorded at the time of sampling for laboratory studies of turbidity. Statistical processing was carried out using Microsoft Excel.

Results. Based on the results of laboratory studies and instrumental measurements of water turbidity:

1. An electronic database of the results of turbidity measurements with a turbidity meter and laboratory studies was formed (table 1);

Table 1

An example of filling in the database of results of laboratory studies and measurements by means of automatic control of water quality indicators of centralized drinking water supply systems

Sampling location	Sampling data	Sampling time	Indicator	Type of measurement	Unit	Concentration	Low measured value	Measurement error
water intake in Neva river	08.08.2019	$10^{\underline{00}}$	turbidity	automatic measurement	ntu	2,26		
water intake in Neva river	08.08.2019	$10^{\underline{00}}$	turbidity	laboratory measurement	mg/l	2,14	0,1	0,42

2. statistical processing of the results was carried out:

2.1. the measurement results of the turbidity meter are recalculated in mg/l according to the formula:

$$C = Cntu * 0{,}58 \quad (1)$$

C – turbidity value, мг/л;

Cntu – turbidity measurement result with automatic measurement, ntu;

0,58 – conversion factor.

2.2. results for which the condition of simultaneity of sampling and fixing the measurement was not met were excluded from further analysis,

2.3. 216 laboratory test results and 216 turbidimeter measurements remained in the sample (Fig. 1),

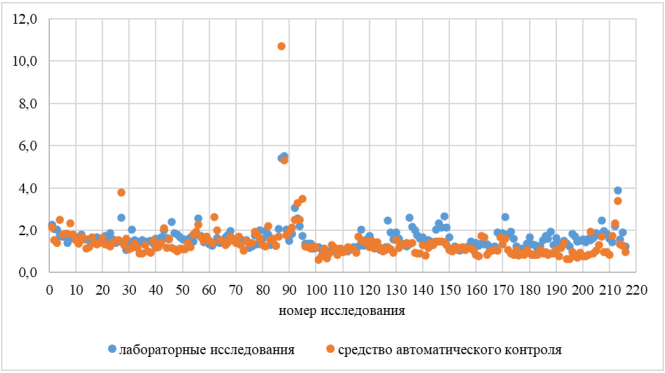

Figure 1. *Results of laboratory studies of turbidity and measurements using a turbidity meter, mg/l*

2.4. mean values were calculated, standard deviation, median, mode, minimum and maximum values (Table 2), distribution normality assessment,

Table 2

Results of statistical processing of laboratory studies and measurements by means of automatic turbidity control

Name	Results of laboratory measurement	Turbidimeter measurements
Average value	1,62	1,40
Error of mean	0,037	0,057
Median	1,55	1,27
Mode	1,23	1,40
Standard deviation	0,55	0,84
Minimum value	0,92	0,61
Maximum value	5,51	10,70

2.5. correlation analysis, the correlation coefficient between the measurements performed by both methods was 0.73, the standard deviation was 0.65, the difference between the measurements was 0.16. In accordance with the Chaddock scale, a correlation coefficient value of more than 0.7 indicates a strong relationship between the studied values [7].

Discussion. Based on the analysis carried out, it was concluded that turbidity measurements using automatic control tools can complement studies conducted by "classical" laboratory methods. Based on the results of the study, a scheme was developed for using the measurement results by means of automatic control to assess the quality of drinking water. (Fig. 2).

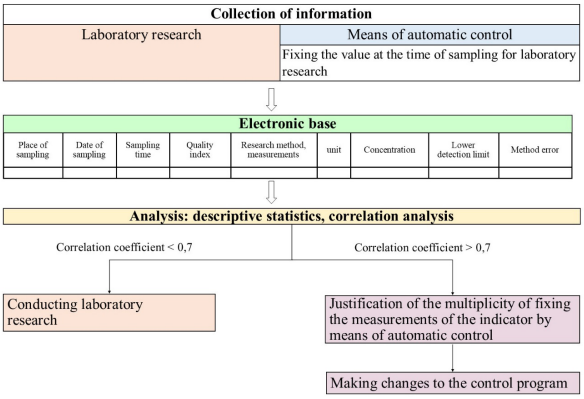

Figure 2. *Block diagram of the use of measurement results by means of automatic control for drinking water quality assessment*

At the 1st stage, it is necessary to organize the fixation of the measurements of the indicator in the water quality control log, for example, at least 1 time per hour - at the points of water intake from surface water sources; at least 4 times a day - after water treatment, in the distribution network.

At the 2nd stage, an electronic database of the results of laboratory studies and measurements of the indicator by means of automatic control is formed.

At the 3rd stage, statistical processing of the obtained results is carried out. If the correlation coefficient between the measurements of water quality indicators by means of automatic control and the results of laboratory studies is not less than 0.7, the inclusion of measurements of the indicator using automatic control means in the control program, the frequency of recording measurements in logs of water quality control, an electronic database is justified; reduction in the frequency of laboratory tests.

When organizing water quality control, when choosing means of automatic control, it is necessary to take into account:

- the measurement method should be comparable to the arbitration laboratory method, have a lower limit of the range of determined concentrations of not more than 0.5 MPC;

− the qualification of service personnel must correspond to the degree of complexity of the automatic control means;

− means of automatic control must meet the requirements of state standards of the Russian Federation [8].

The placement of automatic control devices should be carried out taking into account an objective assessment of the technological process, the possibility of taking water samples for research by laboratory methods, ensuring working conditions and routine maintenance of automatic control devices in accordance with the technical passport.

When forming a list of indicators controlled using automatic control tools, it is necessary to be guided by the current regulatory and methodological documents and take into account regional features, water treatment technology (Fig. 3).

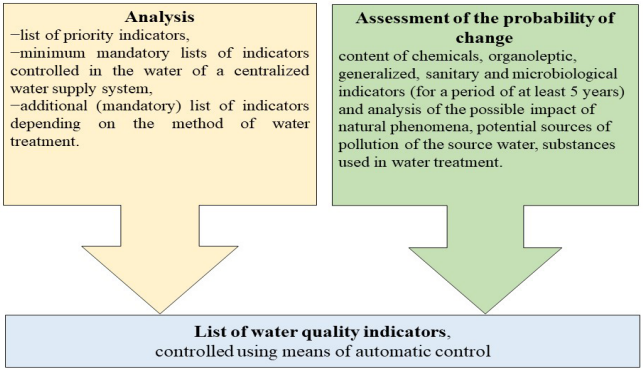

Figure 3. *Scheme for the formation of a list of indicators measured by means of automatic control for assessing the quality of water in centralized water supply systems*

Conclusion. The results of the study confirm that the consistent equipping of intelligent water consumption meters with a data transmission function makes it possible to form a digital model of the enterprise's activities, which, in turn, will lead to a reduction in the time for taking measures in case of violation of the water treatment process or deterioration in the quality of the water source, to the rational use of the supplied water and will contribute to solving the problem of providing the population with guaranteed quality of drinking water.

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

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DOI 10.34660/INF.2023.18.69.170

正戊烷用于生产电能的能量能力
ENERGY CAPABILITIES OF N-PENTANE FOR THE PRODUCTION OF ELECTRICAL ENERGY

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抽象的。 分析了以正戊烷为工质在有机朗肯循环（ORC）中利用地球深层热量发电的能源选择。 确定循环的初始参数和最终参数之间的关系。 估算了沿过流部分的涡轮级平均直径与工作叶片高度的比值。获得了工作气体亚音速流量下轴向单流多级喷射涡轮过流部分的满意轮廓。

关键词：朗肯循环，轴流式涡轮，热力学，涡轮级发散角。

Abstract. *The energy optionsforutilizing the deep heat of the Earth using n-pentane asa working fluid for generating electricity in the organic Rankine cycle (ORC) areanalyzed. The relationships between the initial and final parameters of the cycle are determined. The ratio of the average diameters of turbine stages to the working blades height along the flow part is estimated.A satisfactory profile of the flow part of an axial single-flow multistage jet turbinewith subsonic flow rates of the working gas has been obtained.*

Keywords: *Rankine cycle, axial-type turbine, thermodynamics, diverging angle of the turbine stage.*

Introduction

The transition to renewable energy sources is a promising direction of energy development. The extraction of heat from dry hot rocks of the Earth and its transportation to the surface for subsequent conversion into electricity and heat of increased potential is a serious scientific and technical problem.

When utilizing underground energy, the efficient heat removal from the heat transfer surface of a heat source at great depth should be organized. It is necessary

to circulate the working fluid with the removal of thermal energy with the specified parameters from hot underground layers. This is achieved by an artificially created petrothermal circulation system (PCS), which provides movement of a heat carrier extracting the heat of hot rocks of the Earth, its input and output to the surface with subsequent use in heat and power supply systems [1-4]. The most important element of the PCS is a permeable reservoir between wells, formed by hydraulic fracturing or by stimulating natural defects. The latter approach prevails in practice. The PCS efficiency is characterized by an increase in heat removal from the heat transfer underground surface, the role of which is performed by a system of macro- and microcracks. Recently, the "Eavor" company (Canada) has proposed new PCS schemes with the formation of an underground reservoir by drilling vertical wells connected by multi-barrel horizontal holes [5]. A patented working fluid is used as a coolant instead of water, and a protective coating is applied to the well walls to avoid coolant losses.

In Russia, at the moment there is only one circulation system of the so-called doublet type at the Khankala geothermal water deposit with an aquifer temperature of 96°C at a depth of 900 m and a distance between water intake and return of 1 km [6]. The technologies for the creation of underground circulation systems are at the research stage. Works in this direction are very relevant because they open up the possibility of constructing an underground energy facility with a developed heat transfer surface.

In the issue of deep heat utilization, it is necessary to distinguish two aspects: first, the creation of an underground (at depths of more than 3 km) petrocirculatory system that allows achieving the required thermodynamic parameters; second, an increase in the effectiveness of underground thermal energy conversion. Research on the use of the heat of dry hot rocks of the Earth continues.

Traditional steam-water heating technology dictates an increase in the efficiency of power plants in the direction of increasing the initial temperature of the thermodynamic Rankine cycle. In terms of energy, a substance with a high critical temperature is preferable for generating electricity, which allows the maximum of the enthalpy difference in the turbine with the minimal flow rate of the working fluid. However, for an underground power boiler, which is the most capital-intensive element of this system, a lower boiling point of the working fluid at normal pressure with the exception of air penetration to the working circuit and associated negative processes during condensation is also an important property. This allows a reduction in the initial temperature of the working fluid (the capital intensity of the petrocirculatory system) and a compensation for the reduction of the available heat drop due to its increase in the region of low temperatures. There are also the counter-influencing factors.

Underground heat is used both for heat supply (installed capacity in 2015 in the world was 70.3 GW) and for electricity generation (installed capacity in 2020 reached 16 GW) [2]. We are interested in the production of electricity from the deep heat. At the initial stage of the development of petrothermal energy, when operating not very deep wells, we will have to deal with sources at relatively low temperatures (70-130°C). In this case, the generally accepted approach is to use binary schemes based on the organic Rankine cycle (ORC). There are many candidates for the role of an ORC working fluid with a low boiling point. Therefore, one of the main tasks is to choose the working fluid depending on the numerous requirements and criteria [2,7-12]. Practice shows that only several substances are used for commercial purposes: R134a, R245fa, n-pentane, isobutane, isopentane, and isobutane-isopentane mixture. Utilization of liquids with a low boiling point as the working fluids in electricity production allows more complete utilization of the low potential heat [8-10].

There are quite a few examples of commercial projects with these working fluids. The Swedish company Atlas Copco, commissioned by Turkey and Germany, manufactured 5 turbo-generating units with a unit capacity of up to 22.5 MW using isobutane and n-butane (substances with minimal greenhouse effect on the environment) as the working fluids; the Exergy company (Italy) supplied 11 similar installations with a capacity of up to 12 MW on hydrocarbon to Turkey, Italy and France in 2014 -2015. General Electric Energy (USA) has manufactured over 100 power plants using refrigerant R245fa (pentafluoropropane) as a working fluid for generating electricity. The “Ormat” company (USA) supplied more than 200 turbo-generating units with a unit capacity of up to 15 MW, which use C_5H_{12} (pentane) with an initial vapor temperature in front of the turbine of 105 - 180°C, to the foreign and domestic markets. It is necessary to note the advertising nature of commercial information and incompleteness of the submitted data on the published projects with “N/A” marks. This makes it necessary to determine the efficiency of using low-temperature heat carriers in the steam-power organic Rankine cycle (ORC).

The use of natural gases as heat carriers removes issues related to ozone safety and greenhouse effect imposed on refrigerants: working fluids with a low boiling point. The efficiency of the converter plant can be increased by abandoning the ground-based steam generator and the associated energy losses. Ensuring the explosion safety of hydrocarbons is a technically solved task. The disadvantage of this technology is the low efficiency of the heat transfer process (*Table 1*). Table 1 shows that water and n-pentane (R601) have the best heat transfer characteristics and are widely used in practice [2,7,13-15]. However, the use of steam-water coolant in electricity generation is limited by an increase in the final humidity of steam (~12%), and at a temperature of 120°C it returns to the geothermal well

(Mutnovskaya geothermal power plant), or is discharged into the nearest reservoir (Pauzhetskaya geothermal power plant).

Table 1

Thermophysical properties of heat-transmitting rocks, material of the heat exchanger wall and heat carriers

Parameter	Rocks [16]	Steel	Water	R601	R245fa
			at t = 20 °C		
Density ρ, kg/m^3	2700 (1100 – 5100)	7850	998.2	626.0	1352.2
Heat capacity C_p, kJ /(kg· K)	1.0 (0.5 – 1.2)	0.48	4.183	2.28	1.328
Thermal conductivity λ, W/(m·K)	2.7 (0.2 - 8.2)	58.0	0.599	0.114	0.0915

Another important characteristic is the effect of coolant flow rate in the petro-circulatory system on its service life [16].The flow rate of the working fluid at a given electric power of the turbo-generator depends on the available heat transfer per a turbine.

The purpose of this work is to identify the potential energy options for using the working fluid of the cycle, to establish the relationship between the initial and final parameters of the expansion process of a low-temperature gas coolant in an axial multistage turbine and to identify restrictions on the diverging angle of its last stages [17], determining the efficiency and reliability of operation without changing the turbine blade profile [18-20], which greatly simplifies the process of converting underground thermal energy into electricity (Fig.1).

Research results

The presented technological scheme implements the thermodynamic Rankine cycle (ORC), where the processes of heating (6-7), boiling (7-8) and overheating (8-1) of organic liquid are carried out due to the heat of dry hot rocks in an underground power boiler.

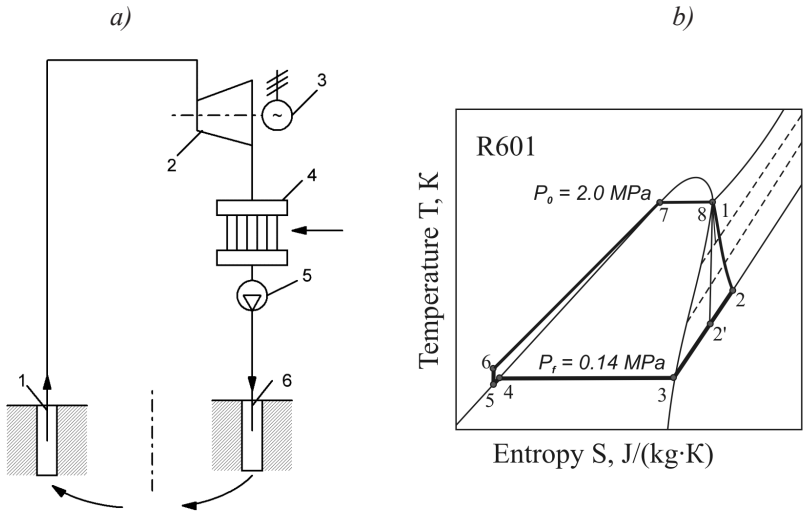

Figure 1. *The basic technological scheme of the underground energy system and the Rankine cycle (ORC) for electricity generation*
a) 1- production well, 2-turbine, 3-electric generator, 4- condenser, 5- feed pump, 6-injection well;
b) 1-2- the process of n-pentane expansion, 2-3- overheating removal, 3-4 - condensation, 4-5- condensate supercooling, 5-6- increasing the working fluid pressure, 6-7-8-1- heating, boiling and overheating of the working fluid in the petrothermal circulation system.

This solution allows the use of relatively low temperatures of the hot source for generating electricity during n-pentane expansion in the turbine (1-2). The physical properties of working fluids at the critical point are presented in Table 2 [13-15].

A comparative analysis of the critical characteristics of the working fluids presented in Table 2 shows that n-pentane is more preferable, and it was accepted for further research because it has a higher available enthalpy difference in the process of energy conversion. It is noted in a comparative analysis of implementations of the ORC cycles using R245fa, n-pentane, and their zeotropic mixtures with different concentrations as the working fluids that R245fa freon has low toxicity and does not ignite [21]. However, its use in a cycle is less economically efficient [22].

Table 2

Values of pressure, temperature of heat carriers at the critical point and boiling point under normal conditions

Parameter	C_5H_{12} n-pentane	C_4H_{10} isobutane	R245fa pentafluoropropane
P_{cr}, bar	33.74	36.47	36.5
T_{cr}, °C	196.62	134.98	154.05
T_b at 760 mm Hg ,°C	36.07	– 11.73	15.1

The need for this study relates to the task of maximizing the use of the available of the enthalpy difference on the turbine in the presence of restrictions on the efficiency of the working fluid expansion caused by the influence of its volumetric flow [23].

An axial, multistage turbine with a capacity of 4000 kW with full gas supply along the entire circumference of the nozzle grid is considered. The choice of an axial multistage turbine is conditioned by its greater energy efficiency as compared to a radial type turbine due to the beneficial use of part of the internal losses during the working fluid expansion in the intermediate stages of the turbine. At that, the rise in the cost of a multi-stage turbine is not a determining factor in the cost of an underground energy system. To achieve this goal, the process of n-pentane expansion in the turbine was studied taking into account internal energy losses per the expansion stages [18-20].

The thermodynamic domain of changes in the parameters of n-pentane during thermal energy conversion is presented in Table 3.

Table 3

Changes in the parameters of n-pentane (R601) during expansion in an axial turbine

Parameter	Initial parameters before the nozzle grating of the first stage (1)	Final parameters of the last stage of the turbine (f)
Pressure P, bar	20	1.4
Temperature T, °C	170	45.7
Enthalpy h, kJ/kg	1136.73	1005.5
Density ρ, kg/m^3	59.62	3.9

Figure 2 shows the expansion process in the turbine stage of the cycle, the methodological provisions of which are set out in [18-20]. However, depending on the task, there are the features of calculation process modeling, which are influenced by the properties of the working fluid that determine the quantitative values of the design characteristics.

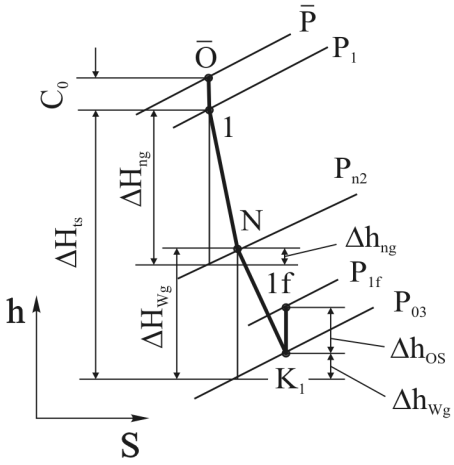

Figure 2. *Calculation of the turbine stage in the h-s diagram* ΔH_{ts}, ΔH_{ng}, H_{wg} *- adiabatic of the enthalpy difference and operation processes (O - 1 , 1 – N , N - K) in the stage, nozzle and working grids, respectively.*

To evaluate the efficiency of each of the turbine stages, a relative coefficient of blade efficiency, which characterizes the perfection degree of energy conversion, is adopted. At the same time, energy losses in the nozzle grid Δh_{ng}, on the turbine blades Δh_{tb} and with the output velocity are taken into account Δh_{ov}. In addition to these energy losses, there are a number of other losses associated with the design of turbine elements that are not considered here (working fluid leakages, its friction against the surface of the disk, bandages, etc.).

Mathematical modeling of the process of n-pentane expansion in a turbine includes an independent separation of the available heat drop by individual stages. At that, the initial parameters (pressure and temperature) of n-pentane at the inlet to the nozzle grid of the first stage are calculated with the zero velocity of the working flow after its throttling in the control valves ($C_o = 0$). For all subsequent stages of an axial multistage turbine ($C_o = 1$), energy losses with an output velocity Δh_{ov} are beneficially used, increasing the enthalpy and temperature of the working fluid at a reduced pressure of the expansion process.

The coolant flow rate at a given electric power of the generator was calculated by expression

$$D = N_g / (\Delta h_a \cdot \eta_{ri} \cdot \eta_m \cdot \eta_g) \ , \qquad (1)$$

here D is the flow rate of gas per turbine, kg/s; N_g is the power of electric generator, kW; Δh_a is available heat transfer to the turbine, kJ/ kg; η_{ri} - relative internal

efficiency of the turbine; η_m, η_g are the efficiency of the mechanical and electric generators, respectively.

The relative blade efficiency of the stage is determined by dependence

$$\eta_{rb} = 1 - \sum \Delta h_i / \Delta h_{ai}, \quad (2)$$

where $\sum \Delta h_i$ is the sum of energy losses in the flow part of the turbine (Δh_{ng}, Δh_{wg}, Δh_{ov}).

An increase in triggered heat transfer (the process takes place in the area of superheated gas) is accompanied by a decrease in the working fluid density (Table.3), an increase in the volume flow of the gas coolant ($D \cdot v_{1t}$) and an increase in the working blade height of the last expansion stage, which leads to a decrease in the ratio of the average diameter of the blade row of stage d_a to the length of the working blade l_{wb} $\theta = d_a/l_{wb}$ [17-20, 23-28]. It should be noted that when analyzing the diverging angle of the last stages of the turbine, specialists use the ratio θ and the ratio $1/\theta$, whose defining characteristic is the working blade length.

$$l_{ng} = D \cdot v_{1t} / (\mu_1 \cdot \pi \cdot d_{a1} \cdot C_{1t} \cdot \sin \alpha_1 \cdot e), \quad (3)$$

where l_{ng} is the height of the nozzle apparatus, m; v_{1t} is the specific volume of gas behind the nozzle grid, m^3/kg ; α_1 the angle of gas outlet from the nozzle; e is the degree of nozzle grid partiality, C_{1t} is the theoretical flow rate of the working fluid from the nozzle grid, m/s;

$$C_{1t} = (2 \cdot \eta_{ri} + x \cdot C_o)^{0.5}, \quad (4)$$

here x is a ratio of the circumferential velocity to the equivalent velocity of the adiabatic outflow.

The height of the working blade (h_{wb}, m) is assumed to be equal to the increase in the size of the nozzle height to exclude working fluid leaks through the axial and radial gaps between the nozzle and working grids (at the root and on the periphery) [20].

Figure 3 shows a change in θ of the stages of n-pentane expansion depending on the working fluid pressure in front of the stage. The main attention in the analysis of the expansion process is associated with an increase in the efficiency of thermal energy conversion. Consideration of the axial turbine allowed reduction in working fluid flow due to a higher relative internal efficiency as compared to the radial one. The relative blade efficiency of the intermediate stages of n-pentane expansion is 86%.

In the area of low pressures close to atmospheric, there is a sharp increase in the height of working blades of the stage. This reduces operational reliability of the turbine and the need to

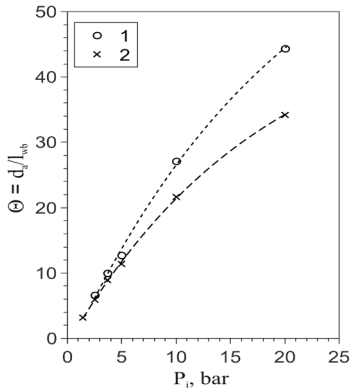

Figure 3. *Influence of pressure P and flow rate D of n-pentane during its expansion on the diverging angle. 1. D = 43.2 kg/s (P_f = 0.25 MPa; θ = 5.9) , 2. D = 38.5 kg/s (P_f =0.25 MPa; θ = 6.6),*

change the profile of the working grid. Despite the possibility of a further increase in the triggered heat transfer (the process takes place in the area of superheated gas), to preserve the original profile of the blades without involving additional technologies, a restriction has been introduced on the diverging angle of the working grid of the last expansion stage θ = 2.5 – 3.0 [23]. In addition to the gas-dynamic and thermodynamic characteristics of the expansion process along the flow part of the turbine, the unit power of the energy generator has a great influence on installation efficiency, whose implementation determines the technical and economic feasibility of the energy system [29]. The single power of the turbo-generator affects not only the occurrence of a critical regime during expansion. The ultimate diverging angle of the last stages (and the power of installation) can be increased by increasing the final pressure (an optimization factor that has a positive effect), using a two-flow turbine where the total gas flow is divided into two symmetrical flows, each directed to its own flow part. However, the fundamental basis for choosing a unit power of the generator is the thermodynamic options for generating electricity, which are determined by the properties of the working fluid used for this purpose. The issue of achieving the upper temperature of n-pentane in the steam-power cycle is a complex circuit-parametric problem of the entire petrothermal energy system.

Conclusions

1. Studies have shown that n-pentane is an effective working fluid for generating electricity when implementing the low-potential heat of dry hot rocks of the Earth with a temperature of less than 170 °C.

2. The results obtained allow a constructive study of the elements of the system, design and creation of an underground pilot-industrial renewable energy source.

3. Computational and methodological studies have been carried out to establish the relationship between the initial and final parameters of low-temperature n-pentane and the possibilities of its use for generating electric energy in an axial multistage turbine are shown.

4. An estimate of the ratio of the average diameters of the turbine stages to the height of the working blades along its flow part is given.

5. At a fixed electrical power, the effect of pressure and flow rate of n-pentane on the diverging angle of expansion stages is shown. A satisfactory profile of the flow part of a jet-type axial multistage turbine with subsonic flow velocities of the working fluid is obtained.

Nomenclature

ΔH –adiabatic of the enthalpy difference (kJ/kg)
Δh – energy losses (kJ/kg)
d – average diameter of the stage (m)
U – circumferential velocity at the average diameter of the stage (m/s)
D – working fluid consumption (kg/s)
C – working fluid speed (m/s)
l - height (length) (m)

Indexes

0 – initial value of the parameter
1 – first stage
i –the current value of the parameter
f - the final value o-f the parameter
cr –the critical point
ng –nozzle grid
wg –working grid
os –output speed

Greek letters

α — the direction of the working fluid in the turbine stage α
θ – fidelity of the working grid
μ –working fluid speed coefficient
η – energy efficiency of the process

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DOI 10.34660/INF.2023.23.90.171

基于微处理器的无功补偿装置
MICROPROCESSOR-BASED REACTIVE POWER COMPENSATION DEVICE

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注解。 简要回顾了现有50 Hz交流电网6.3/10 kV高压侧和0.4 kV低压侧感性无功补偿方法和装置。 考虑集中补偿、集体补偿和个人补偿的情况。 除了经典方法之外，还提出了应用旋转方案和电容倍增装置补偿交流网络中感性无功功率的非传统方法。 给出了每种所考虑方法的优点和缺点。 对于 50 Hz 交流网络中感性无功功率补偿装置的控制，建议使用 Arduino、STM-32 或 ESP32 微处理器等，以最大限度地降低整个系统的成本。 考虑在整个本地SCADA系统中使用补偿装置来控制和调度农业生产对象的可能性。 考虑了完全可操作设备的方案，并详细考虑了本文提出的方法和算法的逐步实现。

关键词：晶闸管、晶体管、无功功率、回转器、电容倍增器、微处理器、自动调节器、SCADA。

Annotation. *A brief review of existing methods and devices of inductive reactive power compensation in 50 Hz AC networks, both on the high voltage side of 6.3/10 kV and on the low voltage side of 0.4 kV, is carried out. Cases of centralised, group and individual compensation are considered. Besides classical methods, non-traditional methods of compensation of inductive reactive power in AC networks with application of gyratory schemes and capacitance multiplication devices are proposed. Advantages and disadvantages of each of the considered methods are given. For control of inductive reactive power compensation devices in 50 Hz AC networks it is suggested to use Arduino, STM-32 or ESP32 microprocessor and similar to minimise the cost of the whole system. The possibility of using compensation devices in the whole-local SCADA system for control and dispatching of objects of agricultural production is considered. The scheme of fully operable device is considered and step-by-step realisation of methods and algorithms proposed in the article is considered in detail.*

Keywords: *thyristor, transistor, reactive power, gyrator, capacitance multiplier, microprocessor, automatic regulator, SCADA.*

Introduction

The problem of reactive power compensation in the circuits of industrial alternating current with frequency 50/60 Hz appeared simultaneously with creation of the industry of generation of perpendicular current in the life activity of mankind [6].

But, despite the available classical solutions [11] and their further improvement [7], the problem is of interest until today [9].

Let us briefly consider the methods and devices that are mass-produced by modern pro-industry [6].

To begin with, let us note that reactive power compensation devices in industry and agriculture can be used in power supply networks at different levels - figure 1.

In figure (1, a) the capacitor unit (CU) for reactive power compensation is included on the high-voltage side 6.3...10 kV of the power supply of the object, and, although, this type of reactive power compensation is widely used at industrial enterprises, it is not recommended for agricultural objects, due to the necessity of keeping high-voltage electricians for maintenance of such units.

Figure (1, b) suggests the inclusion of a centralised compensator on the low voltage side, which is a more appropriate option for agricultural facilities, whether they are staff residences, outbuildings or production facilities**.**

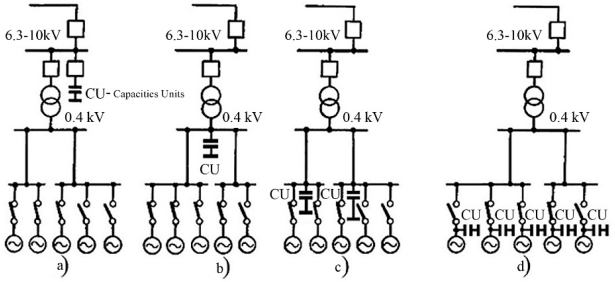

Figure 1. *Methods of reactive power compensation in networks of agricultural enterprises. a) - centralised on the high voltage side; b) - centralised on the low voltage side; c) - group compensation; d) - individual compensation.*

In case of significant distance between heterogeneous premises and individual technological installations, as well as significant energy consumption by each object, Figure (1, c) shows the connection scheme for capacitor installations of group consumers.

In the presence of loads scattered at a considerable distance it is recommended the scheme of connection of individual capacitive compensators of reactive power - figure (1, d).

Types of used inductive reactive power compensators

It is known that the full load of an AC circuit is described by standard equations [9]:

$$Z = \sqrt{R^2 + (X_L - X_C)^2}\,, \tag{1}$$

also $X_L = j\omega L = j2\pi fL$, (2)

$$X_C = \frac{1}{j\omega C} = \frac{1}{j2\pi fC} = \frac{-j}{2\pi fC}, \tag{3}$$

Finally formulas (1-3) can be rewritten in the form

$$Z = \sqrt{R^2 + (X_L - X_C)^2}\,, \tag{4}$$

$$X = X_L + X_C = j(2\pi L - \frac{1}{2\pi fC}), \tag{5}$$

It follows from equality (5) that if the load has a capacitive component, it is compensated by introducing additional inductance and vice versa.

Capacitor installations are used in three ways:

1.Fixed capacitance installations.

2.Switched capacitance units.

3. thyristor capacitor installations.

Non-traditional methods of inductive reactive power compensation

By non traditional methods we will understand special methods of obtaining equivalent capacitors using gyrators and capacitance multipliers.

The gyrator [4], [13], the circuit of which is shown in Figure 2, is a pre-transformer of impedance and, which can behave both as a capacitance and as a capacitor.

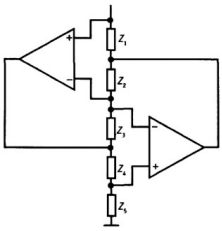

Figure 2. *Classical scheme of a gyrator*

Input impedance of the gyrator [13]: $Z_{in} = \frac{Z_1 Z_3 Z_5}{Z_2 Z_4}$, (7)

Now, if we connect the inductance L as Z4. The remaining complex resistances Z are replaced by active resistances R, then we get $Z_{in} = \frac{R_1 R_3 R_5}{R_2 j\omega L}$, (8)

which is equivalent to the following ; $C_{in} = KL$ (9)

where $K = \frac{R_1 R_3 R_5}{R_2}$. (10)

As follows from formulas (9) and (10), even with a small inductance L of the gyrator it is possible to obtain a large equivalent capacitance, up to one farad [1].

If as R_1, R_2, R_3 и R_5 (or part of them) to take field-effect transistors, it is possible to obtain a variable capacitance with ratios of the larger resistance to the smaller resistance of at least 10^9 [1]. The latter fact allows to easily emulate equivalent capacitance from nano-farad to farad.

The realisation of this approach is possible using powerful operational amplifiers from Apex Microtechnology.

The advantage of reactive power compensation using gyrators is that there is no need to use expensive capacitor installations, as well as the ability to flexibly regulate the amount of compensated reactive power when using dynamic compensation methods.

The disadvantages of this approach include the impossibility to compensate reactive power of more than 20 kVAR using commercially available high-power operational amplifiers. The high price of these amplifiers and the complexity of the control circuitry - these disadvantages are also inherent in gyrator devices.

However, it should be noted that cheaper transistorised, including high-power field-effect transistors, gyrator circuits exist [14].

Another non-standard method of compensating inductive reactive power includes capacitance multipliers [1], [4]. A simplified circuit of a capacitance multiplier is shown in Figure 3.

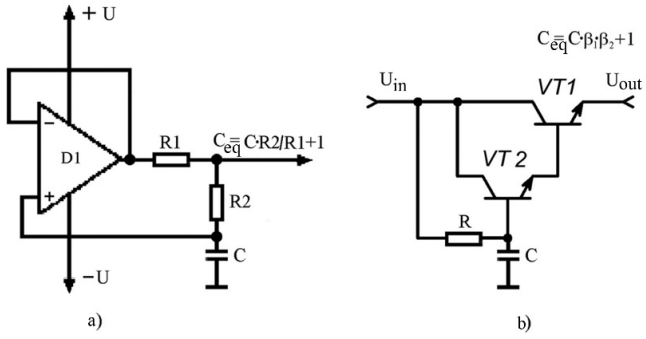

Figure 3. *Capacitance multipliers: (a) on an operational multiplier; (b) on a transistor*

The transistor module by Mitsubishi QM200DY-HB has a permissible collector current of 200 A at collector voltage up to 600 V [3]. The use of powerful power field-effect transistors [5] and industrial types of p-n junction transistors [12] is also promising.

The advantages of capacitance multipliers include a high multiplication factor up to several thousand and the possibility to control this factor. It is possible to compensate reactive power up to 200 kVAR using modern SiC transistors.

Microprocessor realisation of the control device for reactive inductive power compensation units

The functional block diagram of the microprocessor-based reactive power compensation device should contain a block of sensors and input information (1), a computing unit (2) and a control unit (3).

Block (1) constantly monitors and places the instantaneous values of voltage and current of all three phases of the power supply. In addition, this block receives other information necessary for the operation of the device, such as what cosφ should be in the current situation. Unit (2) continuously calculates the parameters of the power system to be monitored, based on data from unit (1), when supplied from a 50 Hz mains supply.

The required parameters include the angle of shift between current and voltage φ, the total power, the required compensating capacitance, etc.

The following algorithm is used to calculate the angle φ. On the signal of zero crossing by voltage U, a high-stability generator with a frequency of f_{gen}, which is switched off when the signal of zero crossing by current I is received, the number n is recorded in the counter of the number of half-periods during the time of switching on the generator. The power supply half-period time τ is also calculated, which is equal to the time between two neighbouring signals of zero crossing by power voltage or current.

Then the angle φ is $\varphi = \dfrac{90^{\circ} n}{\tau f_{gen}}$. (10)

If the angle $\varphi \leq 90^{\circ}$, the current lags behind the voltage and the load is inductive in nature and is denoted by φ_{ind}, in case $\varphi \geq 90^{\circ}$, the voltage lags behind the current and the load is capacitive in nature. In case of capacitive character, the phase shift obtained from formula (10) is calculated as follows $\varphi_{cap} = \varphi - 90^{\circ}$.

The total amplitude instantaneous power S_{amp}, consumed by the load, is calculated as the product of the current amplitude multiplied by the voltage amplitude, then the effective reactive power Q and effective active power P are found from the equations

$$Q = \frac{S_{amp} \sin\varphi}{2} = \frac{U_{amp} I_{amp} \sin\varphi}{2}. \quad (11)$$

$$P = \frac{S_{amp}\cos\varphi}{2} = \frac{U_{amp}I_{amp}\cos\varphi}{2}. \quad (12)$$

Knowing the reactive power, we can calculate the necessary capacitance for its compensation, taking into account that the modulus $X_c = 1/(\omega C)$ and $Q = I^2 X_c$ we obtain

$$C = \frac{I^2}{\omega Q} = \frac{I^2\tau}{2\pi Q}, \quad (13)$$

where I is the reactive current to be compensated.

It is most convenient to measure the current with a Hall sensor, which is the easiest to interface with a microprocessor.

Since $\cos\varphi = P/S$ should not be greater than 0.98, because of the danger of resonances of currents or voltages, in the first approximation, expression (13) should be multiplied by 0.98, i.e.,

$$C = 0.98\frac{I^2}{\omega Q}, \quad (14)$$

Then the calculation block calculates the necessary transfer function coefficient of the capacitance multiplier, gyrator or the value of the capacitance itself to be connected to the compensation device.

It is possible to complicate the computational algorithm, immediately approaching it to the algorithm of dynamic compensation. It is possible to make several trial steps of switching (connection/disconnection) of additional capacitance of obviously smaller value than required, and then, taking into account the sign and value of reactive power change, to calculate the required value and sign of additional capacitance with the help of extrapolation.

Schematic diagram of the device

In order to test the functioning of the proposed microprocessor device, to check the operability of the algorithm and to debug the software, a model of dynamic compensation of reactive inductive power was assembled on the basis of capacitor units switched by means of thyristors.

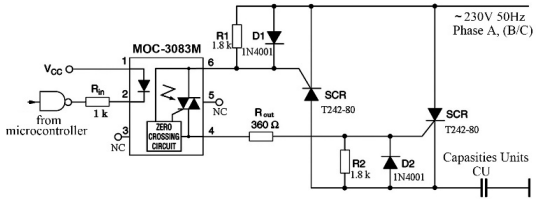

Figure 4. *Power part of microprocessor-based control device for reactive power compensation devices.*

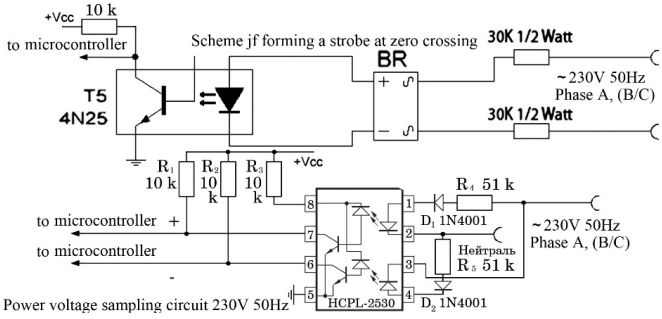

Figure 5. *Sensor part of microprocessor control device for reactive power compensation devices.*

The figure shows strobe pulse generation and voltage sampling. The current sampling circuit is similar to the voltage sampling circuit, the voltage comes from the Hall sensor.

The operation of the proposed device is as follows. Built-in microprocessor in real time mode fixes strobe-pulses of zero crossing current and voltage, with the help of the built-in timer is a continuous recording of the instantaneous values of the current consumed by the object and the voltage supplied with the discretisation of the built-in timer (for Arduino it is 1 microsecond). Then the microprocessor, based on the entered values, calculates the necessary values of phase angle φ and reactive power using the formulas (10-11).

Finally, using the formulas (13-14), the necessary value of the compensating capacitance C_{com} is found. Then, based on the presence of capacitor banks in each phase, the computer connects one or more capacitor banks with a total capacitance C_{sw} to the load. The rule $C_{com} \geq C_{sw}$ is observed. To prevent frequent switching of the compensating capacitances, all entered values I_{max} and U_{max} as well as the phase angle φ are averaged over all periods for one minute. The switching of the capacitor banks (if necessary) also takes place once a minute. The averaging period can be varied over a wide range (typically from 1 sec to 10 minutes), depending on the specific conditions.

Power modules are used in the number of available capacitor banks, usually with capacitance *C, C/2, C/4, C/8, C/16, C/32*, i.e. 6 pieces per phase. Capacitance C is chosen according to the calculation $C_{max}/2$, where C_{max} is the maximum capacitance necessary to compensate the maximum possible reactive component of the power consumed by the agricultural enterprise. In this case, it is guaranteed that in case of maximum power consumption, $cos\varphi$ is not less than 0.97.

Sensor modules of the microprocessor control device for reactive power compensation devices should be present in each phase, i.e. there should be 3 of them

in the system. It is obvious that at such approach to construction of modules of microprocessor control device of reactive power compensation devices, it is possible to compensate reactive component in each phase in dynamic mode. Such a case is most often encountered in practice, because in a large farm, in addition to symmetrical three-phase loads, there are also consumers of single-phase power.

Conclusions

It follows from the analysis that the most flexible methods are those based on circuits that emulate the necessary capacitance to compensate for the reactive component. These methods include gyrator circuits and capacitance multiplier circuits.

The most suitable method for industrial and agricultural production from the point of view of price/quality ratio is the method of dynamic reactive power compensation based on thyristor capacitance switching.

The application of microprocessor for the purposes of tracking the state of power circuits, making the necessary calculations and switching, allows to reduce the cost of the reactive power compensation system as a whole, as well as to increase the reliability and controllability of power consumption at the object of industrial or agricultural purposes..

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DOI 10.34660/INF.2023.54.57.172

基于微处理器的紧急运行模式电动机保护装置
MICROPROCESSOR-BASED ELECTRIC MOTOR PROTECTION DEVICE FROM EMERGENCY OPERATION MODES

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注解。 对交流 50 Hz 0.4 kV 低压侧紧急运行模式下保护电动机的现有方法和装置进行了简要回顾。 分析了基于电流保护继电器的保护的文献数据。 考虑了防止供电网络断路和相位不对称的保护。 重点分析了井下泵鼠笼转子潜水三相电动机的应急运行方式，并考虑了电动机的过热保护。 建议使用霍尔传感器 ACS758-DS 以及光耦合器 HCPL-2530 作为输入传感器，用于输入有关电源状态和电动机消耗的电流的信息。 结论是，应用基于微处理器的三相电动机紧急模式保护系统（以及一般基于微处理器的系统）不仅可以提高工业和农业机械的可靠性、生产率和效率，而且可以提高工业和农业机械的可靠性、生产率和效率。 还应用先进的现代方法进行生产数字化和数字技术。

关键词：电动机运行应急模式、微处理器、自动调节器。

Annotation. *A brief review of existing methods and devices for protection of electric motors from emergency modes of operation on the low-voltage side of AC 50 Hz 0.4 kV is carried out. Literature data on protections based on current protection relays are analysed. The protection against breakage and non-symmetry of phases of the supply network is considered. Special attention is paid to the analysis of emergency modes of operation of submersible three-phase electric motor with squirrel cage rotor of downhole pumps, the protection of such motor from overheating is also considered. The use of Hall sensors ACS758-DS, as well as optocouples HCPL-2530 is proposed as input sensors for input of information about the state of power supply and current consumed by electric motors. It is concluded that the application of microprocessor-based system of three-phase electric motor protection against operation in emergency modes (and microprocessor-based systems in general) will allow not only to increase reliability, productivity and efficiency of industrial and agricultural machinery, but also to apply advanced modern approaches to digitalisation of production and digital technologies.*

Keywords: *emergency mode of electric motor operation, microprocessor, automatic regulator.*

Introduction

The problem of protection of electric motors in industrial alternating current circuits of 50/60 Hz frequency appeared simultaneously with creation of three-phase electric motors and their wide introduction into industry, i.e. in the beginning of the XX century.

But, despite the available classical solutions [1-8] and their further and not once improved[9-12] the problem is of interest until today[10-16].

Especially acute is the problem of protection of three-phase electric motor from operation in emergency modes for submersible electric motors of well pumps [3], [19]. The drop of water source level in a well and water level in a water tower, from which water is distributed for industrial, agricultural and household needs, sometimes exceeds 100-120 metres.

Types of applied devices for prevention of emergency modes.

Let us briefly consider the methods and devices that are used in modern industrial installations. In the most general case it is protection against phase loss, under-voltage supply of the electric motor from the industrial network of electric power supply and excessive operating or starting currents [1, 2, 17, 18, 19]. Each of these approaches of electric motor protection ultimately prevents excessive heating of electric motor windings and its failure due to insulation failure of winding wires or combustion (destruction) of electric motor windings themselves. The microprocessor-based emergency shutdown system is potentially capable of analysing emergency shutdown situations [7, 8] and can, having analysed the situation, transmit an emergency signal to the control room and completely disconnect the power supply, leaving the possibility of switching on only by a special password.

Microprocessor realisation of reactive inductive power compensation device

The block diagram of the microprocessor-based reactive power compensation device shall consist of sensor and input information blocks (1), which constantly monitor and place the instantaneous values of voltage and current of all three phases of the power supply.

The computing unit (2) continuously calculates the parameters of the monitored electric motor on the basis of the data coming from the unit (1), while supplying it from the 50 Hz mains.

The protection unit (3) controls switching on or switching off of the protected electric motor depending on the protection algorithm and current parameters of the power network and electric motor operating current. The main function of the protection unit is to prevent destruction or other long-term failure of the electric motor.

Schematic diagram of the device and experimental results

To test the functioning of the proposed microprocessor device, to check the operability of the algorithm of work, as well as debugging software was assembled microprocessor protection unit of three-phase electric motor from working in emergency modes with a flexible and variable algorithm of work on the basis of a widely used system Arduino [9-10], STM-32 or ESP32.

The main computing device of the proposed microprocessor system is a single-chip microprocessor ATmega 328/P.

As input sensors for input of information about the state of power supply and current consumed by electric motors the use of Hall sensors ACS758-DS [20] and optocouplers HCPL-2530 [21] is proposed (Fig. 2).

To increase the system performance for multichannel protection systems it is necessary to use faster microprocessors of STM-32 type.

If it is necessary to use wireless sensors and/or wireless sensor networks, the optimal solution will be the use of blocks based on microprocessor modules ESP32.

The applied optocouplers and Hall sensors (Fig. 1) have galvanic isolation, which reliably protects microprocessor circuits from power supply circuits of protected electric motors, thus increasing the reliability of the protection system as a whole.

The actuating mechanism at the output of the microprocessor device for protection of a three-phase electric motor against operation in emergency modes can be conventional electromagnetic relays equipped with single and single-transistor DC amplifiers to reduce the load on the microprocessor output stages.

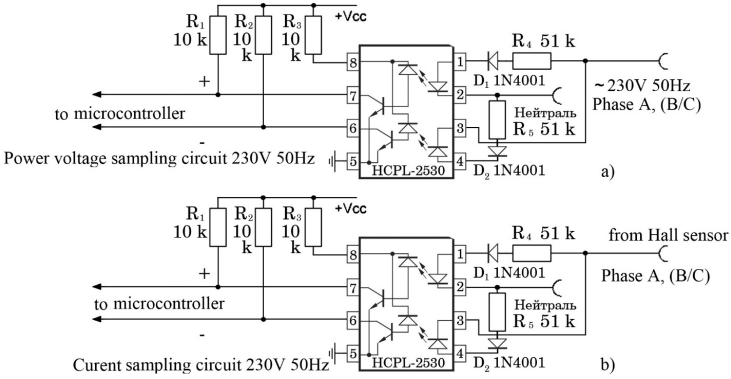

Figure 1. *Sensor part of the microprocessor device for protection of a three-phase electric motor against operation in emergency modes. Discretisation schemes a) supply voltage 220 V, 50 Hz; b) current consumption*

The breakdown test voltage for optocouples is 5 kilovolts, and for Hall sensors 4.8 kilovolts [20, 21].

The actuating mechanism at the output of microprocessor device for protection of three-phase electric motor against operation in emergency modes can be conventional electromagnetic relays, equipped with single and single-transistor DC amplifiers to reduce the load on the microprocessor output stages.

To increase the load capacity, reliability and service life of electromagnetic relays, they should be replaced by solid-state thyristor relays. One of the possible variants of such a relay is shown in Figure 2.

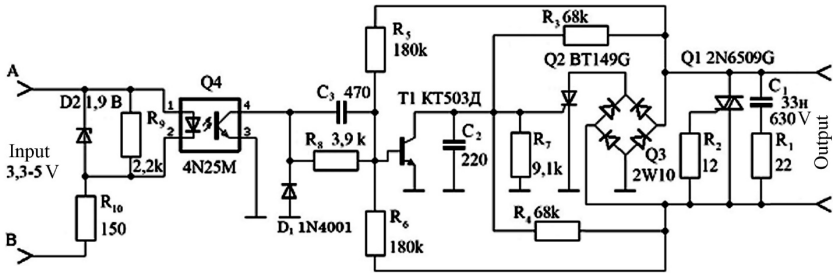

Figure 2. *Power part of three-phase electric motor protection unit against operation in emergency modes*

From the peculiarities applied in the power part of the three-phase electric motor protection system against operation in emergency modes, it should be noted the necessity to apply a variant of thyristor Q1 type-nominal. It should be selected from the maximum operating current required for reliable operation of three-phase motor starter, and the minimum holding current for reliable holding of the starter armature after operation. The tripping power of modern AC starters is in the range of 10-200 W, and the holding power in the range of 1-20 W. The ratio of the maximum starting current to the minimum holding current is 1:10, which, fortunately, most modern thyristors fulfil.

Conclusions

From the carried out analysis of existing methods and circuit solutions of systems of protection of three-phase electric motor from work in emergency modes it follows that the most flexible are methods based on microprocessor circuits which, thanks to their universality, cover all methods applied to the present time.

The algorithms described in [11-18], as well as [1-4] and [6-8] have been tested on the assembled mock-up of the microprocessor-based system of protection of three-phase electric motor against operation in emergency modes. The proposed

protection system has shown stable operation in a wide range of variation of power consumption by electric motors and power supply network parameters of 50 Hz.

Special attention should be paid to the mode of long-term recording of current consumption and parameters of the power supply network in order to detect degradation of the electric motor insulation and wear of mechanical parts, as proposed in [6].In general, the use of microprocessor-based protection system of three-phase electric motor from working in emergency modes (and microprocessor-based systems in general) will allow not only to increase the reliability, productivity and efficiency of industrial and agricultural machinery, but also to apply advanced modern approaches to digitalisation of the electric motor protection system. The proposed microprocessor-based system of three-phase electric motor protection against emergency operation will easily fit into SCADA system and the approach based on the Internet of Things (IoT).

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DOI 10.34660/INF.2023.29.95.173

MICROPROCESSOR DEVICE FOR NUMERIC CONTROL OF THYRISTORS

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注解。 对现有工频交流电路中晶闸管的控制方法进行了简要回顾。 其中包括维持给定功率的精度较低。 长波和中波广播频段的无线电干扰程度较高。 工频电源电压形式明显畸变（尤其是大功率稳压负载时）。 提出了一种基于现代单片机的全数字控制大功率晶闸管的方法。 所考虑的算法是完全自同步的，不依赖于设备和调节对象的电源电压参数。 作者提出的方法使得在小位微处理器上以任何预定精度调节负载中的功率成为可能。 该算法旨在嵌入对设定参数进行高精度调整的数字系统中，例如PID控制器、物联网、SCADA以及用于工业和农业自动控制对象和控制系统的类似系统。 详细描述了所提出的用于生成打开功率元件的脉冲的算法，用于控制强大的晶闸管和三端双向可控硅开关。 给出了计算公式来确定相对于正弦波通过零的控制脉冲的开始。 控制信号的持续时间的值被证实。 给出了该装置的电源部分的电路图并对其进行了详细分析。 详细分析了设备组成无线电组件的要求。 控制微处理器的选择得到证实。 建议过渡到更便宜的微控制器类型。

关键词：晶闸管、双向可控硅、微处理器、PID控制器、物联网、SCADA

Annotation. A brief review of the existing methods for controlling thyristors in AC circuits of industrial frequency has been carried out. *These include low accuracy of maintaining a given power. High level of radio interference in long- and medium-wave broadcast bands. Significant distortion of the form of the power supply voltage of industrial frequency (especially with powerful regulated loads).* A method for controlling powerful thyristors in a fully digital way based on modern single-chip microcontrollers is proposed. The considered algorithm is completely self-synchronizing and does not depend on the parameters of the power supply voltage of devices and regulated objects. The method proposed by the author makes it possible to regulate the power in the load with any predetermined accuracy on a small-bit microprocessor. The algorithm is intended for embedding in such digital systems with high accuracy of adjustment of the set parameters as PID controllers, IoT, SCADA and similar systems for industrial and agricultural automatic control of objects and control systems. A detailed description of the proposed algorithm for generating pulses that open the power element is given,

both for controlling powerful thyristors and for triacs. Calculation formulas are given to determine the beginning of the control pulse relative to the passage of the sinusoid through zero. The value of the duration of the control signal is substantiated. The circuit diagram of the power part of the proposed device is given and its detailed analysis is carried out. The requirements for the constituent radio components of the device are analyzed in detail. The choice of a control microprocessor is substantiated. Recommendations are given for the transition to cheaper types of microcontrollers.

Keywords:thyristor, triac, microprocessor, PID controller, IoT, SCADA

Introduction

Recently, there has been a significant increase in the energy intensity and energy intensity of industry and agriculture in Russia. The most demanded and convenient in use is electricity. It is heating, and lighting, and the operation of electric motors in a variety of industrial, agricultural and household appliances. But since the electrical energy consumed by receivers must be regulated within wide limits, depending on external and technological conditions, a reliable regulating device (device) is required. One of such devices is thyristor (triac) [3, 6, 7, 9, 18], which is an ideal alternating current commutator.

Changing the polarity of the supply voltage ensures that such power devices switch off when their currents are reduced to zero [3, 9, 18]. Thus, their disadvantage that switching off by means of control pulses is impossible is levelled in thyristor (triac) based AC interrupters [7, 9].

The principle of operation of AC interrupters is explained in Fig. 1.

From Figure 1 it is clear that the power released on the load depends on the time of switching on the thyristor during each half-period. This is what is known as phase control of the load power. The disadvantage of the phase control method is the low accuracy of maintaining the set power in the load by analogue methods[6, 7, 9]. The way out is to introduce feedback tracking, which measures at each half-period the allocated power and the current period duration[2].

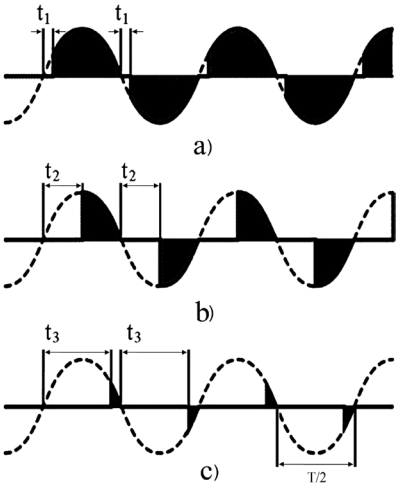

Figure 1. *Phase method of power control by thyristor (a) power close to full power (t_1>>T/4); b) half power (t_2=T/2); c) close to zero power (t_3<<T/4). T – period*

After that the time (phase) of switching on of the power thyristor is set. The scheme was developed due to the introduction of programmable microprocessors into the feedback loop with the necessary analogue inputs of the microprocessor used.

It is known [8, 18] that phase control methods have a serious disadvantage. At an arbitrary phase of switching of a powerful load, such devices are a source of intensive radio interference in long- and medium-wave sections of radio broadcasting bands. It is possible to get rid of this disadvantage by switching the load at the moment when the alternating voltage passes through zero. Then by adjusting the number of half-periods during which the load is switched on with the total number of half-periods counted by the device, the average power consumed by the load can be adjusted. Obviously, the method works either when the load is very inertial (heating furnace) or when the intermittent nature of the power process is not important to the load (electrolysis, battery charging).

Schematic diagram

The control circuit for thyristors (triacs) is shown in Figure 2. The circuit realises switching on of the power element at the moment of passing of the mains voltage through 0. The microprocessor produces a pack of ignition pulses at the beginning of each half-period of the mains, according to the original algorithm of

control of thyristors (triacs) considered below. The algorithm of the pack formation is described in detail in [4, 9, 13].

Almost any microprocessor can be used in the device, for example, PIC, AVR, Tiny, Mega, Arduino, Raspberry, etc. [5, 7, 10, 17]. In multichannel devices STM-32 [11] with a clock frequency of 80 MHz or ESP32 is recommended.

The microprocessor is galvanically isolated from clock pulses and from control signals of powerful thyristors (triacs).

Algorithm of operation

The general algorithm of the proposed regulator is as follows: any integer number N>1 (2, 3, 4, etc.) is taken, the necessary part of power for supplying to the load p is selected or calculated, then two values are calculated:

1. A=[p×N];
2. B={p×N},

where A is the integer and B is the fractional part of the product. Moreover, B has a finite number of decimal places equal to the achievable accuracy of the applied microcontroller (practically any, predetermined). The number A is always less than or (at p=1) equal to N. The described device during the period N (integer number of input AC voltage waves) supplies 2×A unlocking pulses (for each half-wave of the input voltage), distributing them (alternating opening and zero (non-opening) pairs of pulses) as evenly as possible during the period N. The fractional part B after the first cycle is placed in a special counting cell λ (the initial value of which is equal to zero), where the number B is added to it after every N periods. After each such addition the sum C is calculated and its integer part is highlighted, if the integer part is equal to zero, then 2×A unlocking pulses continue to be supplied, if the integer part is equal to one, then:

1. the number of unlocking pulses is increased by 2;
2. the fractional part of C is sent to the special counting cell λ.

Then the process is repeated: the device delivers 2×A unlocking pulses (for each half-wave of the input AC voltage) during the period N (integer number of input AC voltage waves), distributing them (alternating opening and zero pulse pairs) as evenly as possible during the period N.

The new, calculated fractional part C, placed in a special counting cell λ, is added after every N periods, with the number B. In this way, the device, for a countable and finite number of periods N, accurately measures the required power to be transferred to the load.

Figure 4 for zero value of B and N=10 explains the above.

Let's see how the algorithm works at p=0.17. Let's take N=10 again.

Let's calculate:

1. A=1;
2. B=0.7.

Initial value of the number in the cell λ=0.

1. The first cycle will produce two release pulses at the beginning of the first and second half-wave (one wave through the load).

2. Before the second cycle, 0.7+0.7=1.4, so 0.4 will be sent to the λ cell and an additional pair of opening pulses for the 6th wave will appear in the second cycle.

3. Before the third cycle 0.7+0.4=1.1, so 0.1 will be sent to the λ cell and in the third cycle again two waves will pass through the load, the first and the sixth wave.

4. Before the fourth cycle 0.7+0.1=0.8, so 0.8 will be sent to cell λ and in the fourth cycle one wave, the first wave, will pass through the load.

5. Before the fifth cycle 0.7+0.8=1.5, so 0.5 will be sent to the cell λ and in the fifth cycle two waves, the first and the sixth, will pass through the load.

6. Before the sixth cycle 0.7+0.5=1.2, so 0.2 will be sent to cell λ and in the sixth cycle two waves, first and sixth will pass through the load.

7. Before the seventh cycle 0.7+0.2=0.9, so 0.9 will be sent to the λ cell and in the seventh cycle one wave, the first wave, will pass through the load.

8. Before the eighth cycle 0.7+0.9=1.6, so 0.6 will be sent to cell λ and in the eighth cycle two waves will pass through the load, the first and the sixth.

9. Before the ninth cycle 0.7+0.6=1.3, so 0.3 will be sent to cell λ and in the ninth cycle two waves, first and sixth will pass through the load.

10. Before the tenth cycle 0.7+0.3=1.0, so 0 will be sent to cell λ and in the tenth cycle two waves, first and sixth will pass through the load.

As it is not difficult to calculate for ten periods of N (i.e. one hundred whole waves have passed) 17 complete waves will pass through the load, i.e. p=0.17!

Thus, the proposed algorithm allows to realise any accuracy of power setting in the load with the use of the simplest microcontrollers.

Experimental results and conclusions

To verify the functioning of the proposed algorithm, a working model was assembled to control the heater with a power up to 3 kW with power supply from 230V 50Hz network. STM-32 is used as a control microprocessor. An encoder is used to enter information about the power required at the moment. In case the device is included in the circuit of automatic regulation, the value of the required power can come from the PID controller, from the IoT (Internet of Things) system, from SCADA (Supervisory Control And Data Acquisition), etc.[1, 2, 7, 12, 15, 16].

The schematic diagram of reading synchronous pulses and supplying control signals is shown in Fig. 2.

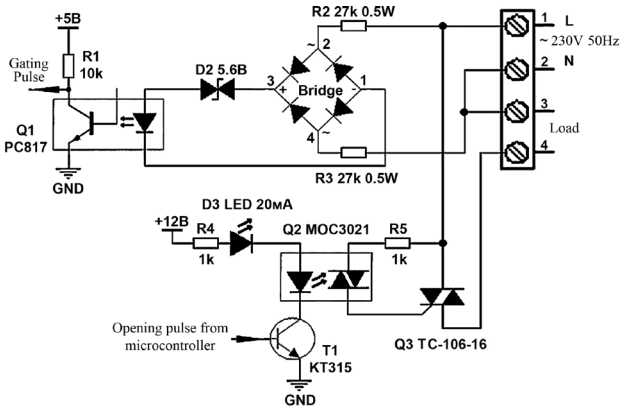

Figure 2. *Power part of the thyristor control circuit using microprocessor*

Elements R1, Q1, D1, D2, R2, R3 connected to the power supply are a generator of the gate signal of the mains voltage passing through 0 [13, 14, 17]. This signal is fed to the microprocessor input, signalling the beginning of the thyristor opening pulse formation in case it is enabled.

Elements R4, Q2, T1, R5 form the opening impulse of thyristor Q3 by the signal from the microprocessor. LED D3 serves as an indicator of the presence of unlocking impulses.

The choice of radio components is determined by the power and supply voltage of the load, from these data the operating voltage and current through the thyristor are determined and, as a consequence, the type of thyristor to be used. Transistor T1 is necessary at low-voltage (3.3 V and below) supply of the microprocessor, in other cases it can be excluded and directly control the driver Q2 by the signal from the microcontroller. The diode-stabilitron D2 should have minimum temperature drift of stabilisation voltage. Resistors R2, R3 limit the operating current of the LED optocoupler Q1 and are calculated on the basis of the operating power supply of the powerful load and the maximum operating current of the applied optocoupler. The permissible operating voltage on resistors R2, R3 is determined by the operating voltage of the load.

The beginning and duration of the control signal for 230V 50Hz network are determined as follows.

For sinusoidal alternating voltage at any moment of time, the equality is true:

$$u(t) = Asin(\omega t + \varphi) = Asin(2\pi ft + \varphi), \quad (1)$$

where u(t) is the instantaneous value at time t;

A - amplitude of alternating current, which in turn is equal to $\sqrt{2}\,U_{эфф}$ (in our case $U_{эфф}$ =230V);

ω - angular frequency of alternating current;

f - frequency of alternating current (for our case f=50 Hz);

φ - initial phase.

For further calculations in our case we can put the value of phase at the beginning of the sinusoid equal to zero, then equality (1) takes the form:

$$u(t) = Asin(2\pi ft), \quad (2)$$

hence the time t at which the voltage is equal to u(t):

$$t = \frac{arcsin\frac{u(t)}{A}}{2\pi f}. \quad (3)$$

The cut-off voltage at which a positive gating pulse is formed is equal to the stabilisation voltage of diode D2, i.e. 5.6 V. Substituting the numerical values of the values in formula (3) we obtain the duration τ of the gate pulse, which is symmetrical with respect to the zero of the sinusoid, so the value calculated by formula (3) must be doubled:

$$\tau \approx 115 \text{ μsek}. \quad (4)$$

Consequently, it is necessary to organise an interrupt of the microprocessor on the fall of the strobe pulse, which will be in 57.5 μsec after the sinusoid passes the zero value. It follows from reference books[16, 17, 18] that any thyristor will reliably open from the triggering pulse at voltage at its anode not less than 12 V. When calculating by formula (3) it will happen in 121 μsec after the sinusoid passes zero. Taking into account the microprocessor delays and the real variation of the mains voltage -15 and +10 per cent of the accepted value, we choose the duration of the opening pulse 100 μsec, which begins at the fall of the strobing pulse. Test results of the assembled layout showed its reliable operation at ambient temperatures from - 30 degrees Celsius to + 40 degrees Celsius.

Conclusion

The conducted tests of the considered hardware-software complex have shown its high reliability and flexibility in a wide range of ambient temperatures and supply voltage fluctuations, and the presence of the built-in microcontroller excludes its manual adjustment within the specified limits of temperature, frequency and supply voltage level changes.

The microcontroller allows to realise the algorithm of power control supplied to the load with any predetermined accuracy.

The proposed approach to building the circuitry of the power part of the device is universal, self-adjusting to the frequency of power supply and does not depend on fluctuations in the value of the input voltage. As in the overwhelming number of cases of power supply at the production enterprises of Russia use 400/230 volt networks with current frequency of industrial frequency 50 Hz, it is recommended

to use in this device a widespread and cheap microcontroller of Arduino or ESP32 family.

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DOI 10.34660/INF.2023.67.27.174

特殊用途白色颜料生产技术

TECHNOLOGIES FOR THE PRODUCTION OF SPECIAL-PURPOSE WHITE PIGMENTS

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抽象的。 该文章描述了特殊用途白色颜料的制造技术，即。 钛酸镁、钛酸锌、磷酸钛。 详细介绍了钛酸镁、钛酸锌、磷酸钛的特点、应用及现有技术。 钛酸镁的制造基于表面扩散-迁移； 钛酸锌的制造基于氧化锌与金红石型和锐钛矿型二氧化钛的相互作用； 磷酸钛的先进制造基于废物与磷酸的相互作用。

关键词：白色颜料、钛酸镁、钛酸锌、磷酸锌、磷酸钛、二氧化钛、氧化镁。

Abstract. *The article describes technology for manufacture of special-purpose white pigments, viz. magnesium titanate, zinc titanate, and titanium phosphate. The detailed description of the features, application and existing technologies for magnesium titanate, zinc titanate, and titanium phosphate are given. Manufacture of magnesium titanates is based on surface diffusion-migration; manufacture of zinc titanates is based on interaction of zinc oxide with rutile and anatase forms of titana; advanced manufacture of titanium phosphates is based on interaction of waste products with phosphoric acid.*

Keywords: *White pigments, Magnesium titanate, Zinc titanate, Zinc phosphate, Titanium phosphate, Titania, Magnesia.*

1. Introduction.

White pigments are inorganic pigments having optical action mainly based on non-selective light scattering [1]. Special-purpose white pigments include magnesium and zinc titanates, as well as zinc and titanium phosphates. Due to their high opacifying ability, white pigments have been widely applied in various branches of technology, e.g. in the manufacture of light-resistant products, heat-resistant paints, varnish and refractory materials, as well as plastics, paper laminates etc [2].

2. Features of special-purpose white pigments.

Under processing conditions, there are obtained two types of titanates as pigments: magnesium titanate and zinc titanate (orthotitanate), and two types of phosphates: titanium phosphate and zinc phosphate [3,4].

Physical and chemical properties of the most commonly applied of white pigments are given in Table 1 [3,4].

Table 1.

Physical and chemical properties of special-purpose white pigments.

Parameter	Magnesium titanate (MgO_3Ti)	Zinc titanate ($ZnTiO_4$)	Zinc phosphate ($Zn_3(PO_4)_2$)	Titanium phosphate ($Ti_3P_4O_{16}$)
Whiteness, conditional units	96.0…96.5	96.5…97.5	96.0…96.5	92.0…97.0
Reflectance factor, %	96.0	97.0	96.0	96.5
Mass fraction of compounds, % Titanium dioxide, or titania (TiO_2) Magnesium oxide, or magnesia (MgO) Zinc oxide (ZnO) Free magnesia Free zinc oxide Phosphorus, in terms of PO_4^{3-}	 67.5 30.0 – 2.5 – –	 32.0...33.0 – 65.0...66.0 – 2.0 –	 – – 44.0...47.0 – – 43.0...47.0	– 53.0...57.0 – – – – 43.0...47.0
Hiding power. g/m^2	60.0	90.0	85.0	60.0
Residue after wet sieving on a 0.045-opening sieve, %, no more than	0.1	0.1	0.5	0.5

3. Features of obtaining magnesium titanates.

The interaction of titanium and magnesia at high temperatures obtains magnesium titanates of various compositions, the most valuable of them being magnesium metatitanate $MgTiO_3$ with its high reflective factor and increased heat resistance. These magnesium titanates are widely applied for the manufacture of special light-resistant and heat-resistant materials and products.

The technology for processing titanates is shown in Figure 1.

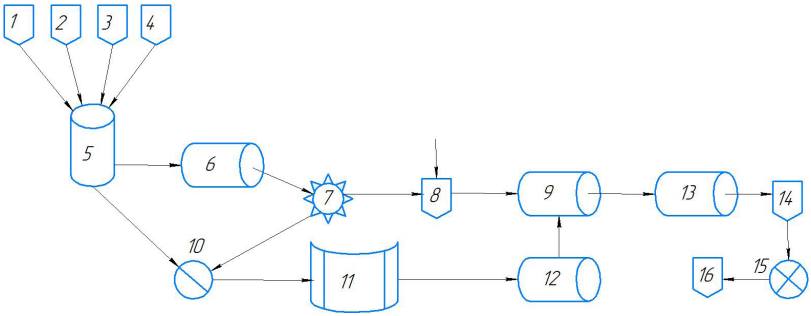

Figure 1. *Technology for processing titanates: 1 – measuring tank for titania; 2 – measuring tank for magnesium carbonate or zinc oxide; 3 –measuring tank*

for potassium sulphate; 4 –measuring tank for zinc sulphate; 5 – reactor with the stirrer; 6 – ball mill; 7 – pump for pumping slurry; 8 – repulper; 9 – high-temperature calcining furnace; 10 – filter press; 11 – dryer; 12 – low-temperature calcining furnace; 13 – cooling drum; 14 – bin for the calcined product; 15 – crusher; 16 – bin for the finished product.

The formulation of raw materials for obtaining special-purpose white pigments, viz. titanates and phosphates, is given in Table 2.

Table 2.

The formulation of raw materials for obtaining special-purpose white pigments, %.

Product name	Magnesium titanate	Zinc orthotitanate	Zinc phosphate	Titanium phosphate
R-1 grade of titania	16.0	25	–	53…57
CH grade of magnesium carbonate, or magnesia alba ($CMgO_3$)	8.07	–	–	–
Zinc oxide (ZnO)	–	65	44…47	–
Potassium sulphate (K_2SO_4) solution, in terms of 50 g/l concentrated K_2O	0.6	–	–	–
Zinc sulphate ($ZnSO_4 \cdot 7H_2O$) solution, in terms of 50 g/l concentrated zinc oxide	0.8	–	–	–
Chemically purified water	75.0	–	–	–
Phosphoric acid (H_3PO_4)	–	–	53…56	43…47

The technological process for manufacturing magnesium titanate includes three stages:

1. Mixing of the components of raw materials;
2. Calcining of the reaction mixture;
3. Grinding and packaging of the finished product.

The mixture of components according to the given formulation is prepared in reactor 5, into which raw materials are fed in the following sequence: chemically purified water is poured with the operating stirrer, then titania and magnesia alba are fed, and, consequently, there are fed solutions of potassium and zinc sulphates. After stirring for 60 minutes in reactor 5, the composed mixture is transferred to ball mill 6, in which the mixture is subject to grinding for 5...7 hours until the mass ratio of free magnesia in the mixture decreases to no more than 2.5%. After grinding, the mixture is pumped by pump 7 to repulper 8, in which it is diluted with chemically purified water to the concentration of 230...250 g/l and then

fed to high-temperature calcining furnace 9, with the maintained temperature of 950...1050 °C. After calcining, the magnesium titanate is cooled in cooling drum 13 to the temperature of 50°C. After cooling, as the magnesium titanate is accumulated in bin 14, it is subject to grinding in crusher 15, and, finally, fed to bin 16.

The primary reaction product in the mixture of titania and magnesia is magnesium metatitanate H_6MgO_3Ti. After the obtaining of magnesium metatitanate is complete, either magnesium dititanate $MgTi_2O_5$ is yielded in case of a surplus amount of titanium (mostly anatase) in the mixture, or magnesium orthotitanate Mg_2TiO_4 is yielded in case of a surplus amount of magnesia at a temperature above 1200°C [3,4]. However, it was found that at three different temperatures of 700, 800, and 900°C an extra amount of magnesia in the mixture of titania and magnesia accelerates the interaction of its components. As for a surplus amount of titania, it does not noticeably affect the speed of the interaction, whereas anatase-containing mixtures accelerate the obtaining of magnesium ditanate.

Under the taken processing conditions, in a mixture of finely crystalline oxides at a temperature below the Tammann temperature there are yielded new forms of titania, and mass transfer under such processing conditions is conducted by surface diffusion-migration of adatoms or molecules over the surface of the crystals. Since titania has a higher diffusive mobility than magnesia, there is observed predominant mass transfer and diffusion-migration of titania adatoms or molecules over magnesia crystals. In mixtures with anatase and rutile forms of titania there is obtained magnesium metatitanate with a certain variety of its mass ratio equal to 12...14 %.

Since anatase crystals are smaller than rutile crystals, the concentration of adatoms on the anatase crystals than that of the rutile crystals will be higher and so will be the rate of mass transfer by surface diffusion, which corresponds to an increase in supersaturation and causes the formation of smaller crystals of a new form, which, in turn, increases the obtaining of magnesium dititanate in mixtures with anatase form of titania. In order to improve the quality of the finished pigment, there are applied titanium compounds as a mixture of anatase form of titania with titanium hydroxide (H_4O_4Ti) sol having their mass ratio equal to (38.0...48.0):(0.5...10.0) in terms of titania [3].

The introduction of zinc sulphate with the mass fraction equal to 0.4...1.0% of titania in terms of zinc oxide to anatase form of titania increases the reflectance factor of magnesium titanate and, consequently, the obtaining of the finished pigment, which was confirmed by researches [7]. The increase of the reflectance factor of titania and the consequent obtaining of magnesium titanate are also observed when the initial components are mixed in 0.1...5.0% ammonia solution [8]. To improve the hiding power of the finished pigment, the mixture is dispersed in organic media with a surface tension of 29030 dynes/cm [9], whereas, to improve

the optical properties of the finished pigment, there is either introduced potassium-containing compound into the initial mixture in the mass fraction equal to 0.07...1.48% of the mixture of titania and magnesia in terms of potassium oxide [10], or there must be maintained the mass ratio of soluble titanium, magnesium and zinc salts TiO_2:MgO:ZnO equal to 1:(0.39...0.40):(0.09...0.011) in terms of oxides in the mixture [3].

4. Features of obtaining zinc titanates.

Processing conditions for obtaining zinc titanates differ significantly from those for obtaining magnesium titanates. In this regard, to establish the optimal processing condition for obtaining zinc orthotitanate Zn_2TiO_4, the following set of three different mass ratios of zinc oxide and titanium hydroxide was taken: 2.25:1; 2.6:1; and 2.8:1. The yielded mixtures with added water were stirred in a ball mill for 25 hours, then consequently dried, and, finally, calcined at three different temperatures: 800, 900, and 1000°C.

The X-ray diffractometry and chemical form analysis of the calcined samples based on the selective dissolution of (free) zinc oxide not associated with titania in a 2% ammonium acetate solution found that zinc orthotitanate is the primary product of interaction of zinc oxide with rutile and anatase forms of titania in the finely dispersed mixture. Zinc metatitanate $ZnTiO_3$ is obtained in rutile-containing mixtures, whereas zinc orthotitanate is obtained in anatase-containing mixtures, which is related to the similarity of the structures of zinc metatitanate and rutile form of titania, and also that of zinc orthotitanate and anatase form of titania. The predominant transfer of zinc oxide over titania crystals is observed in the mixture of zinc and titanium oxides due to the high diffusive mobility of zinc oxide adatoms or molecules. Zinc orthotitanate is recommended to be obtained from a mixture of anatase form of titania and zinc oxide.

In order to improve the optical properties of titanium-zinc pigment and simplify its processing, there is applied 20...40% solution of water-soluble zinc salt, with ammonium hydroxide NH_4OH and zinc oxide taken in the reaction mixture with a mass ratio of 0.9...1.1 [3].

Certain minor additions to the equipment shown in Figure 1 make it applicable for manufacturing zinc orthotitanate. The latter is obtained from rutile form of titania and zinc oxide taken in a molar ratio of 1:2 at the temperature of 800...900 °C by means of wet grinding in ball mill 6, consequent cooling in cooling drum 13 and final grinding in crusher 15. Zinc orthotitanate obtained under such conditions has higher property values, especially reflectance factor.

5. Promising methods for obtaining titanium and titanium-magnesium phosphates.

Metal phosphates have a number of valuable properties, which allows them to be applied in various industries as pigments and fillers, as well as binders, cat-

alysts, etc. [5]. Titanium phosphates having high whiteness, corrosion and heat resistance, are commonly applied as pigments and fillers, whereas products based on titanium phosphate are commonly applied in aggressive environment and at high temperatures [6].

The deficiency of titania in white pigments stimulated the development of technologies for obtaining titanium phosphate $Ti_3P_4O_{16}$ on the base of waste products, such as titanyl and ammonium carbonate $(NH_4)_2CO_3$, by their interaction with phosphoric acid with a molar ratio of TiO_2:P_2O_5 equal to 1:(0.8...1.2) [3]. In order to increase reflectivity to ultraviolet radiation, a neutralizing agent, viz. an aqueous solution of ammonia or ammonium carbonate with mass fraction equal to 50...200 % of the mixture of titania and phosphoric acid, is introduced into the slurry [11]. In order to increase water resistance, mechanical strength and adhesion to metals, as well as to decrease the curing temperature, titanium phosphate is obtained from the mixture of components with the following mass fractions: titania – 72.8%; phosphoric acid – 15.18%, and hydrofluoric acid HF – 5.10% [12]. To obtain mixed titanium and magnesium phosphates that outperform titanium phosphate in a number of properties, the reduced consumption of titania is required. To obtain titanium and magnesium phosphate, solutions of magnesium salts and titanium tetrachloride $TiCl_4$ interact with phosphoric acid with a molar ratio of Mg^{2+}:Ti^{4+}:P_2O_5 equal to (5...10):1:(15...20). There is required fewer amount of titanium tetrachloride with the pH of the mixture equal to 4...5 and the temperature of 50...90 °C in the presence of ammonium carbonate [13].

In order to increase the yield and simplify the technology for obtaining hydrated double titanium-magnesium phosphate, titanyl-ammonium sulphate is applied as titanium-containing raw material, whereas magnesium acetate is applied as magnesium compound, and the process is conducted with a molar ratio of Mg^{2+}:Ti^{4+}:P_2O_4 equal to (5…10):1:(13…20) [3]. To obtain catalysts and ion exchangers, there is applied disubstituted titanium phosphate hemihydrate $Ti(HPO_4)_2$ $0.5H_2O$ which does not contain impurities of other metals. The extraction of impurities from such phosphates is attained by thermal dehydration of disubstituted titanium phosphate dihydrate at a temperature of 100...130 °C and a pressure of 10^2...10^4 mm Hg for 1...2 hours [14].

In order to reduce the ratio of pure products (titania and titanium tetrachloride) in the manufacture of titanium phosphates, there was developed a method applying titanium and iron sulphate solutions as raw materials by reacting them with phosphoric acid in the presence of polyethylsiloxane $CH_3[Si(CH_3)_2O]_nSi(CH_3)_3$ [15].

For the manufacture of catalysts, it is also suitable to apply double titanium-magnesium salt $0.5MgO{\cdot}TiO_2{\cdot}P2O_5{\cdot}6H_2O$ obtained by the interaction of hydrochloric acid solution of titanium tetrachloride with monosubstituted mag-

nesium phosphate $Mg_3(PO_4)_2$ heated to the temperature of 30...70 °C with the molar ratio of Ti^{4+}:$Mg(H_2PO_4)_2$ equal to 1:(7...10). The addition of 30...75 % ethyl or propyl alcohol not only increases the specific surface area of the obtained titanium phosphate, but also accelerates the process of phosphate precipitation [3]. There is also introduced crystalline double titanium-magnesium phosphate γ-$TiMg(H_2PO_4)_2$ $3H_2O$ as an ion exchanger, catalyst and filler, which is obtained by treating titanium phosphate γ-$Ti(HPO_4)_2$ $2H_2O$ by magnesium acetate solution in the presence of ammonia at the initial molar ratio of Ti^{4+}:Mg^{2+}:NH^{4+} equal to 1:(2.0…2.5):(1.6…2.0) [16].

6. Conclusions.

The current study have stated that

1. There are obtained two types of pigment titanates: magnesium titanate and zinc titanate (orthotitanate), and two types of phosphates: titanium phosphate and zinc phosphate.

2. Magnesium titanates, viz. magnesia dititanate and magnesium orthotitanate, are obtained as a result of surface diffusion-migration of titania adatoms and molecules over the surface of magnesia. The introduction of zinc sulphate increases the reflection factor whereas the introduction of potassium compunds improves the optical properties of the obtained magnesium titanate.

3. Zinc orthotitanates, viz. zinc titanate and zinc orthotitanate, are obtained as a result of interaction of zinc oxide with rutile and anatase forms of titana, respectively. The introduction of water-soluble zinc salt improves the optical properties of the obtained zinc orthotitanate.

4. Titanium phosphates are obtained as a result of interaction of waste products, viz. titanyl and ammonium carbonate, with phosphoric acid. The introduction of aqueous solution of ammonia increases the reflectivity to ultraviolet radiation, whereas the introduction of hydrofluoric acid increases the water resistance, mechanical strength and adhesion to metals of the obtained titanium phosphates.

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DOI 10.34660/INF.2023.34.78.175

利用污水恢复土壤肥力
THE USE OF SEWAGE TO RESTORE SOIL FERTILITY

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注解。 随着世界人口的增长和科学技术的进步，人类社会对环境的影响程度必然加大。 越来越多的矿物质被开采，越来越多的产品（工业、蔬菜、动物）被生产，工业和生活用水的使用量不断增加，肥沃土地的面积不断减少，等等。

人类的经济活动伴随着各种生产废物的积累，包括在城市市政经济中，这些废物污染了环境。 此类废物的其中一种是污水，其未得到适当利用，会对全球生态系统（地球的生物圈）造成重大损害。

对此，本文对上述问题进行了调查，并就如何将污水转化为提高土壤肥力和确保人类粮食安全的工具提出了建议。

关键词：uTerra 生物腐殖质、活性污泥、剩余污泥、土壤、污水、污水处理技术。

Annotation. *With the growth of the world population and the development of scientific and technological progress, the degree of human society's impact on the environment is necessarily increasing. More and more minerals are extracted, more and more products (industrial, vegetable, animal) are produced, the use of natural water for industrial and domestic purposes is increasing, the area of fertile land is decreasing, etc.*

The economic activity of mankind is accompanied by the accumulation of various kinds of production wastes, including in the urban municipal economy, which pollute the environment. One of the varieties of such wastes is sewage, which are not properly utilised and cause significant damage to the global ecosystem - the biosphere of the planet.

In this regard, the article investigates the mentioned problematics and gives recommendations on the use of sewage effluents for their transformation into a tool to increase soil fertility and ensure food security of mankind.

Keywords: *uTerra biohumus, activated sludge, excess sludge, soil, sewage, sewage effluent, processing technology.*

Introduction

Food security of mankind can be ensured both by increasing yields and improving the quality of plant products grown on agricultural soils and by restoring the fertility of existing arable land and using deserted areas for agricultural needs.

The main carrier of fertility in soil is organic matter - biohumus. Insufficient amount of humus in the soil leads to its biodegradation, thus making arable land less fertile. It is established that soils under grain crops annually lose 0.5-1.5 t/ha of humus, under row crops - losses are 1.5-3 times higher [1].

At the same time, in deserted areas humus is absent or present in very small amounts. In this regard, it is necessary to search for solutions to restore the fertile layer of soils.

Main part

One of the most effective solutions to this global problem was proposed by the Belarusian scientist-inventor, engineer A.E. Unitsky [2, 3].

The author of the technology notes that oil shale and lignite can be used not so much for generation of electric and thermal energy as for obtaining relict living humus - the basis of fertility of any soil, as such biohumus will have the same chemical composition as the ancient plants that took everything necessary for life from the ancient (relict) soil. According to A.E. Unitsky's technology it is proposed to burn combustible fossils not completely, but only 50-75%. Then combustion wastes (ash, slag, sludge, dust, flue gases) should be mixed with unburned 25-50 % of oil shale or brown coal (with addition of any raw materials of organic origin - grass, peat, sawdust, dung, litter, plant residue, household rubbish, sewage and others). The obtained multi-component mixture, which contains both organic and mineral raw materials, is finally processed into living fertile biohumus in bioreactors with the help of specially selected aerobic and anaerobic associations of soil agronomically valuable microorganisms. The obtained relict biohumus uTerra can be applied to the soil in the proportion from 2 % - with such a content even desert sand will become fertile [2, 3].

The question arises: are there any other ways of obtaining a cost-effective and environmentally friendly organic fertiliser that can meet the needs of mankind?

Sewage is a huge resource on the scale of the planet, the potential of which has not been fully unlocked in comparison with other types of natural resources. At the same time, the living nature has already created biotechnologies, which

mankind needs to reproduce - after all, any soil humus is the result of previous bioprocessing of organic wastes of all living organisms inhabiting the biosphere, including humans.

Recycling of domestic, industrial, surface runoff, as well as sewage waste can help resolve crisis situations, prevent their possible occurrence, and significantly save natural resources.

Thus, for sewage treatment, each production/city has treatment facilities, the appearance of which is shown in Figure 1.

Based on the existing practice, in most cases the biological method of wastewater treatment is used, the essence of which is the ability of activated sludge microorganisms to use a variety of substances contained in wastewater as a source of nutrition in the process of vital activity [4].

Figure 1. *General (panoramic) view of the wastewater treatment plant*

Microorganisms free the water from contaminants, and the metabolism of these substances in the cells of microorganisms provides their energy needs and biomass growth. During the regeneration of activated sludge, excess sludge is produced and then sent for disposal. The excess sludge consists of bacteria, dead microorganisms and their waste products. The dry residue of activated sludge is 70-90 % organic and 10-30 % inorganic. The organic carbon content is more than 60 % [4].

As a result, activated sludge is quite a valuable secondary resource. In essence, excess sludge, fragments of which are shown in Figure 2, is a type of biohumus, which, based on the current practice, is disposed of in landfills or incinerated instead of being reused effectively.

Figure 2. *Excess sludge (fragments)*

So far, the main factor restraining the large-scale use of activated sludge on the planet is the presence of heavy metal salts, oil products, surfactants, pathogenic microorganisms, the effect of which on soil, plants and harmlessness of food products is not fully studied, which is confirmed by the results of the analysis of numerous scientific papers on the studied area in open sources of information. At the same time, it should be noted that salts of heavy metals are present in all plant and animal organisms (any living cell includes more than 80 chemical elements of the Mendeleev table), which is also not accidental: their complete absence in plants and other living organisms leads to their diseases and even death.

It should be noted that a number of scientists have proposed measures for the use of activated sludge, including the extraction of excessive amounts of harmful substances from it.

In particular, one of the methods is sludge purification with the help of microscopic soil fungus [5, 6]. Active sludge can be mixed with the fungus culture, incubated, after which detoxification of heavy metals and pre-oxidation of petroleum products takes place. In addition, the fungus has a number of other unique properties: it stimulates the development of the root system of plants and cleans the soil of parasitic fungi by feeding on them.

Another option for improving the quality of sewage sludge is liming. The addition of lime increases the pH value and slows down or temporarily stops microbial activity, particularly fermentation with the formation of foul-smelling gases. The content of pathogenic microorganisms is significantly reduced by liming, but only at a lime dose of 30 per cent of the dry matter of the sludge can their almost complete disappearance be achieved [7].

There is also known a method of reclamation of disturbed lands according to [8], which includes introduction on a soil surface of wastes of chemical productions, as which sludge - a waste of a soda plant in the quantity of 10–40 kg/m^2 is used. Then ploughing is carried out, after which additionally active sludge

of chemical plant treatment facilities is applied in the amount of 4–5 kg/m^2 with subsequent sowing of plant seeds.

However, in general, these methods, as well as other methods, have not found wide practical application so far and are used at the laboratory (local) level.

In addition, it should be noted that about 360 billion cubic metres of wastewater is generated annually worldwide, with about 48% of this water currently discharged without treatment [9]. At the same time, the secondary utilisation of treatment products is less than 6%. Table 1 summarises the quantification of sludge per person, which can be used as secondary raw materials, in different countries.

Table 1

Sewage sludge from wastewater treatment plants by country [9]

Country	Amount of sludge per year by dry matter, tonnes/year		Population of the country as of 2020, million people	Kilogramme of sludge per inhabitant
	2005	2020		
Belarus	150 000	190 000	9,355	20
Latvia	23 950	50 000	1,908	26
Estonia	33 000	33 000	1,328	24
Lithuania	71 252	80 000	2,790	28
Sweden	210 000	250 000	10,313	24
Denmark	130 000	140 000	5,762	24
Finland	147 000	155 000	5,526	28
Poland	523 000	950 000	38,313	24
Germany	1 523 674	1 950 000	83,349	23
Russia	2 059 000	2 000 000	146,171	13

As shown in Table 1, in general, over the last 15 years, almost all European countries (out of those considered) have experienced negative dynamics related to the increase in the amount of sewage sludge generated in wastewater treatment plants. In this regard, it is necessary to introduce projects and technologies for the use of activated sludge as an initial technological raw material for the production of organic fertiliser/plant feed at treatment plants.

However, based on the results of the analysis, the following negative peculiarity was revealed in this direction: in the Republic of Belarus, the Russian Federation, the countries of the Shanghai Cooperation Organisation (SCO) as a whole, there is still no or not fully developed regulatory and technical base, allowing at the legislative level to place sewage sludge in the environment, to use it in accordance with the requirements of environmental safety. For this reason, activated sludge, which is such a valuable resource on a global scale, is not used within the framework of a closed cycle, but - in practice - is utilised and harms nature due to its high concentration in the settling areas, or is simply incinerated.

At the same time, EU countries are currently making serious attempts to use treatment products as fertiliser and to recycle sewage sludge to produce valuable products, while other regions in general do not make much use of this opportunity. Thus, according to the European Commission report, the average percentage of sludge used in agriculture in the EU countries is about 40 %, which is presented in Table 2 [9], and various methods of sewage sludge utilisation are used.

Table 2

Main methods of sewage sludge utilisation in EU countries, %

Country	Use in agriculture as organic fertiliser	Placement on sludge sites	Incineration	Discharge to the sea, ocean and other technologies
England	53	16	7	24
Austria	20	49	31	–
Germany	25	55	15	5
Denmark	45	28	18	9
USA	25	25	35	15
Italy	20	60	–	20
Sweden	60	30	–	10
France	23	46	31	–

Agricultural application of treated sewage sludge (excess sludge) is a more economical and environmentally friendly alternative to chemical fertilisers, for which there is no need to invest significant financial resources, as it is a by-product of water treatment. Sludge after treatment can be applied to the soil in any form (liquid sludge, dewatered dried sludge). Table 3 shows that sewage sludge is not only as good as organic fertilisers in terms of organic matter content, but in some respects exceeds them.

Table 3

Content of main elements of plant nutrition in sewage sludge and organic fertilisers, % per dry matter [9].

Fertiliser	Organic substance	N	P_2O_5	K_2O
Cattle manure	70–85	1,9–4,3	0,6–2,8	1,3–5,2
Swine manure	75–85	2,6–6,5	1,4–3,7	1,4–5,4
Litter	50–75	3,6–8,0	3,0–6,7	1,3–4,0
Upper peat	95–98	0,2–0,5	0,03–0,3	0,01–0,1
Transitional peat	90–95	1,4–2,5	0,02–0,4	0,05–0,2
Lowland peat	85–92	1,6–4,0	0,1–0,4	0,02–0,3
Sewage sludge	48–75	1,4–4,3	1,14–4,44	0,28–0,64

Harmful environmental impact of sewage sludge can be eliminated when it is used together with uTerra biohumus. When composting freshly produced sludge, it is dried (to a moisture content of about 50%), kept at a temperature of about +60°C to kill all pathogenic organisms, their eggs, etc., and then mixed with biohumus. The earthworm and its cultivated associations of agronomically valuable thousands of species of aerobic and anaerobic microorganisms in uTerra biohumus also contribute to the destruction of pathogenic microflora and microfauna in the resulting mixture and convert heavy metal salts into insoluble salts of humic acids, which are safe for the soil.

The percentage ratio of sewage sludge to biohumus is calculated based on the possibility of application for specific purposes. Composting as a method of sewage sludge utilisation is characterised by simplicity, accessibility and relatively low cost. Processing of sewage sludge based on the use of a special species of earthworm, which are used in the implemented in practice technology of biohumus production uTerra [2, 3] (see Figure 3), has shown its high efficiency. They are able to accumulate heavy metals in the body and transfer them into bound forms inaccessible for plants, which allows to expand the application area of products of such processing. The technology excludes the use of chemical reagents, which makes biological recycling environmentally safe and does not lead to secondary pollution of groundwater and soils. The research in these areas is currently being carried out in the Belarusian scientific-engineering company “String Technologies”. The results of experiments and approbation of the corresponding technology will be presented in the following scientific papers.

Figure 3. *Fragment from the video film “Anatoly Unitsky spoke about biohumus” [10]*

Also, as recommendations on the possible use on the planet (by the example of individual regions and countries, including the SCO countries) of sewage effluents with the subsequent processing of activated sludge into organic feed for plants, the following is proposed:

a) increasing the amount of budgetary funds allocated in the regions (countries) for conducting scientific research (research, development and technological work) by relevant organisations to enable implementation of the results of developments at individual experimental sites/enterprises for sewage effluent processing, use of optimal application technology, monitoring of soil, water and plant quality indicators; holding thematic competitions (ideas, start-ups) on a permanent basis on a grant basis on the above topics in order to search for optimal solutions

b) adoption of regulatory legal acts in the regions in order to enable the implementation of the results of the research, development and technological work carried out at enterprises/individual regions for sewage processing;

c) adoption of legislative acts at the level of individual states for the introduction of proven technologies and their scaling up at the level of the national economy.

Conclusions

The processing of sewage waste, the volume of which is constantly increasing on a global scale, by applying sewage sludge (activated sludge) into the soil together with uTerra biohumus, represents a significant potential for mankind to improve soil fertility. In particular, the application of sewage sludge (activated sludge) into the soil can increase crop yields by up to 30%-40% [11], contributes to the renewal of the fertile soil layer. Also, the use of wastewater treatment products can be used in landscaping of desert territories and other lands without fertile layer. At the same time, the sewage treatment cycle itself becomes closed and practically waste-free. The use of sewage sludge will free up significant areas currently occupied by sludge pads, which fulfil only an accumulation function.

Application of increasing amounts of excess sludge on agricultural soils, on deserted territories within the framework of landscaping programmes on the basis of the technology proposed by the authors and recommendations on their implementation/scaling within the framework of improved legal field is one of the ways to preserve planetary ecology and improve food security of mankind.

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DOI 10.34660/INF.2023.65.31.176

用于测量发芽种子和营养植物的生物电势的装置和方法

DEVICE AND METHOD FOR MEASURING BIOPOTENTIALS IN GERMINATING SEEDS AND VEGETATIVE PLANTS

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注解。 本文介绍了用于生物电测量的种子制备方法及其测量方法，以及用于测量发芽种子和营养植物生物电的装置的描述。 它还展示了使用自记录仪以侵入方式从各种农作物的发芽幼苗中获取的植物电图。

证实了种子发芽率与植被电图振幅值之间的高度相关性（0.98），这使得可以在短时间内以较少的劳动密集型方式确定种子的播种质量，因此，合理的模式 种子处理受多种因素影响。

关键词：生物电、细胞膜、电图、发芽能、发芽、磁场。

Annotation. *The paper describes the method of seed preparation for biopotentials measurement and the method of their measurement, as well as the description of the installation for measuring biopotentials in germinating seeds and vegetative plants. It also presents electroplantograms taken from germinated seedlings of various agricultural crops using a self-recorder in an invasive way.*

A high degree of correlation (0.98) between seed germination and amplitude values of electroplantograms was confirmed, which allows to determine sowing qualities of seeds in a less labour-intensive way and in a short period of time, and, consequently, the rational mode of seed treatment by various factors.

Keywords: *biopotential, cell membrane, electroplantogram, germination energy, germination, magnetic field.*

Bioelectrogenesis is a process of energy generation by living organisms. Many Russian and foreign scientists have worked and are working on the study of bioelectrogenesis of plant tissue.

Bioelectric potential is an indicator of bioelectric activity determined by the potential difference between two points of plant tissue with different levels of metabolic processes, for example, between the top of the stem and the root of the plant 50-200 mV.

Numerous experiments carried out in the study of cell membranes have shown that the membrane of plant cells, like the membrane of animal cells is polarised. It is negatively charged on its inner surface, and on the outer surface - positively charged, and this is the reason for the resulting potential difference.

In response to the action of various stimuli (heating, cooling, illumination, mechanical action, electric current, chemical reagents, etc.), depolarisation of the membrane occurs, accompanied by the generation of propagating oscillations of electric potentials [2; 4; 9].

The degree of study of bioelectrogenesis of plant organisms is described in detail by Opritov V. A., Pyatygin S. S. and Retivin V. G., in which they argue that in animal organisms it is studied to a sufficient extent, which cannot be said about plants and their seeds [4; 11].

Biopotentials play a role in the course of energy transformations, in the regulation of cellular processes and fulfil a signalling function.

The works of the Russian scientist Ivan Isidorovich Gunar and his school played an important role [12].

According to Barysheva N. N., S. P. Pronin, V. S. Afonin bioelectric potential is the main electrical characteristic of a plant cell. The bioelectric potentials of seeds can be used to judge the germination of seeds, their viability, as well as the physiological completeness of the grain [1].

Barysheva N. N. proposed a methodology for diagnosing the sowing qualities of seeds, germination, as well as the presence of injured, hollow and infected wheat seeds by changes in the membrane potential during the action of mechanical stimulus and electric current on moistened seeds.

A.V. Dubrovin, Y.H. Shagenov considered the method of economically optimal cultivation of plants in protected soil with additional electric influence of deterministic level on their biological and electric potential along the stem of plants. The authors measured and changed the potential difference along the stem of the plant by supplying “+” to the root system and “-” to the top of the plant, thus increasing the potential to the maximum favourable, predetermined, value of the potential difference between these points of the plant, previously grown in optimal agrotechnical conditions [3].

A. V. Bushlyakova, T. E. Kuleshova and N. R. Gall considered a non-invasive method of recording bioelectric potentials of plants in the soil-plant system. The authors note the connection of bioelectrical potentials with water circulation and mineral elements inside plants, as well as with their metabolism [13].

Despite the considerable amount of research on the study of plant tissue bioelectrical potentials, there are only fragments on certain aspects of the problem, which indicates the need for further research and development of technical means for their measurement.

Methodology

The research was carried out on the basis of laboratories of the Electric Power Engineering Faculty of Stavropol State Agrarian University, the plant of JSC "Elektroavtomatika" and the accredited laboratory "UNIL".

Preparation of seeds for biopotentials measurement

1.Seed sampling was carried out according to State standard Russian Federation 12036-85.

2.Seeds are placed in prepared disinfected at 180°C Petri dishes on a filter bed moistened with distilled water in accordance with State standard Russian Federation 52325-2005. To measure biopotentials seeds are placed in Petri dishes 15 pieces at a time.

3.All seeds in Petri dishes are placed in the thermostat at 25 °C. The humidity of the bed is checked once a day and if necessary wetting with equal amount of distilled water with a medical syringe is carried out.

4.After 12-36 hours, most crop seeds begin to germinate, the seeds are ready for biopotential measurement.

Method of biopotentials removal from germinating seeds

In our research, the biopotentials were removed by an invasive (destructive) method on the installation designed and manufactured by us, between the surface of the seed and the base of the germinated seedling (Figure 1). Figure 1 shows the functional scheme of connecting electrodes to the seed when measuring biopotentials.

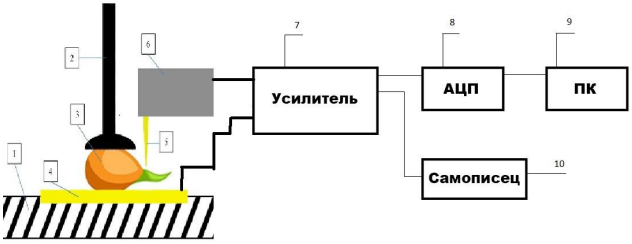

Figure 1. *Functional scheme of connecting electrodes to the seed. 1 - dielectric platform; 2 - seed fixation pin; 3 - seed with germ; 4 - electrode bed; 5 - electrode-needle; 6 - electrode-needle holder*

The seed with a seedling (3) is placed on the bed electrode (4), which is attached to the dielectric base (1), the seed is clamped with the dielectric plate (2), then the electrode-needle (5) (mechanical stimulus) pierces the seedling at the base to a certain depth, regulated by notches on the needle. The received signal (response of the seed to the external mechanical stimulus) from the bed electrode (4) and the needle electrode (5) is fed to the amplifier, then the signal is fed to the recorder (10) or to the ADC (8), from the ADC to the PC (9). The electroplanagram of each seed or the average of measurements of 10 seeds can be taken.

Measurement of biopotentials in our studies was carried out on a **device** designed and manufactured by us, the electrical circuit diagram of which is shown in Figure 2, the novelty of which is confirmed by the patent for invention No. 2796686 [10].

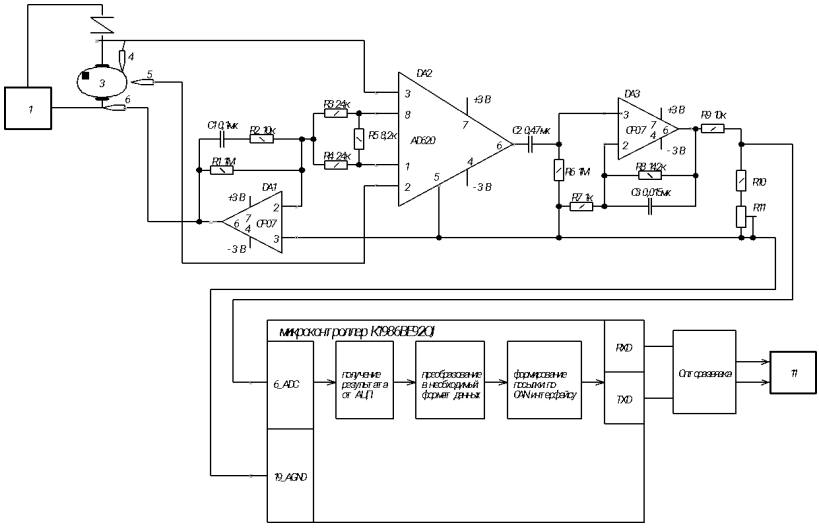

Figure 2. *Electrical scheme of the installation for biopotentials extraction from plant tissues*

A special feature of this device is the common wire (ground, body wire) - this is the point whose potential is taken as zero. All other potentials and voltages are measured relative to this potential, i.e. the common wire. The basis for the construction of the amplifier block is the DA2 AD620 instrumental amplifier. The DA2's low current noise makes it an ideal seed potential meter with a source impedance of tens of kOhms.

The setup uses 3 electrodes: a bed electrode and two needle electrodes. Two types of measurements can be performed on the proposed device, due to the fact that the clamps of the mechanism can be connected to the bed electrode, which in turn is connected to the common wire of the device.

Results and their discussion

We studied potentials in seedlings (between the seed surface and the seedling base using gold non-oxidising electrodes) of different crops (sunflower, barley, oats, peas).

If electrograms taken from animal tissues have definitions, for example electrocardiogram - indications of heart work, electrogram of plant tissues had no name, we proposed to call it "Electroplanagram" and received the certificate for the trade mark №217862.

Electroplatnograms of agricultural crops are shown in Figures 3, 4 and 5.

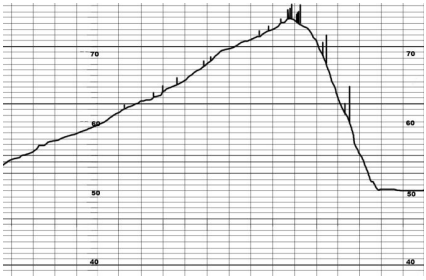

***Figure 3**. Electroplantogram of biopotential of sunflower seed of Steppe variety.*

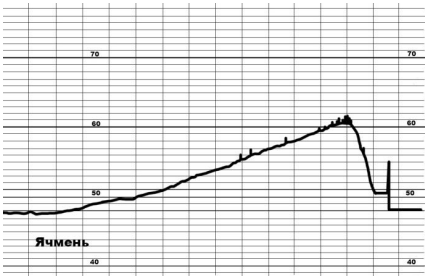

***Figure 4.** Electroplantogram of biopotential of spring barley seed of the variety Fracture.*

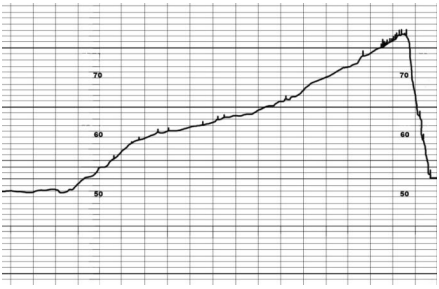

***Figure 5.** Electroplantogram of the biopotential of pea Alpha seed.*

The obtained electroplantograms allowed us to conclude that the amplitude changes of seed biopotentials depend on the crop: in sunflower - 24 mV (Fig.3), in barley - 10 mV (Fig.4), in pea - 26 mV (Fig.5).

To determine the rational mode of pulsed electric field treatment, Alpha pea seeds with reduced sowing qualities were used: germination energy 55.7 %, germination 82.7 %. Since the effectiveness of the physical factor is most clearly manifested in such seeds. Seeds were treated by pulsed electric field on the installations designed by us [2; 7; 8; 10].

To find a rational mode of treatment it is necessary to conduct a large number of experiments. The result of treatment is judged by the sowing qualities of seeds, which are currently determined according to GOST 52325-2005. The studies using this method of determining the sowing qualities are rather labour-intensive, time-consuming and require high qualification of the working personnel [8; 9].

Seeds were treated with pulsed electric field with field strength of 3-9 *105 V/m with a step of 2 *105 V/m. Potentials between the seed surface and the base of the seedling were measured.

The results on the effect of pulsed electric field on seed sowing qualities are presented in Table 1.

Table 1

Seeding qualities and amplitude values of biopotential of pea seeds of variety Alpha depending on pulsed electric field intensity.

Sowing qualities	**Monitoring**	**Pulsed electric field voltage, V/m**				**$NSR_{об}$, %**
		$3*10^5$	**$5*10^5$**	**$7*10^5$**	**$9*10^5$**	
Germination energy	55,7	69,3	62,5	57,5	62,7	2,8
Germination	82,7	94,3	91,5	88,6	89,7	1,8
Maximum biopotential value, mV	26	46	36	34	35	

The results presented in the table show that all seeds treated with pulsed electric field have higher germination than seeds of the control variant (seeds not treated with pulsed electric field). By 11.6%; 8.8%; 5.9%; 7% higher than the seeds of the control variant. The best result was obtained in seeds treated with field strength 3*105 V/m at the amplitude value of biopotential - 46 mV.

Knowing the peak value of biopotential we can conclude to select the optimal mode of pre-sowing seed treatment with physical factors, in this case pulsed electric field with a significant reduction in time and labour inputs.

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DOI 10.34660/INF.2023.95.61.177

氢热成矿
HYDROGENIC THERMAL ORE FORMATION

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注解。 20世纪中叶的原子项目加强了地质工作的密集实践和科学研究，导致发现了具有独特铀储量的新型矿床。 新信息的获得首先促进了关于铀矿石形成的观点的演变，并导致了氢矿石形成概念的出现。 在这一概念的发展过程中，作者提出了含氢热成矿假说。

对氢矿石形成过程的了解带来了成矿学的新思路。

关键词：铀，氢矿形成，风化壳，氢热矿形成。

Annotation. *Atomic projects of the mid-20th century intensified intensive practical and scientific research of geological works, resulting in the discovery of new types of deposits with unique uranium reserves. Obtaining new information contributed to the evolution of views, first of all, on uranium ore formation and led to the emergence of the concept of hydrogenic ore formation. In the development of this concept, the author proposed the hypothesis of hydrogenic thermal ore formation.*

Understanding of the process of hydrogenic ore formation leads to new ideas in metallogeny.

Keywords: *uranium, hydrogenic ore formation, weathering crusts, hydrogenic thermal ore formation.*

Introduction

The uranium boom of the mid-twentieth century in the USA and the USSR provided the discovery of previously unknown types of deposits with huge uranium reserves [17, 26], the development of uranium mining technologies, and a huge progress in scientific research in the field of uranium geology and metallogeny in general.

At the same time, new research and evolution of views on the genesis of uranium mineralisation [11, 23, 2, etc.] resulted in the concept of hydrogenic ore formation [10, 15, 18].

The results of studies and discussion of the genesis of hydrogenic deposits

The information about the geological structure and development of the Earth's crust accumulated by the 21st century needs to be comprehended.

Turning to the period of origin in the USSR of the doctrine of uranium, in particular, and of general mineral deposits, in general, we note the following.

Speaking in 1963 at the Geochemical Conference dedicated to the centenary of the birth of V.I. Vernadsky, the coryphaeus of uranium geology A.I. Tugarinov showed that in the history of the Earth's development the formation of hydrothermal uranium deposits follows the periods of its accumulation in sedimentary strata, and "the process of sedimentation is the main factor in the differentiation of the Earth's matter and the formation of ore provinces". In the zones of halos of intrusions there is extraction of ore substance from sedimentary rocks under the influence of hydrothermal solutions [24].

V.L. Towson in his report "Geochemistry of rare elements in igneous rocks and metallogenic specialisation of magmas" denies metallogenic specialisation of magmas and associates enrichment with rare elements mainly with postmagmatic processes of element transfer [22].

The source of elements in ore deposits, as a rule, are their concentrations in sedimentary rocks. Thus, K.G.Wedepohl (K.N.Wedepohl, FRG) showed that "the source of ore elements of the "cuprous shales" of the northwestern basin of Germany are Palaeozoic sandstones, but not the deposition of sulfides from seawater. Organic matter plays a significant role in the deposition of ore elements, with which there is a clear correlation [6].

At the same time, the volume of dissolved substances carried by rivers into the world ocean from the continents reaches colossal proportions. It is estimated that, for example, on the territory of the USSR this runoff is 486 million tonnes per year. From the entire land territory - 2600 million tonnes per year, and the ratio between the modulus of suspended solids runoff and the modulus of ionic runoff varies from 10 : 1 to 1 : 1, which reflects the general character of silicate weathering, giving a ratio of 3 - 5:1 [1].

V.L. Barsukov revealed the *mechanism of specialisation of granite intrusions arising from the involvement of sedimentary rocks with ore elements* (*emphasis mine - SK*) in the formation of granitoids by deep assimilation or palingenesis [3].

A.N. Ugryumov, competent in the field of gold-bearing jasperoids, having outlined in his article "Magmatic control of jasperoid-type gold deposits" the contradictions about the role of the magmatic factor in controlling the ore-bearing capacity of jasperoids, confirms the conclusions of Yu.A. Bilibin [5] about the paragenetic connection of gold-bearing jasperoids with small hypabyssal intrusions. Further he describes a typical picture of maximum concentration of mineralisation in the centres of magmatic activity and predominance of wide zones of ore-free

(monoquartz) jasperoidisation at the periphery of magmatic areas. In this regard, he concludes that this pattern confirms the magmatic nature of gold-bearing jasperoids [25].

The spatial coincidence of concentrations of jasperoids and hydrothermal ores is remarkable.

Honoured geologist of the Russian Federation with 30 years of industrial experience in the North Kazakhstan uranium-ore province Y.L.Bastrikov established: "In the geological history of the region ... Milestones of "uranium" oreogenesis coincide with the epochs of great peneplenisations, when there was levelling of relief with deep erosion of mountain structures and filling of depressional structures with terrigenous material. During these epochs, large-scale release and redeposition of chemical elements, including uranium, one of the most mobile elements in nature, took place in near-surface conditions. Thus, in the 80s of the last century, the idea of the near-surface source of uranium and its mobilisation during the epochs of regional denudations was formed. In other words, the so-called hydrothermal uranium deposits of the province are in fact palaeohydrogenic sediments, which for millions and millions of years of their existence have undergone multiple deep autometamorphism"[4].

V.I. Vernadsky's understanding of "Nature as a whole" [7, P. 307] allows us to consider the Earth as a living organism [7, C. 298]. Consequently, as for any organism, the condition for the Earth's vital activity is the action of water, the functioning of which ensures the migration of atoms. Thus, the rearrangement of petrogenic elements leads to granitisation of deeply metamorphosed sedimentary complexes [19 et al.], and the concentration of metallogenic elements transported from the weathering crust forms ore-bearing solutions and mineralisation.

With respect to some vein uranium deposits, the change with time of the first ideas about their hydrothermal genesis is indicative. Such objects include, for example, the Central Asian deposits of Tyuya-Muyun and Taboshar, the uranium of which provided for the manufacture of the first atomic bombs of the USSR. Initially, the deposits were attributed to the vein hydrothermal type, because the minerals tyuyamunite and carnotite were discovered at Tyuya-Muyun, and at Taboshar - the classic oxidation zone of hydrothermal uranium-sulfide ores according to V.G. Melkov. Nevertheless, the researchers still had doubts, since not only within the ore fields, but also nearby, no magmatic bodies that could be sources of uranium were found. After a considerable time, during several decades, as a result of the development of the theory of hydrogenic formation, the genesis of these deposits was determined to be hydrogenic [11].

Of the four hypotheses of formation of amagmagmatic hydrothermal deposits considered in the classification of hydrothermal deposits by V.I. Smirnov [21], the third hypothesis suggests that the ore-forming factor is active meteoric wa-

ters of the deep circulation, which transport and deposit metals. Thus, this third hypothesis according to modern ideas corresponds to the concept of formation of hydrogenic ore deposits.

The essence of hydrogenic ore formation is the transfer of ore elements by vadose waters from the weathering of bedrock into permeable channels of near-surface and deeper horizons of the Earth's crust. There, under conditions of elevated temperature and pressure, enriched with introduced metals and fed by pore and constitutional waters, vadose waters form *hydrogenic hydrothermal solutions.* Penetrating organic-enriched zones of various types of (most commonly redox) geochemical barriers, these solutions are transformed into ore bodies. Such a process is characterised as *hydrogenic hydrothermal ore formation*.

It should be emphasised that understanding of the process of hydrogenic ore formation leads to a change in the usual ideas in metallogeny. This is already realised in some modern publications [9].

The most important feature of hydrogenic hydrothermal deposits is the *stratiform* character of localisation of primary mineralisation, which clearly emphasises the main role in its genesis of water-ore flows migrating along weakened zones. Moreover, additional enrichment of ore bodies is usually observed along later, both secant and concordant, tectonic faults [14] - typical solution migration channels.

We use the term "hydrogenic hydrothermal" ore formation to emphasise precisely the medium-high temperature of the ***hydrogenic*** formation of mineralisation. Contrary to firmly rooted in the minds of the absolute majority of modern geologists, relying on the paradigm of V.Emmons-V.Lindgren, the idea of hydrothermal ore formation in mandatory connection with magmatic centres or "transmagmatic" fluids.

To avoid tautology in the above terms, our proposed hypothesis is better formulated as ***hydrogenic thermal ore formation ("HTO")***.

The original publications of D.I. Scherbakov and then I.P. Kushnarev [16], among many other reports, show the distribution of hydrothermal vein deposits of Mo, W, Sn, Au, As and other elements at depths averaging from 0.5-1.5 km to 3.5-4.5 km.

Analysing the temperature regime in the upper part of the Earth's crust, we obtain - in the intervals of the indicated depths of formation of hydrothermal deposits, even based on the previously widely used geothermal gradient of 3 ° C per 100 m - the temperature of the medium more than 50 - 100 ° C, which is sufficient for low-temperature hydrothermal ore formation. At the same time, various geological processes in the Earth's crust increase the temperature of the medium and host rocks up to 200 - 300o C and more, creating conditions for the formation of medium- and high-temperature ore mineralisation. Such processes can be, for

example, heat influx from medium-crust granites, as shown in the geological and genetic model of gold deposits of the Karlin type [8], or stress effects that promote the formation of uranium-thorium-rare-earth mineralization in intensively cataclazed coarse clastic terrigenous strata at the Ural collision [15].

A series of publications of the mid-late 19th century by N.V.Belov, V.I.Lebedev, A.A.Marakushev and other researchers on the topic of the Earth's energy, which is discussed in detail by V.M.Dunichev [10], deserves great attention. Recently, this topic is disclosed at the modern level in the publications of A.V.Pokrovsky and other researchers. A.V. Pokrovsky supports the idea of the decisive role of the Sun's energy in the formation and development of the Earth's crust [20]. According to this idea, solar heat stimulates geological processes in the upper part of the Earth's crust.

Conclusions

Scientific progress in geological research has led to the idea of the process of hydrogenic ore formation, in which the source of metals are the weathering crusts of rocks of peneplainised areas. Understanding of this truth leads to the necessity to revise the established views on metallogeny, based on the concept of V.Emmons - V.Lindgren.

The author expresses his gratitude to those members of his large family, without whose sincere help the writing of this work would have been impossible.

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DOI 10.34660/INF.2023.75.81.178

补偿沉积作为西西伯利亚斜坡复合体形成现实模型的基础

COMPENSATED SEDIMENTATION AS A BASIS FOR A REALISTIC MODEL OF THE FORMATION OF THE WEST SIBERIAN CLINOFORM COMPLEXES

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抽象的。 基于 Shirotnoye Priobye 地区结构和含油能力模型的创建结果以及乌连戈伊、乌拉伊和托尔金斯克的认可，提出了 Neocomian 斜形杂岩沉积物形成机制的新概念。 地区。 这一概念将尼奥科姆期复杂旋回岩的斜形结构与西西伯利亚陆缘海盆条件下沉积物的补偿沉积相结合。 该概念的实施为详细研究含油模型、预测未勘探地区砂体的发育、油气圈闭的形成提供了新的方向。

关键词：新科主义情结； 斜形； 形成条件； 陆缘盆地； 补偿沉降； 沉降; 相关性; 自行车石； 指数化； 造型。

Abstract. *A new concept of the mechanism of sediment formation of the Neocomian clinoform complex has been developed based on the results of creation of a model of the structure and oil-bearing capacity of the region in the Shirotnoye Priobye and approbation in the Urengoy, Urai and Tolkinsk regions. The concept*

combines the clinoform structure of the Neocomian complex cyclites with compensated sedimentation of sediments in the conditions of the epicontinental marine basin of Western Siberia. The implementation of the concept provides the development of a new direction in the detailing of oil-bearing models, forecasting the development of sand bodies, formation of oil and gas traps in unexplored areas.

***Keywords**: Neocomian complex; clinoforms; conditions of formation; epicontinental basin; compensated sedimentation; sedimentation; correlation; cyclite; indexation; modelling.*

At present, the model of formation of clinoform complexes of the West Siberian Neocomian due to the cyclic process of "lateral filling of an uncompensated basin" is undoubtedly the dominant concept [3]. In general, the structure of the Neocomian and the formation of the complex of cover and clinoform sediments are depicted by the known schemes (Fig. 1).

Fig. 1. Typical scheme display the structure and formation of clinoform

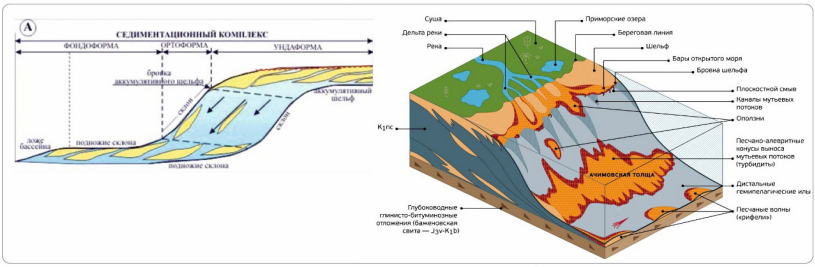

***Figure 1.** Typical scheme displaying the structure and formation of clinoforms*

The main elements of clinoforms (clinocyclites, clinothemes, sequences and other author's variants) are defined as the shelf zone (undaform), slope (orthoform), foot of the slope (fondoform), as well as the shelf edge (shelf edge), feeder channels or channels of mutia flows along the slope (turbidites, upper fan), cones of outflow in the foot of the slope (sedimentation lobes) and other elements.

The model of the clinoform structure of the Neocomian of Western Siberia, proposed by A.L Naumov and implemented with the team of geologists of Glavtyumengeologiya [2, 6], in its original form was presented in 1977 and was an outstanding achievement of geological science, which defined a new direction of geological research. Meanwhile, the adoption of this concept in full measure took place estimated to the end of 1990-2000 years. Thus, the process up to the beginning of its formation took about 20 years.

A certain role in the temporal process of formation of the concept of clinoformism was played by the differences with the existing ideas regarding the mechanism of formation of the Neocomian sediments in the conditions of a shallow-water-marine basin, which assume a subhorizontal model of the structure of the complexes. The main, in our opinion, contradiction is related to the fundamental difference between the concepts in justifying the conditions of basin formation.

The clinoform model assumes uncompensated lateral filling with terrigenous material of the marine basin on the main territory of Western Siberia. F.B. Gurari [1], based on the results of summarising numerous works, distinguished two main concepts on the conditions of clinoform formation. In one group, researchers came to the conclusion that the Neocomian clinoforms are associated with deltaic formations. Others link the formation of clinoforms at the "land-ocean" boundary, on the "continental slope" during avalanche sedimentation. Naturally, the model of avalanche sedimentation in the Neocomian is less widespread.

From the very beginning of the study of the geological structure of Western Siberia, the subhorizontal model is based on the adoption of the mechanism of sediment formation peculiar to epicontinental basins with compensated sedimentation of the basin floor dipping. The main property of epicontinental basins is that "a fairly accurate compensation of the deflection by sedimentation" (Neumann V.B., 1962 [4, 5]).

As a conclusion, the model of compensated sedimentation, firstly, excludes the probability of deltaic deposits formation in the Neocomian shallow marine basin, at least for the near zone of ancient shorelines. Secondly, the postulate with the source of input of materials from the eastern and southeastern frames is questioned. Thirdly, the composition and structure of the section at each stage of tectonic development depends primarily on the depth of the basin, respectively the level of the sea surface.

In addition, there are a number of private contradictions unresolved within the framework of this model, which are not actually emphasised. For example, the deposits of the Achimov strata, which belong to the zone of deep-water turbidites at the foot of the clinoform slope, have long been assessed as shallow-water marine. At the same time, the mechanisms of transport (landslides, mudflow channels, plane washout and others) for the formation of thick sandy-siltstone complexes of sediments with a large extent and width of distribution in the foot of the slope are practically incomprehensible. There is no clear justification of the reasons for the formation of reverse clinoforms in the western part of the Neocomian basin. There is a contradiction in estimates of the depth of the original Upper Jurassic basin with the rate of sinking of the Bazhenov Formation, which is several times higher than the rate of sedimentation of adjacent complexes.

In general, we can conclude that the currently prevailing model of formation of the Neocomian clinoform complex is in no way related to the clinoform structure of this part of the West Siberian platform section. The presence of clinoform zones of the Neocomian cyclites is a real fact established in the process of practical activity. But the available explanations of the reasons belong to the field of theoretical research, which should be continuously supplemented and improved.

The practical implementation of the model of the wedge-form structure of the Neocomian sediments was carried out on the vast territory of the Shirotnoe Priobie with the area of about 30 thousand km^2. High drilling and seismic data allowed us to ensure reliable correlation of sections both in individual areas and for the territory as a whole (Fig. 2).

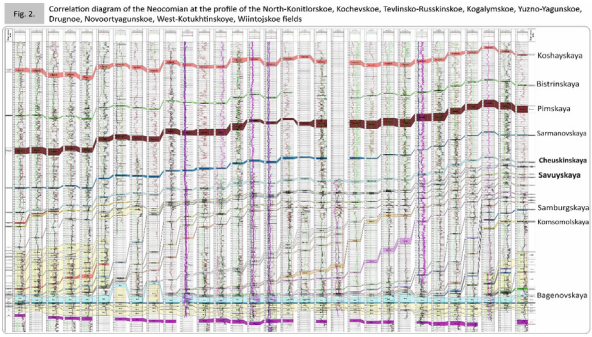

Figure 2. *Correlation diagram of the Neocomian at the profile of the North-Konitlorskoe, Kochevskoe, Tevlinsko-Russkinskoe, Kogalymskoe, Yuzno-Yagunskoe, Drugnoe, Novoortyagunskoe, West-Kotukhtinskoye, Wiintojskoe fields*

The performed studies were the basis for consideration of the processes of formation of clinoform complexes, first of all, in terms of studying the mechanism of sedimentation compensation and the dynamics of tectonic development of the territory.

The results of the processes of precise compensation by sediments for the basin bottom deflection are quite observable in a detailed examination of well sections (Fig. 3). In the cross section, cyclites are characterised by the greatest thickness in the central part, hence in the most submerged area during formation. To the west and east of the centre there is a regular reduction of its total thickness until it is completely wedged out. At the same time, the geophysical characteristic of each separate cyclite - the shape of GIS curves - remains practically unchanged when the cyclite thickness changes. Hence, it should be assumed that there is a constant set of layers of different lithologies with varying thicknesses. Thicknesses of each constituent layer reflect the degree of basin bottom deflection.

In order to study the history of tectonic development, we used the methods of palaeotectonic studies, namely, the study of the character of changes in the thicknesses of the Neocomian complexes - cyclites of different ranks. This is the construction of thickness maps of cyclites and paleogeological alignment profiles.

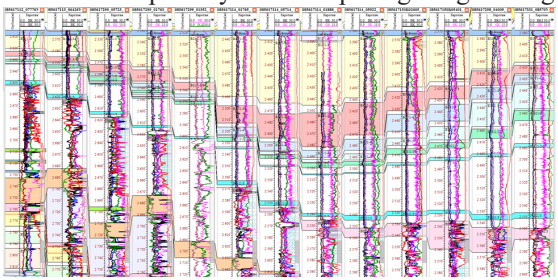

Figure 3. *An example of compensation in the range of individual local sequence (Tevlinsko-Russkinskoe fields)*

To begin with, the formation of the Neocomian complex was modelled on a conventional scheme of the clinoform structure (Fig. 4A). The schematic section shows 4 sedimentary complexes (cyclites), and the boundaries of the clinoforms are, respectively, transgressive clay beds.

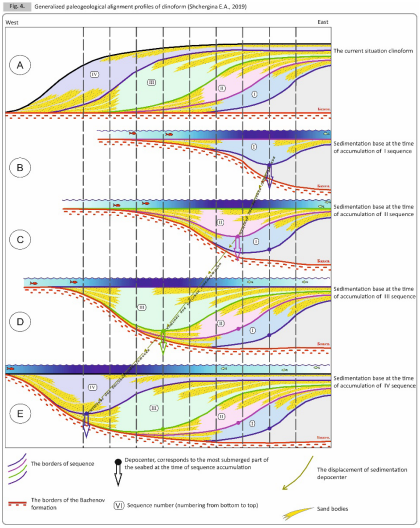

Figure 4. *Generalized paleogeological alignment profiles of clinoform (Shchergina E.A., 2019)*

The construction according to the conditional scheme shows that the formation of clinoforms of each individual cyclite occurred in the areas of successive submergence of the sedimentation basin bottom. The so-called undoform in the right part of the palaeoprofiles (in the conditional east) corresponds to the flat shallow water. In the left part of the scheme (in the conditional west), the fundoform was also preceded by shallow water with wedging out towards the land, and the central part of the basin - the depocentre - corresponds to the most submerged part of the seabed at the time of formation of a particular cyclite.

According to the performed schematic alignment profiles, a unidirectional (conventionally westward) advancement of the deep part of the basin floor, as well as of the western and eastern shallow-water zones is observed. Sandy formations in the Undaform and Fundoform zones, which are accepted as shelf cover strata and Achimov strata, respectively, correspond to the opposite edges of the palaeobasin.

The considered scheme of clinoform development is fully confirmed by palaeotectonic studies of the Neocomian complex, which we conducted within the study area in the Shirotnoe Priobye. The latitudinal extent of the research area is 150 km (Fig. 5).

Based on the results of the studies, it is definitely established that the Neocomian section has a precise compensation of the basin floor deflection by sedimentary rocks. Accordingly, a completely different model of the formation of the Neocomian clinoform complex is presented by the results of the study of the dynamics of tectonic development.

The sedimentation basin of the Neocomian complex at all stages of cyclic development was characterised by the presence of a deep-water zone in the form of a linear sag with the formation of a trough of submeridional strike. At the same time, the deep-water zone of the depression migrated westwards.

During the development of each cyclite separately, the eastern part of the basin, from the deep-water depression zone, represented an extensive shallow-water plain. Within this plain, with the basin depth below the level of compensation of wave activity by gravity, there was accumulation of sandy-silty strata with a wide “cover” spreading over the area. To the west, in the direction of the deep-water trough, there was a full-volume compensation by sediments of the sinking basin surface. Accordingly, such compensation ensured progradation of “cover” sediments - “shelf” strata to the west.

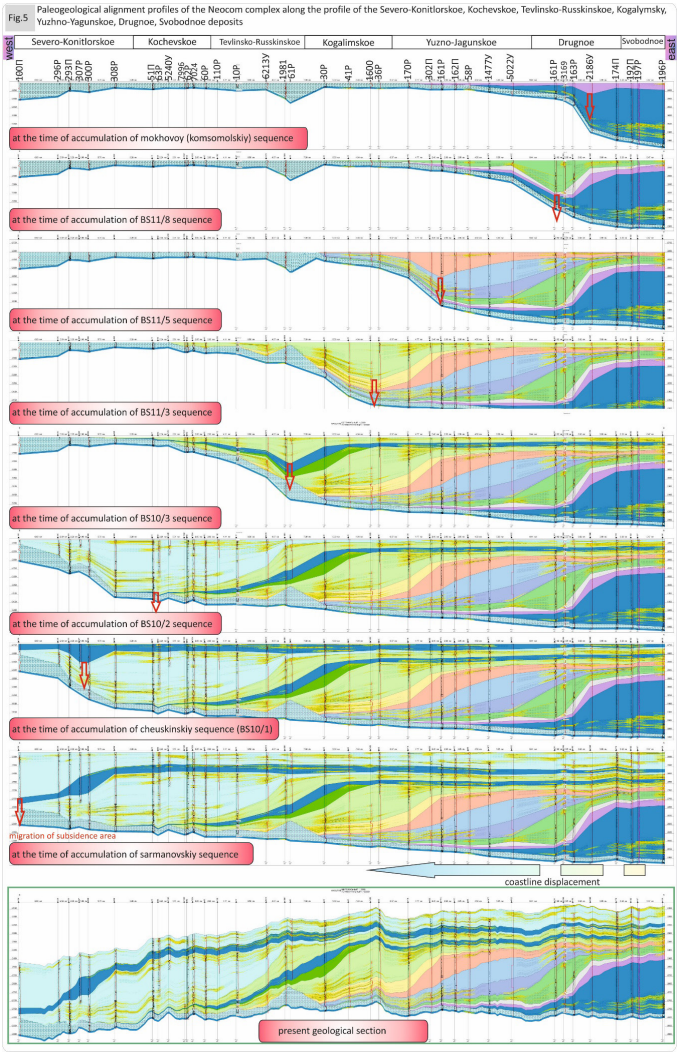

Figure 5. *Paleogeological alignment profiles of the Neocom complex along the profile of the Severo-Konitlorskoe, Kochevskoe, Tevlinsko-Russkinskoe, Kogalymsky, Yuzhno-Yagunskoe, Drugnoe, Svobodnoe deposits*

In the western part of the basin, sea depths are assumed to be substantially shallower than in the east within the flat shallow waters, which predetermined the absence of sedimentation. Sediment accumulation began on the western side of

the deep-water trough. These sediments, classified as part of the Achimov Formation, were naturally wedged up the palaeoslope and replaced by clays towards the centre of the deep-water depression. At the final stage of formation of each cyclite there was a general submergence of the territory with the formation of a cover pack of fine-muddy clays.

The successive migration of the deep-water part of the basin under the conditions of cyclic changes in the total depth of the basin ensured the appearance of new beds of sandy-siltstone bodies of the Achimov strata in the west and the development of shelf beds in the east.

The considered concept of the mechanism of formation of the Neocomian complex sediments with conditions of full-volume and precise compensation by sediments of the West Siberian epicontinental basin bottom deflection, in our opinion, most fully corresponds to the clinoform model developed by A.L. Naumov. Undoubtedly, it will be necessary to expand it from the positions of paleogeography, paleontology, composition and properties of sedimentary rocks, facies diagnostics and many other geological processes and phenomena.

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DOI 10.34660/INF.2023.11.43.179

新罗西斯克群境内植被指数NDVI动态分析
ANALYSIS OF THE DYNAMICS OF THE VEGETATION INDEX NDVI ON THE TERRITORY OF THE NOVOROSSIYSK AGGLOMERATION

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抽象的。 本文包含 2009 年至 2019 年 10 年间 NDVI（归一化植被指数）变化的数据，这些数据是使用新罗西斯克群境内的高空间分辨率卫星图像识别陆地植被而获得的。 城市群及周边地区植被退化程度因层次更细而呈现出整体结构的复杂性。 植被受到抑制的区域与一年中这个季节的植被状况以及人造物体比例的增加有关。 提供了适当考虑气候模式的植被恢复的一些特殊特征。 植被指数数据可以作为乔灌木植被强度的信息来源，为现代城市环境的发展做出正确的决策。

关键词：归一化植被指数、城市群、新罗西斯克、规划。

Abstract. *This article contains data on the change in the NDVI (Normalized Difference Vegetation Index) over a 10 year period from 2009 to 2019 obtained for identification of terrestrial vegetation using satellite images of high spatial resolution in the territory of the Novorossiysk agglomeration. The degree of degradation of the vegetation within the urban agglomeration and surrounding areas has shown the complexity of the overall structure due to finer gradations. Areas with oppressed vegetation connected both with the state of vegetation in this season of the year, and with the increase in the proportion of artificial objects were identified. Some special features of revegetation with due consideration of climate pattern are provided. The vegetation index data can serve as a source of information on the intensity of tree and shrub vegetation for making correct decisions regarding the development of modern urban environment.*

Keywords: *Normalized Difference Vegetation Index, urban agglomeration, Novorossiysk, planning.*

Green spaces are one of the main factors in creating conditions for a quality and comfortable urban environment and arranging recreational areas; they are a part of territorial planning and development of populated areas. The problem of preserving and developing green areas (parks, squares, protected areas) as well as researching possible revegetation of disturbed lands is one of the most important issues for Novorossiysk, which is both an industrial port city and a resort. Vegetation assessment through calculation of vegetation indices is widely used in various fields [1 - 4]. Such studies have been conducted for the territory of the Krasnodar Krai: assessment of the state of agricultural crops, monitoring the dynamics of estuary vegetation in the Kuban River Delta, etc. [5, 6]. The purpose of this study is to determine and describe the state of vegetation of the Novorossiysk agglomeration and adjacent areas using the vegetation index obtained from space images.

The urban fabric of Novorossiysk is located in the valley of the Cemes River. A commercial port, developed marl deposits, 5 cement plants, oil terminals, a car repair plant, and a passenger railway station are located in the eastern part of the city; the western part is mostly a residential area where most of the population is concentrated.

Geographical location as well as geological and geomorphological features of the southern slope of the North-Western Caucasus determine the nature of the vegetation cover of the studied territory [7]. The slopes composed of marly rocks are considered dry; they are covered with vegetation communities dominated by the Jerusalem thorn. Relict mountain steppes, steeped meadows with elements of upland xerophytic vegetation are abundant at the watershed areas. Typical plants here are junipers. Mainly oak and oak and grab forests grow at the highlands near the watershed areas. Beech and chestnut forests prevail on the eastern exposure slopes. Undergrowth is diverse; it is composed of European bladdernut, cornel and privet. Mountain steppe and mountain meadow vegetation is developed at the altitudes above 400 m, where there is no forest vegetation [8].

In general, the territory is characterized by semistructured soils with low humus content. In accordance with the provisions of SP 42.13330.2012 [9], Novorossiysk must have at least 10 m^2 of public green spaces per 1 resident, i.e. at least 315 hectares of green spaces. Within the city, there are such designated natural territories as “Sujuk Lagoon” natural monument as well as “Tsemes Grove” and “Pioneer Grove” forest parks, which can be considered as phytometers of the city territory. Methodically, the work was carried out by calculating the NDVI, which reflects the amount of green phytomass [10]. Interpretation of the obtained values was carried out based on the accepted discrete NDVI scale, where all values are lo-

cated in the range from - 1 (oppressed) to 1 (natural background). It is established that this index takes the highest values for the territories with abundant vegetation. NDVI is calculated using a formula in which the numerator is the difference between the near infrared reflectance (NIR) and the red reflectance (RED), and the denominator is their sum.

Studies carried out with the application of the vegetation index [11] show that spectral range of values for vegetation is much higher than that for other objects of the Earth's surface. This is primarily because the value of the index depends on the species diversity of vegetation; it is influenced by seasonality, as well as the exposure of the slope and other factors.

Remote sensing data from the LAND VIEWER platform were used as initial. Data from the summer seasons of 2009 (8.07.2009) and 2019 (12.07.2019) were taken for accurate comparison and accounting of seasonal climatic indices.

Based on the results of processing the images using the NDVI values, their spatial distribution was obtained. It is shown in Figure 1 and reflects the actual surface types of the studied territory.

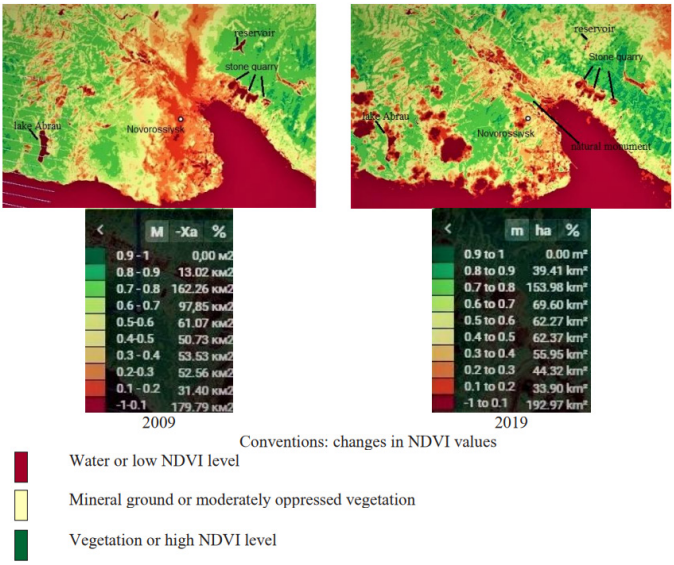

Figure 1. *Territory of the Novorossiysk agglomeration using the NDVI index.*

Since the established decrease in the vegetation index is associated primarily with an increase in the proportion of sparse vegetation due to specific features of weather conditions of the summer seasons of 2009 and 2019, as well as with

an increase in areas where artificial objects are located, the territory was further clustered by object types (Fig. 2). Numerical values of the NDVI for such clusters are presented in Table 1.

The obtained results show that over the past 10 years, the overall ratio of the different surface types identified by the NDVI values has changed significantly. The total technological load on the territory has increased. In the western part, the proportion of vegetation in valleys and vineyards has increased, while in the inner-city areas grassland has replaced the juniper open woods. The area of Novoroscement JSC industrial in the eastern part has transformed due to the ratio of territories with sparse vegetation and exposed soil.

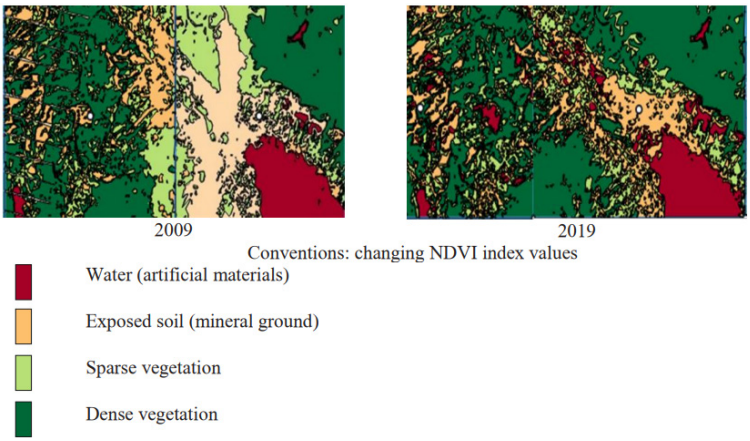

Figure 2. *Clustering of Novorossiysk and surrounding areas by object type.*

The data received, on the one hand, reflect the results of the measures taken in the city to preserve green spaces (over the past period, fruit trees and shrubs have been planted at the curtilages and common grounds, green lawns and flower beds have been laid out), and on the other hand, they demonstrate the complexity of the cluster structure due to the development of the general infrastructure of the city.

Table 1.

Values of NDVI in the territory of the Novorossiysk agglomeration.

Object Type	NDVI value, km²	
	2009	2019
Dense vegetation	91,18	60,68
Sparse vegetation	27,31	42,69
Exposed soil	19,52	33,72

Water	21,34	22,05
Artificial objects	1,38	4,61

Conclusions

1. The work done has shown the transformation of the vegetation of the urban landscape and the surrounding areas. The use of the NDVI makes it possible to identify areas with oppressed vegetation and clearly identify urban areas, quarries, dumps and areas of natural overgrowth.

2. The human impact on the vegetation cover within the Novorossiysk urban agglomeration is manifested both as its complete destruction with later creation of cultivated cenoses and adaptation of natural vegetation to urban environment.

3. Greenspace expansion in Novorossiysk can be difficult as the slope type of terrain is characterized by relatively low forest cover percent. To restore vegetation cover, it is necessary to take into account the climate pattern: we recommend planting species that are not care-demanding (do not need watering) as well as full-storied planting: trees, shrubs, lawn.

4. Thus, urban landscaping activities can be based on data on the NDVI as a source of information on the intensity of tree and shrub vegetation and its spatial distribution, allowing development of planning and landscaping strategies.

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DOI 10.34660/INF.2023.74.29.180

创建工程和环境研究数字模型的制图方法

CARTOGRAPHIC APPROACH TO THE CREATION OF AN ENGINEERING AND ENVIRONMENTAL STUDIES DIGITAL MODEL

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抽象的。　目前信息模型创建的实践目前面临着方法论和技术解决方案的缺乏，这就凸显了研究这一问题的重要性。 现有规范性文件对工程环境调查信息模型的填写描述较少。 本文根据基建建设对象的实际应用经验，提出了一种工程环境调查信息模型的开发方法。　本文涉及初始数据、其处理方法、结构化、可视化和数据库创建。　这种方法的进一步开发和应用将扩大信息模型的应用，将建筑信息模型与环境模型相结合，从而评估和监测物体对生态系统的影响。

关键词：BIM 环境调查、数字模型、BIM。

Abstract. *Current practice of information model creation is currently faced with a lack of methodological and technical solutions, which emphasizes the importance of researching this problem. The filling of information models of engineering-environmental surveys is poorly described in the existing normative documents. This article proposes a methodology for the development of engineering-environmental surveys information model based on the real experience of practical application for the object of capital construction. The article deals with the initial data, methods of their processing, structuring, visualization, and database creation. Further development and application of this approach will allow to expand the application of information models, combining building information models with environmental models, allowing to assess and monitor the impact of objects on ecosystems.*

Keywords: *BIM Environmental survey, digital model, BIM.*

In accordance with SP 47.13330.2016 [5], an engineering digital terrain model is a form of representation of an engineering topographic plan in digital vector-topological form for processing (modeling) on a computer and automated solution of engineering tasks. An information model of a capital construction object is a set of interrelated information, documents and materials about the object in electronic form. Such information is formed at the stages of engineering surveys, design, construction, reconstruction, overhaul, operation, and demolition of the object.

Earlier the environmental information model creation was not a mandatory design procedure. However, in accordance with the RF Government Decree No. 331 dated March 5, 2021, from January 2022, when concluding a contract on preparation of design documentation for construction, reconstruction, capital repair of the object financed with budget funds, formation and maintenance of the object's information model becomes mandatory for the customer, developer, technical customer and operating organization. The only exception is objects that are created in the interests of defense and security of the state [1].

Creation of a digital terrain model is not yet mandatory, but soon in accordance with the emerging trend, it should also become necessary. In the near future the speed of design and creation of working documentation, as well as their accuracy and flexibility, may increase so much that the storage of engineering survey information in traditional versions will simply not meet modern requirements.

Creation of a terrain information model is also necessary to reliably locate the capital construction object created in the digital environment. The digital environment of the terrain model and capital construction object should be compatible with each other and have the possibility of joint editing in the process of project development and increasing its detailing (Table 1).

Table 1.

Detailed information models at different stages of the building life cycle.

Obligatory requirements	**Levels of development of the digital information model at different stages of the building life cycle**				
	Engineering surveys	**Design**	**Construction, reconstruction, major repair**	**Operation**	**Demolition**
Defining element boundaries	X	X	X	X	X
Material boundaries in the element structure		X	X	X	X
Interface nodes with other elements			X	X	X

Creation of such models also implies appropriate approaches to storage of initial information about terrain features, in particular, engineering survey data. Thus, there is a need to form an information model of engineering surveys, which is intended primarily for the formation and storage in a structured form of a set of project documentation in terms of engineering surveys, as well as automation of the established processes (project management processes at the stage of design, construction and operation of capital construction facilities, established in regulatory documents).

As a result, the engineering digital terrain model should consist of a set of separate synchronized and integrated information models by disciplines, each of which should contain structured and interrelated data of all types of surveys (Fig. 1).

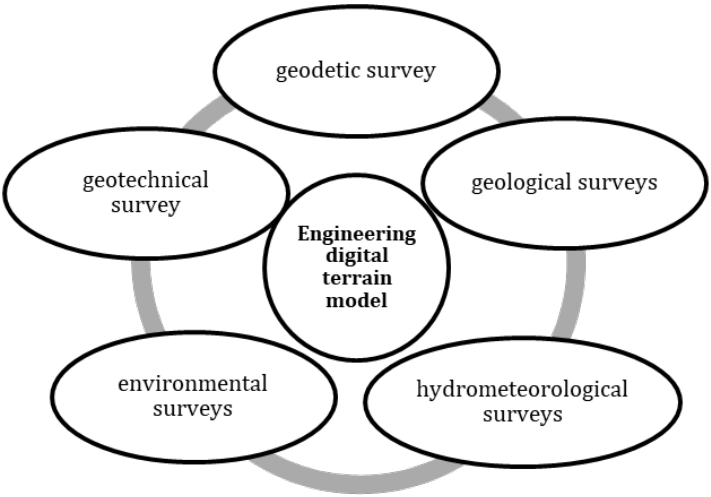

Figure 1. *An engineering digital terrain model.*

Currently, the most complete list of requirements for information models of objects is presented in SP 333.1325800.2020 [4]. The scheme of entering and storing basic information about the project, including the contract for engineering surveys, terms of reference, survey program, etc., as well as data of geological, geodesic and hydrometeorological surveys, is worked out in detail. However, as for engineering-environmental surveys, there is practically no elaboration of the methodology for creating such an information model.

According to SP 333.1325800.2020, the model should contain information reflecting:

1. Assessment of the state of the natural environment components prior to construction of the facility;

2. Background characteristics of pollution;

3. Assessment of the state of ecosystems;

4. Assessment of ecosystem resilience and recovery capacity;

5. Boundaries of the impact area by main components of natural conditions sensitive to the proposed impacts (in mm);

6. Forecast of possible changes in the natural environment in the zone of influence of the structure during its construction and operation;

7. Recommendations on the organization of environmental protection measures, as well as on the restoration and improvement of the natural environment;

8. Proposals for the local environmental monitoring program.

How these data should be structured and provided so that they can be docked with data from other surveys, create 3D models of survey results and use them to place models of capital construction objects, identifying inconsistencies, remains unclear.

And since the main element of the engineering digital elevation model is a topographic plan, the model of environmental surveys should be created on the basis of maps. Thus, the information on the eight mandatory requirements of the model of engineering-environmental surveys specified in SP 333.1325800.2020 should be presented in cartographic form and at the same time contain all the basic data of the report on the results of surveys. To solve this problem, the methodology allowing to do this was tested.

The Information Model of Engineering and Environmental Surveys (IM EES) was based on technical report processing. However, in the future, with the widespread use of information modeling of surveys, it is likely that the format of the report itself will change greatly and will be an explanatory note to the model, in which all the survey data will be stored.

A set of reporting documentation was used as input data, including:

1. Program of environmental surveys;

2. Technical report on the results of environmental surveys;

3. Appendices to the report, including text appendices, primary survey data and a set of final maps.

As a result, two blocks stood out in the model:

1. Information amenable to structuring, which included:

a. Results of studies of chemical contamination of environmental components;

b. Results of radiation studies;

c. Results of studies of physical effects;

d. Results of gas-geochemical studies of soils;

e. Results of sanitary and epidemiologic studies of environmental components;

f. Results of vegetation survey;
g. Results of the study of landscapes;
h. Results of the land cover study;
i. Results of geomorphologic and exogenous process studies;
j. Results of zoological study;
k. Results of the hydrobiologic study;
l. Areas of environmental restrictions on natural resource use;
m. Environmental prediction zones;
n. Zones of recommendations on the organization of environmental protection measures.

2. Unstructured information, which includes the report itself in text form.

The raw data for the IM EES were in tabular form and text form in editable format, text files in non-editable format (scanned copies of acts and protocols), and images in editable and non-editable formats.

All the data had to be put into a tabular form, in which the characteristics for each site or survey point were recorded in rows. Tabular data were transferred with minimal adjustments to the table structure, text data were converted to tabular form by writing numerical values of each parameter into cells. In case of necessity to add images to the model (e.g. photo of a point or sampling act) a link to this image was created for operational access in the information model.

The IM EES objects were created based on of the specified data.

All coordinates of the objects were defined in WGS 84 coordinate system. This was necessary because the survey area was rather large and did not fall within the limits of one sheet with UTM coordinates.

Before transferring the data into the information model, each individual table, based on which the model object was planned to be created, was saved in xlsx format.

Unstructured data were saved in docx and pdf formats.

The main software environment for creating information models on disciplines was the geoinformation system ArcGIS, which was chosen based on the results of comparison of functional and non-functional characteristics of different geoinformation systems. ArcMap component was used to create two-dimensional models. ArcScene component was used to create three-dimensional models.

IM security can be provided by: authentication, authorization, encryption and auditing.

The structure of the IM itself should provide, if necessary, the introduction of additional blocks of information, such as monitoring data, which would update the entire model.

IM contains structured information (three-dimensional images, drawings, layers (levels) of information - schemes, tables, schedules, text part related to

the graphical part of the project documentation) and unstructured information (source-permitting documents, explanatory notes, schemes, protocols, etc.).

The model consists of a software shell, a database and a set of environmental survey data in various forms.

The information model of environmental surveys was developed only in 2D format due to the presence of objects not only at the construction site itself, beyond which no detailed engineering-geodetic survey was conducted to create a sufficiently reliable relief surface corresponding to other sections of the IM. However, if it is available, the entire model can be transferred to 3D format without reworking the information included in it, but simply by simple data modification.

The developed database contained generated tabular, vector and raster data characterizing the survey territory, as well as acts, forms, protocols and photos, references to which allowed linking them to the objects on the map.

Thus the whole technical report on the results of environmental surveys was summarized and presented in the form of a set of inventory-estimation, forecast and recommendation maps. All maps could be further connected with the information model of the capital construction object and changed together with it, being refined and detailed.

As a result, the visualized part of the IM EES was a set of the following digital maps of the survey area:

1) Landscape map;
2) Animal habitat map;
3) Monitoring map;
4) Map of natural and anthropogenic processes;
5) Map of predicted state;
6) Vegetation map;
7) Map of hydrobiological research results;
8) Map of current state;
9) Map of socio-economic studies;
10) Map of factual material;
11) Map of environmental constraints;
12) Soil map;
13) Recommendations Map.

This allowed the information to be divided structurally in accordance with the structure of the original technical report itself.

Each mapped file in the database had a specially developed codification of the name, and vector files inside had mandatory attributes allowing to identify the object itself by looking also in the file parameters.

The actual material map, the monitoring map and the current state map contained only point objects. However, if usually these objects have only characteris-

tics in the form of coordinates and a small decoding in the legend, in the case of IM each point contained a lot of parameters characterizing it from the point of view of the report data. The most interesting thing in this case is the map of the current state. It was created only from point objects, as initially all survey results are recorded in the form of description of samples taken at a point, sample areas, animal encounters, measurement points, etc. As a result of processing of these point data, area objects are already created, creating maps of landscapes, forecasts, etc. But they are already the result of the specialist's creativity.

At this stage, area maps have already been created and presented in the report, which only allowed to digitize them and fill them with additional data. But in the future these maps can be created directly from point data of survey results and thus automatically updated and corrected when survey results are corrected or monitoring data are added.

At the same time, such a system of data storage and digitization of reports even without automatic updating mechanisms allows to create information models of engineering and environmental surveys that meet the requirements of SP 333.1325800.2020, as well as to make reports on the results of surveys unified, which is very rare in the case of engineering and environmental surveys.

Reference

1. Resolution of the Government of the Russian Federation of March 5, 2021, N 331, "On the establishment of the case in which the developer, technical customer, the person providing or carrying out the preparation of investment justification, and (or) the person responsible for the operation of the capital construction facility, shall ensure the formation and maintenance of the information model of the capital construction facility"

2. Resolution of the Government of the Russian Federation of September 15, 2020 N 1431, "On Approval of the Rules for the formation and maintenance of the information model of the capital construction object, the composition of information, documents and materials included in the information model of the capital construction object and submitted in the form of electronic documents, and requirements to the formats of these electronic documents, as well as on amending paragraph 6 of the Regulations on the performance of engineering surveys for the preparation of design documentation, construction, reconstruction and construction of the capital construction object".

3. Order of the Ministry of Construction and Housing and Communal Services of the Russian Federation of May 12, 2017 N 783/pr, "On approval of requirements to the format of electronic documents submitted for the state expert examination of design documentation and (or) the results of engineering surveys and verification

of the reliability of the estimated cost of construction, reconstruction, capital repair of capital construction projects".

4. SP 333.1325800.2020 "Information modeling in construction. Rules for forming an information model of objects at various stages of the life cycle", 01.07.2021.

5. SP 47.13330.2016 "Engineering surveys for construction basic provisions", M. 2019.

科学出版物

上合组织国家的科学研究：协同和一体化

国际科学大会的材料

2023 年 8 月 9 日。中国北京

编辑A.A.Siliverstova
校正A.I.尼古拉耶夫

2023 年 8 月 9 日。中国北京
USL。沸点：98.7。 订单253.流通500份。

在编辑和出版中心印制
无限出版社