

# **THE WORLD OF SCIENCE WITHOUT BORDERS**

**PROCEEDINGS  
OF  
THE 4<sup>th</sup> INTERNATIONAL SCIENTIFIC AND PRACTICAL  
CONFERENCE OF YOUNG RESEARCHERS**

**February 17, 2017  
Tambov**



**Tambov 2017**

Министерство образования и науки Российской Федерации

Федеральное государственное бюджетное образовательное  
учреждение высшего образования  
«Тамбовский государственный технический университет»

## **THE WORLD OF SCIENCE WITHOUT BORDERS**

**PROCEEDINGS  
OF THE 4<sup>th</sup> INTERNATIONAL SCIENTIFIC AND PRACTICAL CONFERENCE OF  
YOUNG RESEARCHERS**

**February 17, 2017  
Tambov**

## **МИР НАУКИ БЕЗ ГРАНИЦ**

**МАТЕРИАЛЫ 4-й МЕЖДУНАРОДНОЙ НАУЧНО-ПРАКТИЧЕСКОЙ  
КОНФЕРЕНЦИИ МОЛОДЫХ УЧЕНЫХ**

**17 февраля 2017 года  
Тамбов**



---

Тамбов  
Издательство ФГБОУ ВО «ТГТУ»  
2017

УДК 001+378  
ББК 72+74.58  
М63

### **Editorial Board**

**Mishchenko E.S.** – Doctor of Economics, Professor, Vice Rector for International Relations,  
Tambov State Technical University, Tambov

**Millrood R.P.** – Doctor of Education, Professor of the Department of International Professional and  
Scientific Communication, Tambov State Technical University, Tambov

**Gunina N. A.** – PhD in Linguistics, Associate Professor, Head of the Department of International  
Professional and Scientific Communication, Tambov State Technical University, Tambov

**Nikulshina N.L.** – PhD in Pedagogy, Associate Professor of the Department of International  
Professional and Scientific Communication, Tambov State Technical University, Tambov

**Korolyova L.Yu.** – PhD in Linguistics, Associate Professor of the Department of International  
Professional and Scientific Communication, Tambov State Technical University, Tambov

**Dvoretzkaya E.V.** – PhD in Linguistics, Associate Professor of the Department of International  
Professional and Scientific Communication, Tambov State Technical University, Tambov

**Mordovina T.V.** – PhD in Pedagogy, Associate Professor of the Department of International  
Professional and Scientific Communication, Tambov State Technical University, Tambov

М63      **Мир науки без границ** : материалы 4-й Междунар. науч.-практ. конференции  
молодых ученых / Тамбовский государственный технический университет,  
17 февраля, 2017. – Тамбов : Изд-во ФГБОУ ВО «ТГТУ», 2017. – 1 электрон. опт.  
диск (CD-ROM). – Системные требования : ПК не ниже класса Pentium II ; CD-ROM-  
диск. – 8,69 Мб ; RAM ; Windows 95/98/XP ; мышь. – Загл. с экрана. – 100 шт.  
ISBN 978-5-8265-1681-2

The 4th International Scientific and Practical Conference of Young Scientists hosted by Tambov State Technical University on February 17, 2017 is focused on the development of education, manufacturing and research. Major topics include problems of humanities, social, and technical sciences in the modern world. The present book contains the papers submitted to the conference.

4-я Международная научно-практическая конференция молодых ученых, организованная Тамбовским государственным техническим университетом 17 февраля, 2017 г., сфокусирована на развитии образования, производства и исследовательской деятельности. Основные темы включают проблемы гуманитарных, социальных и технических наук в современном мире. В настоящий сборник входят статьи, представленные на конференцию.

УДК 001+378  
ББК 72+74.58

**ISBN 978-5-8265-1681-2**

© Федеральное государственное бюджетное  
образовательное учреждение высшего образования  
«Тамбовский государственный технический  
университет» (ФГБОУ ВО «ТГТУ»), 2017

## CONTENTS

<b>FOREWORD</b>	<i>10</i>
<b>I. ARCHITECTURE, DESIGN AND URBAN PLANNING</b>	<i>11</i>
<i>Vorobieva M.O., Tolstosheeva A. P. Architectural Scenes of Tambov. Urban Concept</i>	<i>11</i>
<i>Gunina P.I. Holistic Approach to Design of a Modern Theatre Building</i>	<i>14</i>
<i>Kotov D. O. Trends in Architecture of School Buildings</i>	<i>17</i>
<i>Kuznetsova E.V. Ways of Masking Buildings in the Style of Invisible Architecture</i>	<i>20</i>
<i>Mandrykina A.S. Adaptation of Historical Buildings to Modern Conditions</i>	<i>23</i>
<i>Sladkina A. O., Yakovleva K.E. Reorganization of Residential Buildings</i>	<i>26</i>
<i>Sukhareva T. S., Pavlov P. A. Ecology of the Urban Environment</i>	<i>29</i>
<b>II. CIVIL ENGINEERING</b>	<i>32</i>
<i>Belyaev N. V., Ivankova N. S. The Study of Geometric Forms of Foundations Bases of Buildings Being Reconstructed</i>	<i>32</i>
<i>Dyachkina A.V., Pluzhnikova T.M. Decrease in Deformability of the Cement-Bonded Particle Board by Reinforcement with Composite Fitting</i>	<i>35</i>
<i>Ivankova N. S., Belyaev N. V. System of Composite Floorings for High – Rise Buildings</i>	<i>37</i>
<i>Ivanov I. A., Markaryan R. A. Application of LGSF Technology in Construction of Buildings in the Tambov Region</i>	<i>40</i>
<i>Ivanova S.S., Usnyan S.L. To the Problem of Constructive Solution of the Steel Gridshells</i>	<i>42</i>
<i>Merkusheva N. P. Monitoring Problems and Tasks of Walling in Providing Ecological Parameters of Residential Buildings</i>	<i>45</i>
<i>Novikova N. O., Yartsev V. P. Wood Concrete as an Environmentally Friendly and Energy-Efficient Building Material</i>	<i>48</i>
<i>Obukhova A. Yu. Experimental Studies of the Spatial Sheet Metal Structures</i>	<i>51</i>
<i>Popov D. E., Chernyakov P. S. Reinforcement of Asphalt Concrete Pavement with Geomaterial</i>	<i>54</i>

<i>Sergeev E.O.</i> Energy Efficiency in Construction	56
<i>Struleva I.A., Yartsev V.P.</i> Excessive Insulation of Buildings and Its Application Prospects	59
<i>Surkova O. N., Kutsaya T. A.</i> The Influence of the Foundation Base Tilt on Soil Deformation	62
<i>Sheludyakov N.A., Pronkina M.V.</i> Aviation Service in Tambov and Its Improvement by Refurbishing the Airport Building	65
<b>III. ENERGY AND POWER ENGINEERING</b>	70
<i>Aristov A.A., Koshelev I.Yu., Kuznetsova M.S.</i> Identification of Solar Flux Model onto a Horizontal Surface on the Example of Tambov	70
<i>Danilova A.O.</i> Energy Saving as Energy Resource	72
<i>Kuzyaev R.R.</i> Energy Saving of Thermal Equipment	74
<b>IV. ELECTRICAL AND THERMAL ENGINEERING</b>	77
<i>Bryuzgin A.A.</i> The Analysis of Capacitive Method of Non-Destructive Testing	77
<i>Golub A.S.</i> The Use of a Variable Frequency Drive to Control the Speed of the Induction Motor	79
<i>Eltsov A. G., Shuvaev A. S., Fefelov N.P.</i> Some Aspects of the Dust Filtration Process	81
<i>Eremeev S.A.</i> Methods of Surface Preparing for Gas Thermal	83
<i>Karpenko I.E.</i> The Research in to the Welding Power Source in a Soft Switching Mode	87
<i>Yarmizina A. Yu, Popov V.D., Mainikova N. F.</i> Temperature Field Visualization Whiletreating Polymer-Metal Constructions with Heat Insulation Coating Made of Polyurethane Foam	89
<b>V. MECHANICAL ENGINEERING</b>	93
<i>Deev A.A.</i> Investigation of Curing Process on Press Equipment	93
<i>Istomina I.I.</i> Development Of The Automated Control System for Dried Distillery Dregs Production	96
<i>Maksimenko D.A., Klochnev S.Yu., Vedishchev S.M.</i> A Twin-Screw Hopper	98
<i>Myskin V.A., Nefyodov A.Y.</i> Features of the Design and Exploitation of the Spike-Tooth and Spring-Tooth Harrow in Resource-Saving Technologies	101
<i>Ovchinnikov S.A., Danilova A.O.</i> Facility for Research into Noise Insulation Properties of Coating Based on Polymer Solutions	104

<i>Cherkasov M.S., Chugay D.I., Volchenkov D.E.</i> Machine Elements and Components Standardization	106
<b>VI. ELECTRONICS, RADIO ENGINEERING AND COMMUNICATION SYSTEMS</b>	111
<i>Panfilov V.S.</i> Adaptive Filtering Background Returns in the Radar Air Traffic Control Systems	111
<i>Ryazanova A.G., Grigorov O.O., Erokhin S.D., Belousov O.A.</i> Prospects for the Application of Ultra-Wideband Printed Vivaldi Antennas in 5g Standard Networks	113
<i>Fedotov D.A.</i> Educational Laboratory Complex with Remote Access	116
<i>Churilin O. N., Danilov S. N.</i> Decreasing Energy Costs of the Transmitter with OFDM Modulation	120
<b>VII. IT AND ROBOTICS, INFORMATION SECURITY</b>	122
<i>Vikhlyayev S.N.</i> The Need for Application of Fuzzy Values in Matters of Structural and Parametric Optimization of Information Security in Network Information Systems	122
<i>Kirina M. V., Churikov A. A.</i> Robotic Control System of Technological Parameters for Massive Products from the Heat-Shielding Materials	125
<i>Mazalov A.N., Yakovlev A.V.</i> Protective Mechanism of Identifier Based on the Qr-Code	128
<i>Trefilov P.A.</i> Review of Existing Methods of Designing and Optimizing the Logical Structure of Relational Databases	132
<b>VIII. ENGINEERING SYSTEMS CONTROL</b>	135
<i>Dorohova T.Yu., Tatarintsev S.A, Nguyen V.P., Chan D.K.</i> Classes of Object Identification Models	135
<i>Nuriahmetova N. Yu.</i> Structuring of Decision-Making Problems in Diagnostics of Information Control Systems	137
<i>Petrov D. A.</i> Simulation of Optical Coherence Tomography Images Using Voxel Based Approach	141
<i>Savenkov A.P., Safonova M. E.</i> Metrological Analysis of a Non-Contact Sensor of Distance	144
<b>IX. BIOMEDICAL ENGINEERING</b>	148
<i>Abuladze O. K., Sergeeva Yu. B.</i> A New Method for Non-Invasive Measurement of Blood Sugar	148
<i>Babashkina A.P., Akhtyamov D.V.</i> A New Method of Glucose Analysis	151

<i>Volkov A. Y., Kuzmin D. S.</i> A Method for Detecting Disorders of Blood Circulation in the Fingers	154
<i>Suslova Yu.V., Shvyreva K. E.</i> A Method of Radiation Dose Reducing During Fluoroscopy	156
<i>Trubienko A.A., Vetrov A.N.</i> Home Monitoring of Epileptic Attacks	159
<i>Frolov S.V., Korobov A.A., Aliev N.E.</i> Prediction Condition of the Cardiovascular System Based of Hemodynamic Four-Chamber Models	162
<b>X. BIOTECHNOLOGY AND FOOD ENGINEERING</b>	168
<i>Bogatyreva E.K.</i> Compounding and Technology of Functional Assorted Chocolates with Liquid Fillings	168
<i>Budantsev V.V., Viskov E.E.</i> Control of Technological Parameters of Production of a Container for Foodstuff	171
<i>Bushkovskaya A.I., Bogdanov I.A., Moseev P.A.</i> Processing of Mycelial Wastage of Biotechnological Manufacturing	174
<i>Velikanova A. S.</i> Influence of Process Conditions on the Manufacture of Low-Lactose Dairy Drink	178
<i>Kapustin V.P., Hairullina S.G.</i> The Prospect of Using Advanced Technologies of Cultivation of Soybean Seeds in Tambov Region	181
<i>Nadezhdina A. S.</i> A Study of Kinetic Regularities of Enzymatic Hydrolysis of Whey Lactose	184
<b>XI. NANOTECHNOLOGY AND NANOMATERIALS</b>	188
<i>Annakurbanova A. G., Budantsev Y. A.</i> Design of the Reactor for the Production of Formaldehyde by Catalytic Oxidation of Methanol	188
<i>Babkin A.V., Neskromnaya E.A.</i> Carbon Nanosorbent for Cleaning of Aqueous Media	191
<i>Edapina A.B.</i> Prospects of Development of Domestic Nanoproducts	194
<i>Popova A.A., Glushkova A. A., Edapina A.B.</i> Environmental Risks of Innovative Projects	196
<i>Khan Yu. A.</i> Evaluation of Carbon Nanotubes Structure after Functionalization with Raman Spectroscopy	198
<b>XII. CHEMISTRY AND CHEMICAL TECHNOLOGIES</b>	202
<i>Goncharov A.S., Zhdanova Y.V., Kireev V.V., Pshichkina D.Y.</i> Improvement of Extracting Technology of Sulfamic Acid	202
<i>Subocheva M.Yu., Balashova E.A.</i> The Use of Solvents Restructured to Remove Impurities from the Paste of Azo Pigments	204

<i>Kharin D.A.</i> Galvanic Lines	206
<b>XIII. MATERIALS SCIENCE</b>	210
<i>Dmitriev V.Yu.</i> The Use of Ultrasonic Method for Non-Destructive Testing	210
<i>Mishachenko A.I., Efremov A.B, Kobzev D.E.</i> Prospects of Polymer Composite Materials with Electrical Insulating Repair of Motor Vehicles	212
<i>Moiseev B.S., Kravchuk D.A., Kobzev D. E.</i> Application of Polymer Solutions for Repair of Vehicles' Cooling System Radiators and Coatings	214
<i>Naumov E.O.</i> Research Tool Materials Using Solid Modeling Software	217
<i>Suleev A.A.</i> Development of Energy-Saving Technology of Multilayer Electrically-Conductive Materials under Continuous Quality Control	221
<i>Furletov I.K., Parshin I.A.</i> Process Engineering of Applying Polymeric-Solution-Based Soundproofing and Protective Materials on the Parts of Vehicle	224
<b>XIV. ROAD SAFETY AND TRANSPORTATION</b>	227
<i>Istomina K. V., Minkin N. A.</i> Improvement of Road Traffic Organization on Karl Marx Street in Tambov	227
<i>Krivopalov V.S., Gavrikov A.A., Poplevin A.D.</i> Analysis of Pavement Repair Using Asphalt Mixtures in Urban Environment	230
<i>Strizhevsky A. M.</i> Improvement of Road Traffic Organization at Interchanges in Tambov	234
<i>Tarabrin D.A., Syshhikov D.A.</i> The Analysis and Ways of Reducing Road Accident Rate	238
<i>Ushakova M. A., Dmitrieva Yu. O.</i> Problems of Passenger Transport	241
<i>Frolov D.G.</i> The Influence of Traffic on the Noise Level in Residential Buildings	245
<i>Chukanova V.A., Sviridov D.A.</i> Traffic Organization on The Principle of Using the "Green Wave"	246
<b>XV. ECONOMICS</b>	249
<i>Kashirina O. A.</i> The Specifics of Company Materials Accounting	249
<i>Lyutikova M.V.</i> PR-Technologies for Attraction of Investments of Capital in Incommercial Organizations	251
<i>Mikhailova Zh. V.</i> Problems of Raising Wages in Modern Russia	253
<i>Tulupova I. Yu., Baznamina E. P.</i> The Nature, Problems and Prospects of the Analysis of Financial and Economic Activities	255



<i>Uglyanskiy V.A.</i> Inventory Management in the Enterprise	258
<b>XVI. PROFESSIONAL EDUCATION, PEDAGOGY AND APPLIED LINGUISTICS</b>	261
<i>Akinshina Yu.V.</i> Video Resources for Developing Learners' Listening Skills in a Foreign Language	261
<i>Apraksina O. N.</i> ESP (English For Specific Purposes) of Civil Engineers	263
<i>Volkova I.P., Savelyeva K.M.</i> Reforms of Architectural Education	266
<i>Kozintseva M.D., Igolkina N.I.</i> Some Ways of Implementing Drama Techniques into English Language Teaching	269
<i>Korolyova L.Yu.</i> E-Learning in European and Russian Higher Educational Institutions	272
<i>Kriventsova E.E.</i> Project-Based Learning in ESL Classroom	276
<i>Lekerova M.M.</i> Comparative Analysis of the Methods of Use of the English Prepositions in the Kazakh Language	279
<i>Lobatsevich N.S.</i> Using Pragmatic Texts in ESL Classroom to Develop Learners' Communicative Competence	283
<i>Mayerbekova A. E., Karmanova A. A.</i> Role-play as an Effective Foreign Language Teaching Tool	286
<i>Mordovina T.V.</i> Clil vs "Language Immersion": Differences and Similarities	288
<i>Pechkurova O.V.</i> The Role of an English Teacher when Using Case Study Method	292
<i>Sokolova I.N., Pastushenko T.A.</i> Formation of Positive Motivation of Students within Foreign Language Learning	295
<i>Chernysh Yu.V.</i> Teaching English to Secondary School Learners using Digital Tools	300

## FOREWORD

Over the past decades science and technology have been developing at an ever-increasing pace. The impact of scientific research on the life of humanity has been tremendous. Today, scientists all over the world are making efforts to investigate those areas which have not been paid close attention to. The role of young researchers and their contribution to the advancement of science and technology is becoming more explicit.

For the fourth time Tambov State Technical University provided a platform for young researchers to share the findings of their scientific investigations with the community. On February, 17, 2017 we were happy to welcome the participants of the Fourth International Scientific and Practical Conference **The World of Science Without Borders** organized by the Department of International Professional and Scientific Communication of Tambov State Technical University (Russia) in collaboration with Karaganda State University named after E.A. Buketov (Kazakhstan).

The plenary session speakers deserve special thanks for putting a lot of effort in preparing and giving presentations to the conference participants.

Almost 100 papers were delivered and presentations made on a variety of topics, from engineering to humanities.

A selection of extended abstracts available in this volume can be of interest to students, young researchers and specialists actively involved in scientific research.

*Natalia Gunina,  
Head of Department “International  
Professional and Scientific  
Communication”, TSTU*

УДК 72.01  
ББК 85.118

## ARCHITECTURAL SCENES OF TAMBOV. URBAN CONCEPT

**M.O. Vorobieva, A. P. Tolstosheeva**  
Tambov State Technical University, Tambov, Russia  
*e-mail: vmo-68@yandex.ru*

**Abstract:** *Formation of the urban environment is not a matter of one century it's the work of many generations. Each century leaves its mark on the appearance of some city, on the specifics of stylistic solutions for buildings.*

*One of the primary tasks related to the development of urban space, is to preserve the historic streets. Today, the historic environment requires the most careful attitude, it can't be distorted by excursive elements.*

*There are many means of harmonization, which allow to achieve the unity and artistic expression of the planning structure of the city. One of such means is the stability of the composite shape, based on reasonable functional zoning. This approach to harmonization of spatial environment is based on the use of functional, three-dimensional and architectural-artistic composition of the city.*

**Keywords:** *architecture, panorama of the city, town planning.*

The method of the city environment harmonization is based on graphic techniques that affect the transformation of the planning structure of the city in the process of its development. Harmonization techniques predetermine the possibility of placing new objects in different ways.

The combination of old and new buildings should be very harmonic. The successful integration of neighboring buildings only emphasize the merits and features of all buildings. However, it does not always harmoniously work to "inscribe" new buildings into existing historical buildings without destroying its unique integrity.

Inevitably, there is a contrast between the old and the new. But our past can't be completely forgotten or crossed out, as without knowledge of history and the past there can't be our future. Of course, time brings changes, new needs of people, the need for the construction of certain types of buildings, but the historical buildings and the more architectural monuments should remain the main criterion for designing new facilities of the urban environment.

The problem of preservation and development of architectural and artistic originality of the environment is one of the major professional creative problems at the current stage of development of domestic and foreign architecture. This approach is reflected in numerous publications, discussions of modern architectures.

All this determines a need for the further development of research dedicated to the problem of artistic image of the architecture as a whole, and the general solution of problems associated with the study of the architectural and artistic originality of the regional urban planning systems.

In theoretical studies the problem of the artistic image of architecture is examined in domestic and foreign authors' works. Among them there is a study of the problem of artistic image in general theoretical terms, in terms of perception, interpretation and meaning of the architectural environment, in the context of the relationship of the urban fabric, its structure and landscape.

The broad panorama of urban planning for creating the image of the river town comes to the fore when compared with other means that are specific to other cities, because the one-time perception is a specific feature of the coastal city. However, the analysis of works on the problem demonstrates the lack of theoretical research in this area, that certainly has a negative impact on design, and construction.

Thus, the problem is that despite the fact that the panorama of most seaside and river cities is characterized by specific architectural and artistic features it is insufficiently studied.

Practical significance of the method is the ability to use the main results of the study in the architectural and urban planning. Primarily this refers to Tambov, namely to practical recommendations.

The study of such phenomenon as the architectural view, presumes first of all the analysis of the role and importance of the panorama in the formation of architectural and artistic image of the city as it is obviously in close relationship with such concepts as the structure, shape, composition, appearance and image of the city.

The complexity of the spatial structure and morphological structure of most major cities predetermine fragmentary development of the human environment. Under these conditions, a complete image arises as a result of the gradual formation of concepts based on the synthesis of visual artworks. However, in a complex system of environment the streamlining perception requires certain "costs" for the organization of vision so that the scattered fragments merged into a generalized image. From this point of view the broad urban panorama is very important as many elements of the city in their visual relationship are covered hereby and the position of each in the whole picture appears extremely bright.

The panorama is a view at the landscape, opening from an appropriate point, characterized by a good review space and a wide viewing angle.

Thus, the architectural panorama is a specific form of manifestation of the urban environment. The fundamental basis of it is a visual-spatial integrity of the elements of the city at single perception of large urban structures. As a main form of visual projection of the urban structure for a certain type of urban, architectural panorama is the most important condition and method of forming a holistic visual image.

As for Tambov it was founded on April 17th, 1636. The fortress was situated on the left bank of the river Tzna at the confluence with the river Studenetz.

Analyzing plans of Tambov of different periods the following stages of the planning structure can be noted: a fortress (17th century), a fortress with surrounding

settlements (18th century), a regular plan and its implementation (the last third of the 18th century and 19th century), the development outside the regular plan (the last third of the 19th century and early 20th century), the modern planning structure. The main stage, which created the historical and cultural value of the town, was the third one, which began with the development and approval of the regular plan and ended in its full realization, that took about a hundred years.

In 1968, the city received a general plan, which provided the regulation of buildings. In 1986 another general plan was developed. The concept of urban development, implicit in it is based on the principle of the continuity of the main provisions of the previous plan, with the inclusion of a number of new proposals [1].

The compositions of historical planning structures showed its disharmony. The compositions are based on three series of factors:

1. Analysis of directions of the town formation and development of the road network, which shows of the possibility to ensure the coherence of this area with other areas of the city, as well as the nearest villages.

2. Landscape analysis of the topography of the city.

3. Functional zoning districts.

Analysis of the functional composition of the city, affecting its planning structure, leads to the identification of the nature and composition of the city planning parameters.

1. The transport system requires additional means of communication between the parts of the city;

2. The nature of the relief area refers to the hilly plain of central Russia.

3. The accumulation of functional areas provides the opportunity to organize their accumulation.

The study highlighted the need to develop and improve the streets: Naberezhnaya, Proletarskaya, Karl Marx. There are still problems relating to the conservation of individual unique appearance and planning structure of the central part of Tambov. The efficient use of the urban environment can be increased with the help of completion of previously unfinished blocks of buildings. It's possible to form an "open" planning structure that provides opportunities for the development of main functional areas of the city.

## References

1. Zaleskaya L.S. *Spravochnik arkhitekatora - gorodskaya ekologizatsiya*. [Guidebook of an architect - urban greening]. Moscow, Stroyizdat, 1990. Pp15-16. (Rus).
2. Pereni I., *Gorod, chelovek, okruzhayushchaya sreda. - Vengerskaya Akademiya nauk*. [City, man, environment]. Hungarian Academy of Sciences, 1981. Pp. 49-53. (Rus).
3. *Rekomendatsii po proyektirovaniyu okruzhayushchey sredy, zdaniy i sooruzheniy s uchetom potrebnostey*. [Recommendations for the design of the environment, buildings and facilities, taking into account peoples' needs]. Moscow, 1995. Pp. 23-27. (Rus).
4. Rukovodstvo po razrabotke "ekologicheskoy zaschity". [Guide for the development of "Environmental Protection"]. Moscow, 2005. Pp. 39-42. (Rus).

# АРХИТЕКТУРНЫЕ КУЛИСЫ ГОРОДА ТАМБОВА. ГРАДОСТРОИТЕЛЬНАЯ КОНЦЕПЦИЯ

**М.О. Воробьева, А.П. Толстошеева**

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: vmo-68@yandex.ru*

***Аннотация:** Формирование городской среды не является делом одного столетия, это труд многих поколений. Каждое столетие оставляет свой отпечаток на городском облике, на особенностях стилизового решения зданий.*

*Одной из первейших задач, связанных с развитием городского пространства, является сохранение исторических улиц. Сегодня историческая среда требует максимально бережного к себе отношения, нельзя исказить ее чуждыми ей архитектурными элементами.*

*Существует множество средств гармонизации, которые позволяют достигнуть единства и художественной выразительности композиции планировочной структуры города. Одним из таких средств является стабильность композиционной формы, обоснованная функциональным зонированием территории. Такой подход к гармонизации пространственной среды формируется на основе использования функциональной, объемно-пространственной и архитектурно-художественной композиций города, выраженных графоаналитическими схемами.*

***Ключевые слова:** архитектура, градостроительство, планирование территорий.*

---

УДК 72  
ББК 85.118

## HOLISTIC APPROACH TO DESIGN OF A MODERN THEATRE BUILDING

**P.I. Gunina**

School of Design Higher School of Economics, Moscow, Russia

*e-mail: guninap@gmail.com*

***Abstract:** The paper describes a holistic design approach, which focuses on the relationships between structural elements as a single whole. Its main principle is integrity and combination of aesthetics, comfort, efficient use of space and sustainability. The author offers a planning solution for a theatre of modern art from the perspective of holistic design. Holistic design has multiple benefits, including reduced operating costs of buildings and landscape, open space protection, without harming people's health and environment.*

***Keywords:** space planning, environment, sustainable design, people, holistic design, land, environmentally friendly materials.*

### **Introduction**

Currently, designers and architects are changing their views on public spaces, making them more natural and comfortable for people. Out of this need, a new

approach called holistic design has emerged. Holistic design considers the object being designed as an interconnected whole, which is also part of something larger. However, the concept of holistic design is much wider than a planning or architectural solution. It is a vision of the human environment as single whole that incorporates aesthetics, comfort and sustainability.

Concerns about the environment as well as the quality of life of those who are using the building is primary consideration in holistic design. Designers take into account a variety of factors, such as the impact of the design on the environment, the level of comfort and integration of the structure with the existing environment.

Obviously, designers attempt to reduce the negative impact on the environment by using environmentally friendly building materials. Such materials are quite expensive but it is possible to reduce costs by using natural ventilation and solar energy. Also, they offer space-planning solutions that make place comfortable for people. For example, public places like shopping malls, theaters, museums and cinemas must be easy to access by public transport and close to community. They must have enough places to eat, and have easy access for handicapped people.

A unique feature of holistic design is its aesthetic characteristics that influence the perception of the structure as part of something bigger. To achieve harmony designers consider the role of the lighting, planting and stylistic peculiarities of the surrounding buildings so as the structure naturally fits into the environment.

Holistic design is not only about architecture and construction. It is also a message that designers want to convey to the public. It is about satisfying the unmet needs of people.

### **Modern theatre building as an example of holistic design**

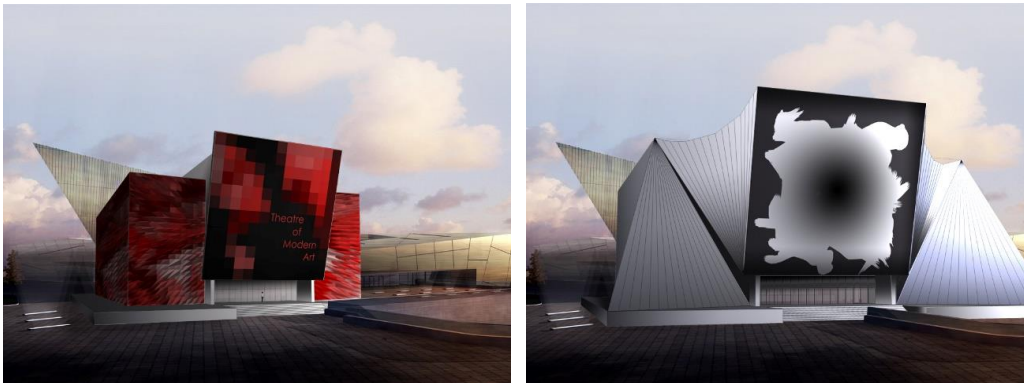
Holistic design in public places is a set of facades and exterior of the Theatre of Modern Art created by myself.



*Fig.1 Theatre of modern art. Brownfield construction*

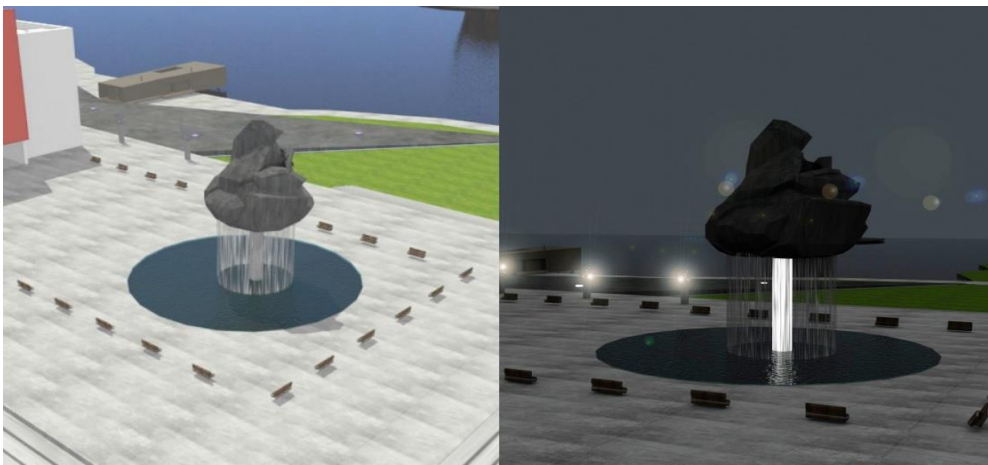
Fig 1 shows the example of building structures on a brownfield – a former rural land but not used anymore. Currently, brownfields are underestimated and as a

result are usually abandoned. My building site will occupy the least attractive piece of land to many people's mind. However, this land will have a new life it is re-developed.



*Fig.2 Theatre of modern art on developed land*

Fig 2 shows contemporary facades. The main idea of Theatre of Modern Art is that it is multifunctional. The same architectural approach applies to facades. They are all contemporary and easy to install. The theater can change design for different occasions and events. Most of these facades are made of light and easy to install materials such as fabrics, bamboo and environmentally friendly plastic.



*Fig. 3 Park zone around theatre with holistic landscape concept*

As for park zone, it is very natural with lots of green space. Instead of concrete, which contains a lot of dust and has low durability, huge stone tiles were installed. Lighting is very important as well. I decided to use solar powered street lights. Street lights are made of aluminum and glass and have very beautiful gloss effect. The whole area is flat to let handicapped people walk easily without obstacles. On the back entrance, there is a fountain made of pieces of rocks and glossy aluminum pipes to run the water.

### **Conclusion**

Holistic design is a way modern architects and designers should use to create interior and exterior constructions. Innovative technologies, durability and sustainability are the main goals of holistic design.



## References:

1. Narongrit Jinjantarawong. A Holistic Design Approach for Ultimate Building and Construction Performance // International Journal of Renewable Energy, 2009, Vol. 4, No. 1, January, pp. 55-63

## ХОЛИСТИЧЕСКИЙ ПОДХОД К ПРОЕКТИРОВАНИЮ ЗДАНИЯ СОВРЕМЕННОГО ТЕАТРА

**П.И. Гунина**

Школа дизайна Высшая школа экономики, Москва, Россия

*e-mail: guninar@gmail.com*

**Аннотация:** Холистический подход в архитектурном проектировании предполагает комплексное рассмотрение отношений между структурными элементами, объединенными в единое целое. Его основной принцип базируется на идее целостности и сочетании эстетики, комфорта, а также эффективного использования пространства для обеспечения устойчивого функционирования среды. Предлагается дизайнерское решение для театра современного искусства в рамках холистического подхода. Данный подход имеет множество преимуществ, в том числе снижение эксплуатационных расходов зданий и ландшафта, минимизирование ущерба для здоровья людей и окружающей среды.

**Ключевые слова:** дизайн среды, окружающая среда, устойчивый дизайн, люди, холистический дизайн, земля, экологически чистые материалы.

---

УДК 727 = 111  
ББК Н712 + К-77

## TRENDS IN ARCHITECTURE OF SCHOOL BUILDINGS

**D. O. Kotov**

Tambov State Technical University, Tambov, Russia

*e-mail: dimakotoff@bk.ru*

**Abstract:** The development of architecture of school buildings is a challenge that all Russian cities and towns now face. To cope with this challenge better, we need to study the long-term Soviet and worldwide experience in the construction of school buildings, to identify positive aspects that can enrich the architecture of Russian schools.

**Keywords:** architecture, blocks, construction, design, educational institution, infrastructure.

The new model of education must meet the needs of the present and future generations of humanity, which has the goal to survive and maintain the environment. It is necessary to learn not only the achievements of the past, but also the technology that will be useful in the future. Hence, the validity of an organized school requires a

different school infrastructure.

In the second half of the last century, Soviet architects successfully conducted research of new-formed school buildings, but their projects were based on the class-lesson learning system. It is necessary to study the long-term experience in the construction of school buildings, to identify positive aspects that can enrich the architecture of Russian schools.

Modernity appeals to the creation of an educational institution, capable to adjust a standardized and straightforward system of schooling for a child. We need different teaching methods designed for different categories of students.

It is easy to notice that in most successful projects there is a tendency to separate a school building into blocks, which include administrative, sports and entertainment parts facing the street, and an "educational part". The last one is hidden from the eyes of pedestrians, protected from noise and open on the sunny side. Blocks are also divided into zones for elementary and high school. All these parts are commonly connected by the passages, which may contain a library or recreation centers. The latest engineering and energy saving technologies should be actively introduced to make school become an economically viable object. Modern technologies of landscape design are actively used in many instances: vertical gardening classrooms, green roofs and facades of the school building.

Unplastered brick and natural materials, having their texture, are often used in the furnish of a school. The modern building is assembled from modular elements (boards, panels) of several types. This allows you to receive various forms of construction. More attention is paid to the internal organization of the building. Designing of the interior space takes into account the tendency of children to change actions frequently. The actual layout of school buildings is a large hall, surrounded by zones that form a space for playing and learning activities.

In the organization of the interior space of high school, we must take into account changes in educational requirements. School buildings can be constructed of individual sections of various levels of "flexibility": general (with a removable functional program), specific (with the stationary equipment) and service (communications and sanitary cabins). These sections can be used to assemble a school building for different learning systems.

One of the principles of organization of the learning environment is the transformation of the interior space by mobile partitions, cabinets or mobile equipment. The internal layout of schools should take into account the use of school buildings as centers of communication and culture of a residential area, the independent use of the gym can be provided in projects, libraries and workshops. The main trend in modern school building architecture becomes an inseparable unity with the nature, the interpenetration of nature and buildings. This interpenetration is not so much about the external effect of "fitting in" in nature, but about "disclosure" of the interior and the entire complex of buildings inside the nature and inclusion of natural elements in its interior. The architecture varied in form and content creates positive and emotional environment for children.

The school must be located in the service area, as well as on public transport

routes. Paths leading to the school should be safe for pedestrians. Educational blocks should not be oriented to the northwest, north and northeast, with the exception of drawing rooms and specialized classrooms. We need to protect classrooms against excessive sun heating. The area of window openings should be at least 1/5 part of the floor area. Extending constructions (balconies, etc.) must be taken into account by adding their area to the floor area. If the width of classrooms is 6.5 m or more we need to design a two-way natural light. Walls and ceilings in the classrooms and workshops should be made of non-burning materials. School buildings with six or more classrooms must have two separate outputs. Fire alarm and fire extinguishing devices should be installed. In other cases, schools with five or less classes or work space should have a fire extinguisher. Classrooms and workshops should be protected from noise by means of structural measures, which provide sufficient sound insulation and good acoustic quality. Avoiding the appearance of noise sources in the building is one of main points too. Existing sources of noise should be provided with soundproofing.

An example of the modern Russian school architecture is an experimental school for 1000 pupils on Khodynka Field in Moscow, designed by architect U.V. Ilin-Adaev. The school is divided into three blocks: elementary school, secondary school and a sports block. Gyms can be used by the district residents at non-academic time.

The important features of modern school should be: the ability to transform the educational environment; the planning of large functional zones; the formation of an "open" space systems; availability of mobile equipment in classrooms; new system of technical utilities location, the possibility of autonomous existence, the availability of energy-efficient systems.

Thus, the new modern school will focus on the development of non-academic disciplines. Flexible space-planning structure of school buildings is an instrument of overcoming their functional aging. To meet the changing social and educational requirements for school is also a very important moment.

In Russia, the problem of the architecture of modern school buildings is relevant, but more often discussed issues are related to the education system, competence of teachers, improvement of material and technical base, etc. It seems to us that there is no future for modern teaching systems in older buildings. This new school architecture can change the standard ideas about education, create a flexible training system, which will be aimed at a child's individuality formation.

### References

1. Arhitecturnoe proektirovanie obschestvennyh zdaniy i sooruzheniy. [Architectural design of public buildings and constructions]. Moscow, Stroyizdat, 1989. P. 543. (Rus).
2. Maklakova T.G., Nanosova S.M., Sharpenko V.G. Proektirovanie jilyh i obschestvennyh zdaniy. [Design of residential and public buildings]. Moscow, ACB, 1998. Pp.203-205. (Rus).
3. Naydanova P.V. Arhitecton: vestnik VUZov. Arhitectura sovremennyh shkolnyh zdaniy. [Architecton: university news. Architecture of modern school buildings]. July 2012, Vol. 38. (Rus).
4. Noyfert E. Stroitelnoe proektirovanie. [Construction design]. Moscow, Stroyizdat, 1991. Pp.206-221. (Rus).

# ТЕНДЕНЦИИ В АРХИТЕКТУРЕ ШКОЛЬНЫХ ЗДАНИЙ

Д. О. Котов

Тамбовский государственный технический университет, Тамбов, Россия

e-mail: dimakotoff@bk.ru

***Аннотация:** Развитие образования и архитектуры учебных зданий является проблемой, с которой сейчас сталкиваются все российские города. Для того, чтобы лучше справиться с этой проблемой, мы должны изучить долгосрочный советский и мировой опыт в строительстве школьных зданий, выявить положительные аспекты, которые могут обогатить архитектуру российских школ.*

***Ключевые слова:** архитектура, инфраструктура, конструкция, образовательное учреждение, проектирование, части.*

---

УДК 72.023

ББК 38.3

## WAYS OF MASKING BUILDINGS IN THE STYLE OF INVISIBLE ARCHITECTURE

E. V. Kuznetsova

Tambov State Technical University, Tambov, Russia

e-mail: ekuznetsova94@yandex.ru

***Abstract:** The article focuses on those ways which are used in architecture to mask buildings. This is called invisible architecture. The style of invisible architecture is new and poorly studied to date. The result of the literature review is a classification and analysis of materials which were used in creating this style. These are mirrors, metal, camouflage and greening. The proposed research will help to make these homes more affordable.*

***Keywords:** camouflage, greening, invisible architecture, masking, metal, mirrors.*

There are many trends and directions that can satisfy all tastes and ambitions in modern architecture. One unusual style is gaining in popularity: the invisible architecture. Various methods of masking are used in the construction of buildings in the style of invisible architecture. There are some of them.

Mirrors. The main raw material for the production of mirrors is a glass sheet. Building glass as a building material is characterized by durability, high resistance to moisture, solar radiation, temperature changes, frost resistance, incombustibility, rigidity and universality. The main physical property of the mirror is its reflection. Mirrored façade is used in the construction of homes in the suburbs of Warsaw in Poland (Fig. 1). In this case, the mirror coating is laid only on the first floor of the building. It seems that the second floor is floating in the air. The appearance of the

house changes quite often together with nature: you can expect the change of seasons and the changes associated with the time of the day [1].



*Fig. 1. - A house in the suburbs of Warsaw.*

Metal. As it is known, metals are characterized by a special "metallic" luster, which is determined by their ability to strongly reflect the rays of light [2]. This property was successfully used by the architects in the design of a new facade of Louis Vuitton store which is located in Tokyo (Fig. 2). They used an aluminum shell with a perforated pattern. Aluminum sheets mask steel frame and reinforced concrete structures of the existing building.



*Fig. 2. - Louis Vuitton shop in Tokyo.*

Camouflage. The house also may become conditionally invisible if it is in harmony with the environment [3]. For example, you can see «Juniper House» which blends perfectly with the landscape of the island of Gotland in Sweden (Fig. 3). The facade is decorated by a translucent fabric which has a picture of juniper bushes.



*Fig. 3. - «Juniper House» in Sweden.*

The common phenomenon is the greening of facades [4]. Plants reduce transport noise, purify and freshen the air, have a positive emotional impact. The use of vertical gardening of facades helps to regulate thermal conditions of the interior of the buildings, gives the chance to disguise ugly buildings and create optimal microclimatic conditions, reduce the noise level, the power of the wind, increase humidity, provide shade, enrich the air with oxygen, absorb harmful gases and dust.

House in California National Park creates such an impression that it is a part of the area and it was created by nature out of sand and stone through the use of cement, glass, copper and steel (Fig. 4).



*Fig. 4. - House in California National Park.*

Materials for masking buildings are common in our country, so we can use this effect. This will help the buildings to blend with existing buildings or blend in with the landscape and not to disrupt the composition as a whole.

## **References**

1. Chernejkina I. Mirror architecture. Available from: <http://www.admagazine.ru/arch/buildings/55161.php>.
2. Mikulski V. G., Gorchakov G. I., Kozlov V. V., Kupriyanov V. N. *Stroitelnye materialy. [Building materials]*. Moscow, Publisher Association building universities, 1996. (Rus).

Brooks K. Architectural trends that will define the next decade. Available from: <http://www.archdaily.com/512235>. (Accessed 5 Juny 2014).

3. Buldakova E. A. Sovremennye priemy organizacii zelenyh zon v uplotnennoj zastrojke goroda. [Modern methods of organization of green areas in a compaction building of the city]/ Sovremennye nauchnye issledovaniya i innovacii [Modern scientific research and innovations], 2012, Issue 5. Available from: <http://web.snauka.ru/issues/2012/05/12660>.

## СПОСОБЫ МАСКИРОВКИ ЗДАНИЙ В СТИЛЕ НЕВИДИМОЙ АРХИТЕКТУРЫ

**Кузнецова Е.В.**

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: ekuznetsova94@yandex.ru*

**Аннотация:** *Внимание акцентировано на тех способах, которые используются в архитектуре для маскировки зданий. Это так называемая невидимая архитектура. Стиль невидимой архитектуры является новым и малоизученным на сегодняшний день. Результатом литературного обзора является классификация и анализ материалов, которые были использованы при создании этого стиля. Это зеркала, металл, камуфляж и озеленение. Предлагаемое исследование поможет сделать эти дома более доступными.*

**Ключевые слова:** *зеркала, камуфляж, маскировка, металл, невидимый, озеленение.*

---

УДК 574  
ББК 0145

## ADAPTATION OF HISTORICAL BUILDINGS TO MODERN CONDITIONS

**A.S. Mandrykina**

Tambov State Technical University, Tambov, Russia

*e-mail: alina.mandrykina.ru@gmail.com*

**Abstract:** *The article considers one of the relevant problems of Russian cities, i.e. a loss of architectural and artistic features of historical centers. This process is determined by distortion of a historically developed composition of centers due to a destructive housing development and loss of a wide-scale historical housing development which forms the urban structure. The article presents one of the most effective mechanisms of preserving the uniqueness of historic cities such as immovable historical and cultural heritage and a wide-scale historical housing development by their adaptation to current needs of the society.*

**Keywords:** *adaptation; architectural heritage; historical housing development; preservation; restoration.*

Architecture is an integral part of the human environment, which is formed over many centuries and decades based on the conditions of time, place, used building materials, methods, tools and traditions in construction. Historical architectural

buildings, carrying layers of cultural strata of different epochs, determine the individuality of places and the image of cities, play the main role in the continuity of cultures of different epochs. Study, use and the presence of historic buildings in the modern architecture of the city is one of the factors of formation of national identity. The attractiveness of the historic cities in Europe for tourists all over the world is precisely that. Using historical architecture they learn about the culture and traits of people. The architecture is associated with identity in the context of the place.

Because of this, the problem of preservation of historical buildings has a particular relevance at the present stage of the development of the society.

The purpose of this article is to identify the importance of maintaining compositional and artistic integrity of historical buildings in the contemporary world, to identify the most optimal methods of reconstruction of the historical buildings of cities [1, 2].

The city as a complex organism develops continuously, that is manifested in increase of population; in change of the size and intensity of use of developed areas; in the increase of technical capacity and the complexity of the information field of the city.

The reconstruction of the cities that have preserved valuable historical and cultural heritage is based on independent techniques with different goals and objectives. The differences may be between the cities that preserve the unique and inimitable nature and between regions, functional design parts of the same city (city center, residential area, industrial area).

Reconstruction of the historically formed environment of the central part of the city implies the preservation of this environment as a unique phenomenon, exceptional in each case. To preserve this environment, it is necessary to make it viable, and this should not only be preserved but continuously reconstructed. This process is complex, including restoration, regeneration, rehabilitation, repair, and improvement and new construction.

Methods of reconstructive measures:

In practice, the reconstruction methods are described in the "implantation" of new buildings in historical environment:

1. Hidden reconstruction
2. Stylistic imitation
3. Contrast solution

The method of covert reconstruction must be used in order not to result in the destruction of the building in case of its reconstruction.

There are two fundamentally different situations of the use of covert reconstruction:

In the first case, the goal of reconstruction is to create a rich urban environment, the calculated mass flows of visitors, diverse and permeable in all directions. So, the use of old buildings in the old housing in the former quality may be impossible.

In the second case, traditionally proposed for the centers of old cities, the path reconstruction, decompression, and rehabilitation (to ensure the necessary standards of insulation and ventilation, landscaping, improving sanitation, and maintenance)



seems feasible.

In conditions of densely built-up districts with acute shortage of available territories the technique of vertical zoning can be used. This technique includes:

- overlapping the inner yard at the level of 2-3 floors;
- the 1-floors under the service institutions of the basements under the garages of technical and warehouse premises;
- the inclusion of intra in the space of the passage and premises for different types of commercial and recreational activities;
- accommodation of auditoriums, restaurants, pedestrian crossings at various levels;
- the upper floors are reserved for housing;
- the complex has a connected system of pedestrian communication on several levels [3].

The principle of stylistic imitation is used to restore the facade of the historic neighborhoods as an imitation of the style of old buildings. New buildings must rather rigid requirements: the preservation of the silhouette of the building (limitation of height and volume), correct plastic facade of the new building (the proportions of windows, decoration) depending on the neighboring facades of the solution to the texture, the color (material of lining).

The practice of building new buildings on the principle of stylistic imitation has many examples of successful incorporation of these buildings into an ordinary historical building of the street. Most often this principle is applied in the case of a firewall construction in order not to violate the architectural and artistic appearance of the street usual for this city.

Method of height restrictions is particular for the historic core and forms a clear recommendation system to select the height of new buildings in different parts of the city, the formation of the silhouette of the new building does not violate historically formed contours.

New buildings in the old quarter of the surrounding historic buildings play a significant role in the forming of a new building because the new building should integrate harmoniously into the historic environment and not distort the historical appearance of the old street. The importance of the historic buildings should be considered not only from the point of view of humanity to the past, and the preservation of compositional and artistic integrity. Historicism in architecture plays an important role. Without recourse to historicism, we cannot speak about the development of the history of architecture. One of the methods to harmonize the environment is an appeal to the roots of our past, namely the use of historicism in the design of modern buildings.

#### **References:**

1. Romanova, L.S. K probleme sokhraneniya arkhitekturno-khudozhestvennogo svoeobraziya istoricheskikh tsentrov gorodov. [To the problem of preserving architectural and artistic hallmarks of historical city centers]. Issledovaniya i innovatsionnye razrabotki RAASN [RAACS R&D]: RAACS collected papers, 2010, Volume 1. Pp. 231–236. (Rus).

2. Romanova, L.S. Iz istorii restavratsii doma grazhdanskogo inzhenera A.D. Kryachkova v g. Tomske [From the history of restoration of Kryachkov's house in Tomsk-city]. *Proceedings of the conference 'Historic Environment and Problems of Tomsk's Wooden Architecture'. Centenary of Kryachkov's house*, Tomsk, TPU Publishing House, 2011. 92 p. (Rus).
3. Pod"yapol'skii, S.S., Bessonov, G.B., Belyaev, L.A., Postnikova, T.M. Restavratsiya pamyatnikov arkhitektury. [Restoration of architectural monuments]. Moscow, Stroyizdat, 2000. 288 p. (Rus).

## АДАПТАЦИЯ ИСТОРИЧЕСКОЙ ЗАСТРОЙКИ К СОВРЕМЕННЫМ УСЛОВИЯМ

А.С. Мандрыкина

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: alina.mandrykina.ru@gmail.com*

**Аннотация:** Рассмотрена одна из актуальных проблем российских городов – утрата архитектурно-художественного своеобразия исторических центров. Этому процессу способствует искажение исторически сложившейся объемно-пространственной композиции центров за счет появления новой деструктивной застройки и утраты массовой (фоновой) исторической застройки, составляющей городскую ткань. Рассмотрен один из действенных механизмов сохранения своеобразия исторических городов — сохранение недвижимого историко-культурного наследия и фоновой исторической застройки посредством адаптации к современным потребностям общества.

**Ключевые слова:** адаптация; архитектурное наследие; восстановление; историческая застройка; сохранение.

---

УДК 728 = 111  
ББК Н711 + S-67

## REORGANIZATION OF RESIDENTIAL BUILDINGS

A. O. Sladkina, K.E. Yakovleva

Tambov State Technical University, Tambov, Russia

*e-mail: la\_dolce@ro.ru*

**Abstract:** *The article presents the characteristics of construction of houses in the 60-70s of the XX century in Tambov on Pionerskaya, Naberezhnaya, Uborevicha, Andreevskaya streets. The solutions for the reconstruction of buildings, improvement of yard areas and creation of the favourable urban and natural environment are made.*

**Keywords:** *reconstruction, remodeling, renovation.*

Construction in the mid-60s was aimed at solving the housing problem in the shortest possible time, the formation of new systems of enclosed courtyard spaces, regional and district development with integrated public buildings.

Residential areas of Naberezhnaya Street are closed systems situated near other

buildings of other periods, with adjacent recreational areas along the river Tsna. Disadvantages of the quarter are pedestrian permeability, lack of organized platforms inside courtyards, parking areas, fire driveways not corresponding to SNIP standards [1].

Houses built in the 1960-70s are standard four-five-storey brick residential buildings with three load bearing walls. Thus, the bearing skeleton consists of three longitudinal and transverse load-bearing brick walls - two external ones and an internal wall between the stairwells.

While remodeling houses it is recommended to dismantle the walls in double and triple apartments, to combine kitchens and living rooms, replacing gas stoves with electrical, in double and triple apartments replacing combined bathrooms into separate ones, redevelopment of one-bedroom apartments is not recommended.

Structural transformation includes strengthening of bearing structures (foundations, walls), insulation of walls, superstructure of additional floors, roof reconstruction, extension of lifts, lobbies device.

Redesign of apartments includes increasing the area of the bathroom and kitchen, creating a more comfortable layout by replacing internal partitions. In the center of the building one-room apartments are joined into two-bedroom apartments, because they do not meet the norms of isolation.

Accomplishment of territories near houses requires an individual approach, due to the features of the relief (strong bias) and a small area. This includes passages device in accordance with the standard organization of sites for various purposes in accordance with SNIP [1] and the SP [2] and VSN 58-88 [3], demolition of dilapidated houses, the resettlement of residents from dilapidated housing in new residential high-rise building in the quarter, the organization of zones of landscaping.



*Fig. 1 – Cultural and leisure area of Naberezhnaya Street in Tambov.*

It is worth noting the value of Naberezhnaya str. for Tambov in the urban

development plan (fig. 1). This is a cultural and recreational zone of the city, along which there are numerous parks, alleys, playgrounds, catering, cultural centers, in the southern part of the organized beach area, including organized sports grounds, swimming areas (fig. 2).

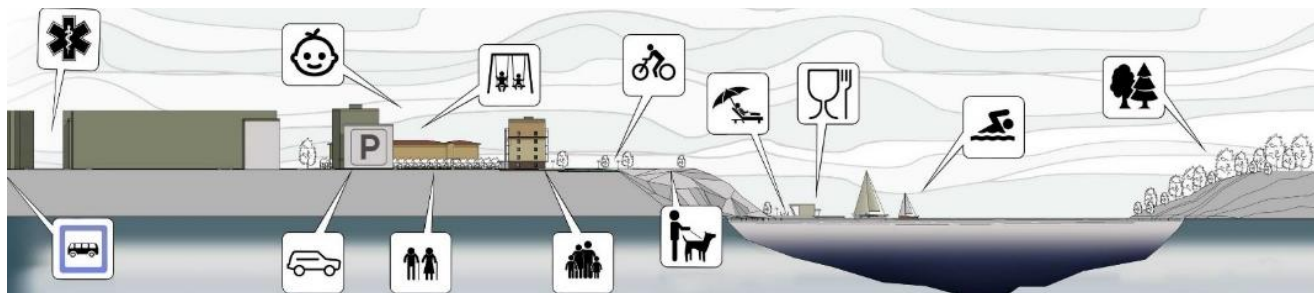


Fig. 2 – Development scheme. *Recreational development.*

Integration of the quarter to the urban environment must take into account the natural dominant of the River Tsna. It will create the finished look of Naberezhnaya street, will raise the quarter (district) indication of the comfort of living in the city of Tambov. For visitors and residents of the city, the development of this area can become a kind of attraction, and undoubtedly a great contribution to the modernization and transformation of the city of Tambov.

#### References

1. SNiP 31-01-2003 Zdaniya zhilye mnogokvartirnyye. [SNIP 31-01-2003 Residential apartment buildings]. 2004. 23 p. (Rus).
2. SP 131.13330.2011. Stroitel'naya klimatologiya. Svod pravil. [Building Climatology. Set of rules]. FGUP TSPP, 2013. 124 p.(Rus).
3. VSN 58–88. Polozheniye ob organizatsii i provedenii rekonstruktsii, remonta zdaniy. [Regulations on the organization and carrying out of reconstruction, repair of buildings]. TSNIIEP zhilishcha, 1990. 48 p. (Rus).

## РЕОРГАНИЗАЦИЯ МАССОВОЙ ЖИЛОЙ ЗАСТРОЙКИ

**А. О. Сладкина, К.Е. Яковлева**

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: la\_dolce@ro.ru*

**Аннотация:** Представлена характеристика домов застройки 60-70-х годов XX века в квартале в границах улиц Пионерская, Набережная, Уборевича, Андреевской в г. Тамбов. Представлены решения по реконструкции зданий, благоустройстве дворовой территории и созданию гармоничного слияния городской и природной среды.

**Ключевые слова:** перепланировка, реконструкция, реновация.

## ECOLOGY OF THE URBAN ENVIRONMENT

**T. S. Sukhareva, P. A. Pavlov**

Tambov State Technical University, Tambov, Russia

*e-mail:* suhareva.toma2016@yandex.ru

**Abstract:** *Ecology of the urban environment is a very relevant problem addressed by many scientists. The task of urban planners, architects, environmentalists is to work together to improve the environment of the city. In this article, we consider the issue of ecology of the urban environment.*

**Keywords:** *city, environment, health, noise, people, pollution, problem.*

### **Introduction**

With the increasing growth of cities and urbanization of the population, the problem of the ecological condition of the urban environment becomes increasingly important. Since the city is the environment where there are all processes of human activity. Humans are biosocial beings, and thus a vital factor for people is the quality of air, food and water. There is also a number of other environmental factors that affect the health of urban residents. These include noise, radiation and vibration exposure. The problem of urban ecology will be discussed in this article.

### **The history of creation of the urban environment**

During the centuries of urbanization of the planet urban methods have been formed and perfected by trial and error. In this case, the dream of all the participants in the process of urbanization, including urban planners, architects and residents, was the city with the perfect environment. Ideas about the ideal city were various. Some saw them as small towns, some as large dynamic metropolitan areas, some as small-scale green "cities of the sun", and some as giant cities with glass skyscrapers. Urbanization of the planet has a long history — from the first small settlements to large cities [1].

The first human settlements were mostly simple environments, which served to meet their basic needs (shelter, procreation, protection from enemies, etc.). Subsequently, cities developed into more complex structures, with the increased needs of humanity.

Technological progress was not only a key point in the development of cities, but also had a significant impact on the ecology of the city. Every year there are more cars that not only pollute the air with emission gases, but also provide a tremendous noise and vibration impact on the environment. The increase in built-up area and roads resulted in the reduction of green spaces, which are a source of oxygen.

### **Environmental problems of the urban environment**

Pollution affects the health of the urban population greatly. This is evidenced, in particular, by significant differences in the health condition of the population in separate areas of the same city.

Health of citizens is affected by many factors, in particular the characteristic

features of urban life — lack of physical activity, increased nervous stress, transport fatigue and a number of others, but the greatest problem is environmental pollution. The most visible negative consequences of environmental pollution in a major city, are manifested in the deterioration of the health of the residents compared to rural residents.

Along with air pollution, human health is negatively impacted by many other factors of the urban environment.

Noise pollution in cities is almost always local and it is mainly caused by means of transport — cars, trains and planes. The noise levels on main roads of big cities already exceed 90 dB and have a tendency to increase annually by 0.5 dB. This is the largest environmental hazard in the areas close to busy highways. Medical studies show that increased noise levels contribute to the development of neuropsychiatric diseases and hypertension. The protection from noise in central areas of cities is hampered by the density of existing buildings which make construction of noise screens and broadening highways and green areas to reduce noise levels very difficult. Thus, the most promising solutions to this problem is to reduce the intrinsic noise of vehicles (especially trams) and to build soundproofed buildings on the main highways additionally as well as to install green facades and triple glazed windows (with a simultaneous application of mechanical ventilation) [2].

A particular problem is the increase in the level of vibration in urban areas, the main source of which is transport. This issue is under research, but there is no doubt that its importance will increase.

Vibration contributes to a more rapid deterioration and destruction of buildings and constructions, but most significantly, it can adversely affect the most accurate technological processes. It is especially important to emphasize that vibration harms advanced industries the most and, accordingly, its growth may have a limiting effect on the ability of scientific and technological progress in metropolitan areas [3].

### **Conclusion**

The way to create the environment in the city that will be comfortable for life of people is very long and tedious. At the present stage of development, when the city is over-populated compared to other settlements, the relevant problem about the ecology of the urban environment raises. At the moment, the main task of environmentalists, urban planners and architects is to create the most comfortable conditions for human life. This will require a tremendous amount of work so that the modern city could enjoy all the benefits of scientific progress, while remaining ecologically suitable for the life of people.

### **References**

1. Tetior A.N. Ekologiy gorodskoy sredi. [Ecology of the urban environment]. Publishing center Academy, 2013, Vol. 4. 352 p.(Rus).
2. Marsalkovic A. S.,Afonin M. I., Ekologiy gorodskoy sredi. [Ecology of the urban environment]. Moscow, GOS. Stroitelstvo, 2016. (Rus).
3. Sazonov V. E. Ekologiy gorodskoy sredi. [Ecology of the urban environment]. Spb., GIORD, 2010. 312 p. (Rus).

# ЭКОЛОГИЯ ГОРОДСКОЙ СРЕДЫ

**Т.С. Сухарева, А.А. Павлов**

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: Isuhareva.toma2016@yandex.ru*

***Аннотация:** Экология городской среды является очень актуальной проблемой. Эта проблема решается многими учеными. Каждый год появляются новые опасности. Задача градостроителей, архитекторов, экологов работать вместе, чтобы улучшить экологию города. В этой статье рассмотрена тема экологии городской среды.*

***Ключевые слова:** город, загрязнение, здоровье, проблемы, среда, человек, шум.*

---

УДК 624.1=111

H 58

ББК В-41

## THE STUDY OF GEOMETRIC FORMS OF FOUNDATIONS BASES OF BUILDINGS BEING RECONSTRUCTED

**N. V. Belyaev, N. S. Ivankova**

Tambov State Technical University, Tambov, Russia

*e-mail: kol.belyaev2009@yandex.ru*

**Abstract:** *The article focuses on studying geometrical forms of foundations bases of buildings being reconstructed. It also considers the geometric characteristics of such bases. In the reconstruction of buildings we are dealing with existing foundations, so a new foundation that will be constructed nearby, should be a complex form. It is necessary to consider mutual influence of foundations. This study is relevant today, because the construction is developing more and more every year. We are surrounded by a huge number of "old" buildings that must be reconstructed. Many of these buildings are architectural monuments, so it is important to keep them in a good condition.*

**Keywords:** *coefficients, foundation bases, geometric characteristics, geometric forms, reconstruction, torque loads.*

### Introduction

In this paper we have studied geometric forms and geometric characteristics of foundations bases of buildings being reconstructed. Foundations are an essential part of buildings, which transmits loads from the building structure on the soil. To settle the new foundations in limited conditions of the existing underground structures of buildings being reconstructed the foundations of complex forms have to be often used and the impact of existing and newly constructed foundations must be taken into account [1]. In this paper we have studied the most common types of foundations bases used in the reconstruction of buildings.

### 2. Types of foundations bases and their characteristics

The choice of the type of the foundation base depends on the load and the presence of underground structures.

Foundations with symmetric T-beam base are used when there are significant alternating torque loads or when it is required to reduce the length of the base of developed underground structures.

Foundations with T-shaped base are used for torque loads of one direction and under the same conditions as foundations with symmetric T-beam bases, when the distance from the gravity centre of the base to one of its edges should be minimal.

Foundations with L-shaped base are used in cases of significant torque loads in mutually perpendicular planes, or when the conditions specified for T-shaped foundations, must be followed in relation to two adjacent edges of the base.



Closely-shaped strip foundations rectangular in plan are used under the separately located structures and under porches to buildings. These porches are separated from the buildings by expansion joints.

Cross-shaped foundations are used instead of rectangular foundations in case where the rectangular foundations include concrete posts to provide support for stands and other structures for various purposes.

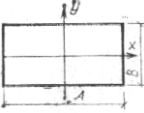
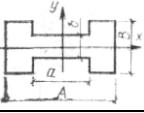
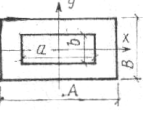
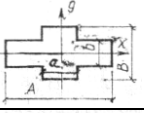
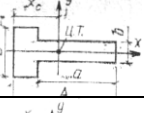
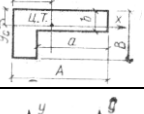
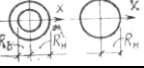
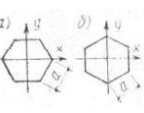
Ring-shaped and round foundations are used under different round structures. It is recommended to use ring-shaped foundations for relatively small loads. These foundations are separate supporting structures; their moments can act in different directions.

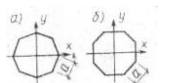
Polygonal foundations are often used instead of round foundations, as they are easier to work with and it takes less time to produce the formwork.

These types of foundations are also successfully used for various types of equipment and other technological devices [2; 3].

Geometrical characteristics of foundation bases of various forms and their values are given in table 1. The values of the geometric characteristics of the polygonal bases (a) in the table correspond to the location of the bases, illustrated on the left, and the values of (b) are shown on the right.

Table 1. Geometric characteristics of foundations bases of various forms

Scheme	Form	$F$	$x_c/y_c$	$I_y$	$I_x$	$W_y$	$W_x$			
1	2	3	4	5	6	7	8			
	Rectangular	$k_1 AB$	$\frac{0,5 A}{0,5 B}$	$k_2 A^3 B$	$k_3 AB^3$	$k_4 A^2 B$	$k_5 AB^2$			
	T-beam symmetrical									
	Closely-shaped strip foundations rectangular in plan									
	Cross-shaped									
	T-shaped							$\frac{\mu_x A}{0,5 B}$	$W_{\max} = k_4 A^2 B$	$W_{\min} = k_5 AB^2$
	L-shaped							$\frac{\mu_x A}{\mu_y B}$	$W_{\min} = k_4' A^2 B$	$W_{\max} = k_5' AB^2$
	Ring-shaped, round	$k_1 R_H^2$	$R_H$	$k_2 R_H^4$	$k_2 R_H^4$	$k_4 R_H^3$	$k_4 R_H^3$			
	Hexagonal	$k_1 a^2$	a) $\frac{\mu_a}{\mu_a}$ b) $\frac{\mu_a}{\mu_a}$	$k_2 a^4$	$k_3 a^4$	a) $k_4 a^3$ b) $k_5 a^3$	a) $k_5 a^3$ b) $k_4 a^3$			

	Octagonal	a) $\frac{\mu_a}{\mu_a}$	б) $\frac{\mu'_a}{\mu_a}$		a) $k_4 a^3$	б) $k_5 a^3$	а) $k_4 a^3$	б) $k_5 a^3$
---	-----------	-----------------------------	------------------------------	--	-----------------	-----------------	-----------------	-----------------

$F$  – the area of the bases;

$a$  – the side of the base in the form of a regular polygon;

$x_c, y_c$  – the distance from the gravity center of the square base to its edge along the  $x$ -axis and  $y$ -axis, accordingly;

$I_y, I_x$  – the base area inertia moments relative to the axes  $y$  and  $x$ , accordingly;

$W_y, W_x$  – the base area resistance moments relative to the axes  $y$  and  $x$ , accordingly;

$A, B$  – the length and width of the base, accordingly;

$R_n, R_g$  – the outer and inner radii of the ring-shaped base, accordingly.

The values of the coefficients  $k_i, \mu, \mu'$  for different types of foundations are given in [1], where these foundations are discussed in detail.

### 3. Conclusion

In this paper we have studied the possible geometric forms of foundations bases of buildings being reconstructed. We have also considered the geometric characteristics of foundations bases of various forms and considered the conditions of application of each type of foundations bases. The study has shown that the geometric forms of foundations bases are very diverse, so they can be applied in various fields of construction.

### References

1. Ryibin V. S. Proektirovanie fundamentov rekonstruirovemykh zdaniy [Design of foundations of buildings reconstructed]. M., Stroyizdat, 1990. 296 p. (Rus)
2. SP 50-101-2004. Svod pravil po proektirovaniyu i stroitelstvu. Proektirovanie i ustroystvo osnovaniy i fundamentov zdaniy i sooruzheniy [A set of rules for design and construction. The design and layout of bases and foundations of buildings and structures]. M., Gosstroy Russia, 2004. (Rus)
3. SP 22.13330.2011. Svod pravil po proektirovaniyu i stroitelstvu. Osnovaniya zdaniy i sooruzheniy. Aktualizirovannaya redaktsiya SNIp 2.02.01-83\* [A set of rules for design and construction. The base of buildings and structures. The updated edition of SNIp 2.02.01-83\*]. M., Minregion Russia, 2011. (Rus)

## ИЗУЧЕНИЕ ГЕОМЕТРИЧЕСКИХ ФОРМ ПОДОШВ ФУНДАМЕНТОВ РЕКОНСТРУИРУЕМЫХ ЗДАНИЙ

**Н. В. Беляев, Н. С. Иванкова**

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: kol.belyaev2009@yandex.ru*

**Аннотация:** Изучены геометрические формы подошв фундаментов реконструируемых зданий. Также рассмотрены геометрические характеристики таких подошв. При реконструкции зданий мы имеем дело с уже существующими фундаментами, поэтому новые фундаменты, которые будут возводиться рядом, должны иметь сложную форму.

При этом необходимо учитывать взаимное влияние фундаментов. Это исследование актуально на сегодняшний день, потому что строительство развивается с каждым годом все больше. Нас окружает огромное количество «старых» зданий, которые необходимо реконструировать. Многие из этих зданий являются памятниками архитектуры, поэтому так важно сохранить их в достойном состоянии.

**Ключевые слова:** геометрические формы, геометрические характеристики, коэффициенты, моментные нагрузки, подошвы фундаментов, реконструкция.

---

УДК 691=111  
ББК Н30/Д-98

## DECREASE IN DEFORMABILITY OF THE CEMENT-BONDED PARTICLE BOARD BY REINFORCEMENT WITH COMPOSITE FITTING

**A.V. Dyachkina, T.M. Pluzhnikova**  
Tambov State Technical University, Tambov, Russia  
e-mail: dyachkina-nastya@mail.ru

**Abstract:** This article is devoted to developing a way of decreasing the deformation of cement bonded particle board (CBPB). The method will be developed on the basis of investigating the major factors that have an impact on physical-mechanical properties of CBPB. The goal of the work is achieved by considering the principle of reinforcing CBPB with composite fitting. It is supposed that reinforcement of CBPB is able to refine its durability and effectively strengthen the construction of the material. This method has an important practical significance because it helps to increase fields where CBPB can be applied as well as its performance characteristics.

**Keywords:** cement bonded particle board (CBPB), composite fitting, deformation, reinforcement.

### Introduction

In recent times the application of CBPB is becoming more widespread. The production of CBPB allows to get competitive construction material and also it helps use wood and recycle wood residue. Therefore, the elaboration of the method which can help to increase the strengthening characteristics is given a great attention.

One of the main disadvantages of CBPB is the low bending strength, so it leads to deformations, which appear during storage, installation and maintenance of boards.

### The reinforcement of CBPB with composite fitting

The previously proposed methods of improving the physical-mechanical characteristics of CBPB were investigated in the course of the work. This method introduces such options as reinforcing glue nanostructures [1], the modification of the size and the placement of wood particles [2], the revision of manufacturing technology [2], the change of wood filler [3].

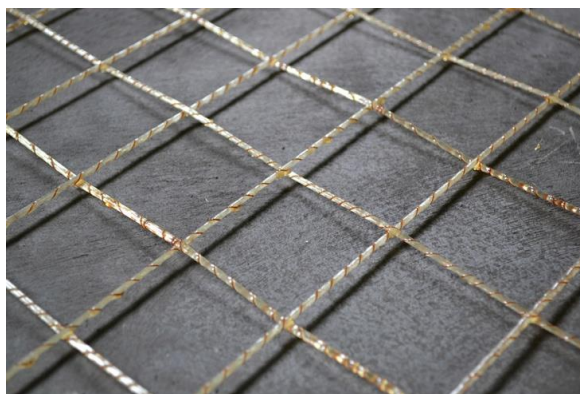
This research allowed to find out that structure of the material is one of the main

factors, which affect the CBPB strength.

The durability of CBPB is provided by a unique three - layer structure. Panels are made of two layers of fine wood particles on the external sides and a layer of larger particles inside [4]. However, this multi-layered structure ensures good tensile and compression strength.

The reinforcement of CBPB with composite fitting will help to create a bending resistant material. Composite fitting is not an additive in the composition of the investigated material, so it will not enter into the reaction in the process of hardening. Composite fitting will be placed in the CBPB in the form of reinforcing mesh. The pitch and diameter of reinforcement are determined by the result of calculations. Correct compound of CBPB with composite fitting and properly created bond between them will decrease the deformability of the material. If the reinforcing area is too large, it will lead to lower strength characteristics.

In the method of reinforcement, it is important how CBPB transfers stress to composite fitting. If this transfer is carried out without energy loss, the overall strength of the material will be high.



*Fig 1. The composite mesh*

## **Conclusion**

On the basis of theoretical overview, we have investigated the properties of the CBPB and previously studied ways of reducing deformations. It was revealed that a significant influence on the effectiveness of the reinforcement is provided by the geometry of the fitting and its location.

The application of this method in practice will make easier the process of installation the CBPB and reduce the spoilage during transportation. Also if the material has a good bending strength, it can be used in different new ways.

## **References**

1. S.S.Ivanchev, Ozerin A.N. Nanostruktur v polimernykh sistemakh [Nanostructures in Polymer Systems]//Nauka o polimerah [Polymer science], 2006, Vol. 8, Issue 8, 213-225pp. (Rus)
2. Meloni T. Sovremennoe proizvodstvo drevesnostruzhechnykh i drevesnovoloknistykh plit [Modern production of particleboards and wood boards]. M., Lesnaja promyshlennost', 1982. 416 p. (Rus)
3. Pozdnjakov A.A. Prochnost' i uprugost' kompozicionnykh drevesnykh materialov.[Strength and elasticity of wood composite materials]. M., Lesn.prom-st',1988. - 133 p. (Rus)
4. Mel'nikova L.V. Tekhnologija kompozicionnykh materialov iz drevesiny. [Technology of wood composite materials], 2-e izd. M., MGUL, 2004. 234 p. (Rus)

## СНИЖЕНИЕ ДЕФОРМАЦИЙ ЦЕМЕНТНО-СТРУЖЕЧНОЙ ПЛИТЫ ПУТЕМ АРМИРОВАНИЯ КОМПОЗИТНОЙ АРМАТУРОЙ

**А.В. Дячкина, Т.М. Плужникова**

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: dyachkina-nastya@mail.ru*

**Аннотация:** Разработан способ уменьшения деформации цементно-стружечных плит (ЦСП) на основе исследования основных факторов, оказывающих влияние на физико-механические свойства ЦСП. Цель работы достигается с учетом принципа повышения ЦСП композитной арматуры. Предполагается, что армирование ЦСП способно повысить его прочность и эффективно укрепить строительную конструкцию. Этот метод имеет важное практическое значение, поскольку увеличивает область применения, где ЦСП может быть использовано, а также его эксплуатационные характеристики.

**Ключевые слова:** армирование, деформация, композитная арматура, цементно-стружечная плита (ЦСП)

---

УДК 69.032.22=111

H702.3

ББК И – 197

## SYSTEM OF COMPOSITE FLOORINGS FOR HIGH – RISE BUILDINGS

**N. S. Ivankova, N. V. Belyaev**

Tambov State Technical University, Tambov, Russia

*e-mail: ivankova.natalija2011@yandex.ru*

**Abstract:** In this article designs of floorings of high-rise buildings are reviewed and studied. The high safety of load-bearing elements in high-rise buildings demands such constructive solutions which meet the increased requirements of strength, rigidity, fire resistance, low level of dead load. Thus designs of floorings should have high economic parametres: a small building height and specific materials consumption, fabricability aimed at domestic building experience.

**Keywords:** composite, facture strength, flooring, high-rise buildings, monolithic house building, steel sheet reinforcement.

### Introduction

In this article, we have studied the system of floorings of high-rise buildings. A system of composite floorings, meeting all requirements of high-rise buildings has been developed for the construction of high-rise buildings nowadays. This system

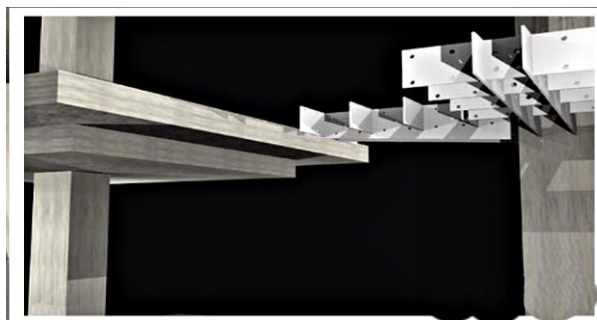
uses developments of Reinforced Concrete Research Institute which were made under the guidance of professor I. G. Ljudkovskoy.

### **The modern system of flooring.**

The basic element of the system is steel sheet reinforcement which carries out the following functions: it completely takes a lateral force; due to apertures in sheets they act like templates for building a reinforcement core; in the frame junctions area sheet reinforcement creates an «effect of a clip», thanks to the restriction of concrete deformations; the sheet reinforcement works like a fixed shuttering; decreasing the weight of a plate due to the installation of light-concrete inserts.

Advantages of the offered system of floorings:

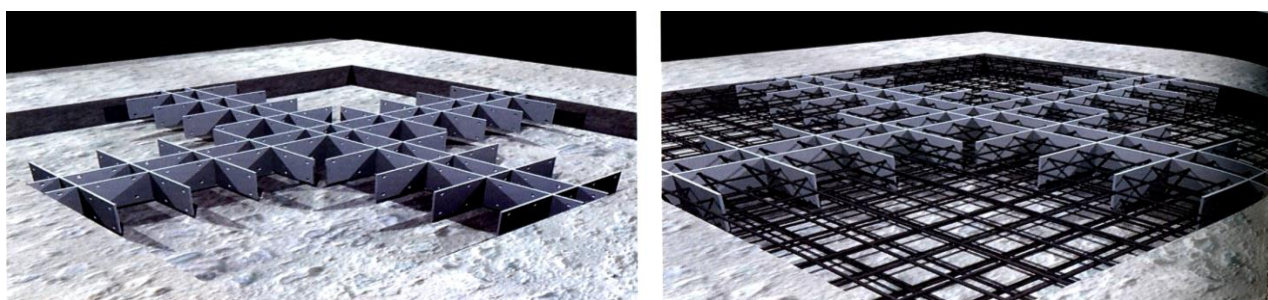
– It excludes destruction of joints. Joints are impossible due to full perception of the lateral force, thus there is a real possibility to decrease the height of flooring and not to use chapters. (Fig. 1).



*Fig. 1. Two schemes of work peculiar for the traditional joint and the joint developed by RCRI.*

– It increases the rigidity of the frame. Due to the installation of sheet reinforcement, there appears the area of increased flexural and shift rigidity, the so-called «collar» working as the rigid stamp. It essentially influences the rigidity and fracture strength of the flooring structure. (Fig. 2a);

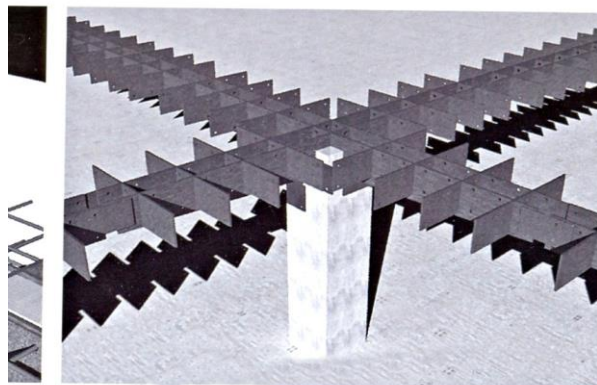
– It increases the quality of reinforcement installation. The high quality of reinforcement installation is attained due to exact cross-sectional positioning of a reinforcement bar. It is especially important in frame joints where the insignificant error in a reinforcement arrangement on sectional height can essentially lower the strength of the section and rigidity of the joint. Steel prefabricated sheets with apertures for the reinforcement bars serve as a pattern for its installation in a final position. (Fig. 2b);



*Fig. 2. Rigid insert in floorings in the «collar» area.*

1. It allows to make separate concreting of the frame joint by special concrete (high-strength polymer concrete, fibrous concrete) [2];

2. The offered system of floorings allows to create a system of hidden girders combined by frame joints which provides the space stability of a framing during the assembling process. (Fig. 3);



*Fig. 3. Installation of a hidden frame – the first stage of building floorings.*

3. A big variety of section layouts configurations and constructive schemes is allowed in steel sheet elements system;

4. It provides reliable work under dynamic loads [3];

5. It allows the construction of flooring with fire-resistance.

### **Conclusion**

The proposed system of flooring completely corresponds the domestic practice of monolithic house-building, and is aimed at V25-V35 concrete. Sheet elements of hidden girders can be produced even by poorly equipped plants, which is confirmed by the experience of their in-situ production.

The instances of the suggested designs made it possible to estimate the expediency of the proposed floorings system:

- Floorings of stylobate part with span up to 18 m, loading – up to 3 tonns. The thickness of flooring on a supporting structure was 500 mm, the size of haunch - 2 m, the thickness of flooring - 250 mm.

- Due to the use of light-concrete inserts, floorings of a standard storey with 12 m span have the resulted thickness of 130 mm.

### **References**

1. Prochnost i deformativnost betona i specialnyh zhelezobetonyh konstrukcij/ pod redakciej I.G. Lyudkovskog [Strength and a deformation property of concrete and special reinforced concrete constructions]. RCRI Gosstroy of the USSR, Moscow, 1972. (Rus);

2. Klimenko F. E. Stalebetonnye konstrukcii s vneshnim polosovym armirovaniem [Steel concrete constructions with external bar reinforcement]. Kiev, 1984 (Rus);

3. Prochnost ehlementov zhelezobetonyh konstrukcij pri odnokratnom dinamicheskom vozdeystvii//noe o prochnosti zhelezobetona/ pod redakciej K.V. Mihajlova [Strength of reinforced concrete constructions' elements at single dynamic impact // *News about the strength of steel concrete*. RCRI Gosstroy of the USSR, Moscow, Stroyizdat, 1977. (Rus).

# СИСТЕМА СТАЛЕЖЕЛЕЗОБЕТОННЫХ ПЕРЕКРЫТИЙ ДЛЯ ВЫСОТНЫХ ЗДАНИЙ

Н. С. Иванкова, Н. В. Беляев

Тамбовский государственный технический университет, Тамбов, Россия

e-mail: ivankova.natalija2011@yandex.ru

**Аннотация:** Рассмотрены и изучены конструкции перекрытий высотных зданий. Высокая степень ответственности несущих элементов каркаса высотных зданий требует таких конструктивных решений, которые отвечают повышенным требованиям прочности, жесткости, огнестойкости, наличия небольшого собственного веса. При этом конструкции перекрытий должны иметь высокие экономические показатели: малую строительную высоту и материалоемкость, технологичность с ориентацией на отечественный опыт строительства.

**Ключевые слова:** высотные здания, монолитное домостроение, перекрытия, сталежелезобетон, стальная листовая арматура, трещиностойкость конструкции.

---

УДК 69(470.326) = 111

ББК Н711 – 09

I - 10

## APPLICATION OF LGSF TECHNOLOGY IN CONSTRUCTION OF BUILDINGS IN THE TAMBOV REGION

I. A. Ivanov, R. A. Markaryan,

Tambov State Technical University, Tambov, Russia

e-mail: ivan.ov-tambov@list.ru

**Abstract:** The article deals with the issues of relocating residents from hazardous and ramshackle buildings, construction of new housing to replace those that have a state of failure. It is proposed to apply the light gauge steel framing technology under the restrictions of the economic crisis. A new cluster of pre-fabricated economy class housing with minimal capital investments allows to build a new cluster of pre-fabricated economy class housing with minimal capital investments. This technology offers an opportunity to reduce the amount of the hazardous and ramshackle housing in Tambov.

**Keywords:** cost-effective construction, hazardous and ramshackle housing, light gauge steel framing technology, pre-fabricated economy class housing.

### Introduction

A state of failure is a category of the technical state of a building or a construction and structure in general that is characterized by damages and deformations indicating the loss of carrying capacity and damage of failure [2].

In accordance with the Regional targeted program on relocation of residents from



hazardous housing situated on the territory of the Tambov region, the total area of the regional housing fund, that does not meet the technical standards of living, is now 747,0 thousand square meters, or 2,8 percent of the whole housing fund [3].

### **Problem analysis and ways of their solution**

The rate of increase of the housing fund in the Tambov region now exceeds that of its liquidation. At the same time, it is the ramshackle buildings with the high percent of the physical deterioration of constructions.

The solution of the above-mentioned problems is impossible only with the use of developed programs aimed at the relocation of people from hazardous and ramshackle buildings; there is a necessity for a new effective solution that will also result in the growth of cost efficiency of construction and the reduction of commissioning time for new housing facilities.

Taking into account all facts mentioned above, there is a proposal to introduce the prospective technology of new housing construction applying LGSF. The rapid speed of buildings construction with the application of this technology is determined by the operational compatibility of their structural elements. Due to the metal structural element having light specific weight, there is no longer any necessity to use heavy-weight deep foundations, that make construction cheaper and reduce the labor intensity of work to a large extent.

The outer walls (panels) are made from thermostructures in which light gauge framing structures are laid, that creates a rigid framework of a light weight, that in its turn allows not to use heavy-payload construction machines. The panels are characterized by the fast assembly, both at the factory and the construction site. Their composition includes mineral wool protected with the vapor-barrier and diffusion sheet from excessive moistening [1].

In addition, the application of the effective heat insulation in the framework made out of perforated profiles allows considerably reducing the cost for the housing maintenance as well as reducing the load on municipal services providing heat.

As for cost effectiveness, the technology is characterized by low cost price. The production cost for 1 square meter of the LGSF-made building depends on its complexity and number of storeys and varies from 16000 to 30000 rubles.

### **Conclusion**

Therefore, with the implementation of this technology in solving problems of hazardous and ramshackle housing in the Tambov region it is possible to significantly ease the situation in the housing sector and contribute to the improvement of residential requirements for the community as a whole and for some families in particular.

### **References**

1. EN 1993-1-3: 2004 Eurocode 3. Design of steel structures. Part 1-3: General rules. Supplementary rules for cold-formed members and sheeting / European Committee for Standardization CEN, Brussels, 2004. 125 p.
2. Zhilishnyiy kodeks Rossiyskoy Federatsii. // SZ Rossiyskaya Federatsiya 2005. № 1 (ch. 1). Izobrazitelnoe iskusstvo 14; 2007.- № 1 (ch. 1). Izobrazitelnoe iskusstvo 13. [Housing Code of the Russian Federation] // SZ the Russian Federation, 2005, Issue 1 (ch. 1), Art. 14; 2007, Issue 1 (ch.

1), Art. 13. (Rus).

3. Polozhenie o priznanii pomescheniya zhilyim pomescheniem, zhilogo pomescheniya neprigodnyim dlya prozhivaniya i mnogokvartirnogo doma avariynym i podlezhashchim snosu ili rekonstruktsii na 28. 01. 2006 №47. [Regulations on the recognition of the premises as residential premises, residential premises which have a state of failure and subject to demolition or reconstruction on 28. 01. 2006 # 47] // SZ the Russian Federation, 2006, Issue 6, Art. 702. (Rus).

## ПРИМЕНЕНИЕ ТЕХНОЛОГИИ ЛСТК В ЖИЛИЩНОМ СТРОИТЕЛЬСТВЕ В ТАМБОВСКОЙ ОБЛАСТИ

**И. А. Иванов, Р. А. Маркарян**

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: ivan.ov-tambov@list.ru*

**Аннотация:** Рассмотрена проблема, касающаяся переселения жителей из аварийного и ветхого жилья, строительства нового жилья на смену домам, которые получили статус аварийного и ветхого. Предлагается использовать строительную технологию из легких стальных тонкостенных конструкций, что в условиях экономического кризиса при минимальных капиталовложениях позволяет массово построить новый кластер быстровозводимого жилья эконом-класса. Данная технология предоставляет возможность снизить уровень аварийного и ветхого жилья в г. Тамбове.

**Ключевые слова:** аварийное и ветхое жилье, быстровозводимое жилье эконом-класса, технология легких стальных тонкостенных конструкций, экономичное строительство.

---

УДК 692.45=111

ББК 38.442

## TO THE PROBLEM OF CONSTRUCTIVE SOLUTION OF THE STEEL GRIDSHELLS

**S.S. Ivanova, S.L. Usnyan**

Tambov State Technical University, Tambov, Russia

*e-mail: Ivanova.Svetlana1@mail.ru*

**Abstract:** Metal cylindrical gridshells are popular and promising structures due to a wide range of applications. However, in the literature it is extremely difficult to find a detailed method of calculation of these structures. The main objective of this article is to analyze the literature focused on the calculation methods of metal gridshells and optimal design of spatial metal structures. The article contains a review of scientific works of Russian and foreign authors on the given subject and the main conclusions based on these works are made.

**Keywords:** cylindrical gridshells, spatial constructions, steel constructions.

### Introduction

Metal cylindrical gridshells for coating industrial buildings, trade and exhibition

halls, as well as for the frames of greenhouses, are quite widely used in construction. However, such arches, compared to flat structures, are not fully utilized. This situation can be explained by the fact, that there are not many scientific works, which help with practical application and calculations of these constructions. There are no works dedicated to the analysis of patterns and structures of gridshells formation, comparison of options with different ratio of lifting height to span from the point of view of their sustainability and techno-economic indicators.

This research aims to present scientific data, that are directly or indirectly associated with the calculation of metal cylindrical gridshells and the optimum-design of spatial metal structures.

### **Literature review**

In the last few decades there has been some theoretical and experimental research in the field of folded arches having a constant thickness between the edges and nodes of the arches, which has been conducted in the USSR and Russia. Theoretical research, which was related to the latticed arches and shells, was mainly conducted by A. G. Trusheva [1], V. S. Eremenko [2], V. A. Ignatyev [3], V. A. Lebedev and L. N. Lobo [4]. In these works, it is noted that the loss of the bearing capacity of mesh design begins with a loss of stability of separate truss elements. But this work does not consider the possible overall shape of the buckling mesh design, as complex spatial systems.

Until to 1950, Popov I. G and a number of the author [5] had conducted theoretical and experimental study to clarify the calculation of net systems in the form of a cover of Foppl. In these vaults under the assumption of spatial joints, calculated forces in the rods differed from the experimental results. It was established, based on the research work of these authors, that the cause of the abrupt change of stresses in the rods of the gridshell, on the assumption of the hinges at the nodes, is basically not the rigidity of the nodes of a flat farm, but stiffness of joints of plane trusses.

Among foreign authors, who studied the problem, are G. Ruhle [6] A. Rothe [7] and J. Brodka and M. Lubanski [8], but the problem is discussed in general and in these works you can find only the classification of shells and bases of calculation.

In the works on engineering, concerning to arches, you can see only approximation static analysis and verification of general stability by using a simplified design scheme in the form of two-hinged arches.

G. I. Pshenichnov in his book [9] presents the theory of thin elastic latticed shells and its application in engineering. The author gives the system of differential equations of equilibrium for elements of a cylindrical shell with diamond and square mesh. Pshenichnov proposes to use the simplified formulas and tables for calculations.

Now, there is a need of developing a more accurate method of static and structural analysis of these arches and checking the various forms of buckling them. It has become possible thanks to the improvement of software systems, intended for the calculation of structures by finite element method.

Over the last decade there has been a lack of experimental studies of gridshells in

Russia. A. N. Rajewski and V. I. Kostenecka presented the results of theoretical and experimental research of coverings of greenhouses in the form of a rod metal folds. In the past it was shown that compressed elements with structural flexibilities to 180 can be used in the frames of the greenhouses.

A number of studies were conducted on the problem of convertible rod and fold systems of modular elements. A transformed system (rod or plate) is a state change associated with a change in the position of individual elements and the system as a whole. The ability of the system to transform the batch status allows you to facilitate the delivery of an entire frame or its part to the place of erection.

It should be noted that there are very few published works, which are dedicated to the optimal design of spatial metal steel structures. Perhaps it is due to the fact that the development of design methods was hampered by the development of computers and mathematical programming methods.

However, the optimal methods of designing the individual elements of spatial structures were considered in detail.

A large number of works are devoted to the searching of the rational type of transverse river section of construction elements [10].

The monograph of Klyachin A. Z. [11] has a great importance for parametric optimization of spatial metal mesh constructions. The author investigated the effect of the structures parameters such as the change of the height of the structure, on the weight of the structure. He analyzed the degree of rationality of the outlines of the structural plates and various types of structural designs.

### **Conclusion**

Thus in this article we have made an attempt to analyze works connected with metal gridshells. However, there is a relatively large amount of works, which are indirectly related to this issue. We want to note that there is a lack of scientific works, which are directly dedicated to the problem. You can only find general descriptions of the structures and abstracts. So there are many problems concerning metal gridshells, which should be investigated.

### **References**

1. Trushchev A.G. Prostranstvennye metallicheskie konstrukcii [Spatial metal construction]. Moscow, Stroyizdat, 1983. 270 p. (Rus)
2. Eremenko V.S. Metody issledovaniya napryazhenno-deformirovannogo sostoyaniya sterzhnevyykh konstrukcij [Methods of stress-strain state of beam structures]. Kiev, Kiev. inzh.-stroit. in-t, 1977. 78 p. (Rus)
3. Ignatyev V.A. Raschet sterzhnevyykh plastinok i obolochek [Calculation of core plates and shells]. Saratov, iz-vo Saratovskogo G.U., 1988. 159 p. (Rus)
4. Lebedev V.A., Lubo L.N. Setchatye obolochki v grazhdanskom stroitelstve na Severe [Retina in civil engineering in the North]. Leningrad, Stroyizdat, 1982. 136 p. (Rus)
5. Popov I.G. Cilindricheskie sterzhnevyye sistemy [Cylindrical rod system]. Moscow, Gosstroyizdat, 1952. 112 p. (Rus)
6. Ruhle G. Prostranstvennye pokrytiya [Spatial coverage]. Moscow, Stroyizdat, 1974. P. 98. (Rus)
7. Rothe A. Statika sterzhnevyykh system [Static rod systems]. Moscow, Stroyizdat, 1974. 509 p. (Rus)
8. Brudka YA., Lubinskij M. Legkie stalnye konstrukcii [Light steel structure]. Moscow, Stroyizdat, 1974. 344 p. (Rus)

9. Pshenichnov G.I. Teoriya tonkih uprugih setchatykh obolochek i plastinok [Theory of thin elastic latticed shells and plates]. Moscow, Nauka, 1982. 352 p. (Rus)
10. Berdichevskiy M.M., Gordeev V.N. O podbore sechenij szhatykh i rastyanu-tykh ehlementov v zadache optimal'nogo proektirovaniya ferm [About the selection of sections and compressed stretch-ies of the elements in the problem of optimum design of trusses]. Moscow, TSNIIPSK, 1972. P. 47-52 (Rus)
11. Klyachin A. Z. O racionalnykh formah sechenij tonkostennykh gnutyykh profilej [Metal lattice spatial structures regular structures]. Ekaterinburg, Diamond, 1994. 276 p. (Rus)

## СОСТОЯНИЕ ВОПРОСА ПО КОНСТРУКТИВНОМУ РЕШЕНИЮ СТАЛЬНЫХ СЕТЧАТЫХ СВОДОВ

С.С. Иванова, С.Л. Уснян

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: Ivanova.Svetlana1@mail.ru*

**Аннотация:** Стальные цилиндрические своды являются распространенными и перспективными конструкциями, нашедшими широкое применение. Однако, в научной литературе крайне сложно найти подробное освещение вопроса расчёта данных конструкций. Целью данной статьи является попытка анализа работ, связанных с расчётом стальных сетчатых сводов и оптимального проектирования пространственных металлических конструкций. По данной теме были рассмотрены публикации русских и зарубежных авторов и сформулированы основные выводы по этим работам.

**Ключевые слова:** пространственные конструкции, стальные конструкции, цилиндрические сетчатые своды

---

УДК 69  
ББК Н42 + У9(2)  
М - 523

## MONITORING PROBLEMS AND TASKS OF WALLING IN PROVIDING ECOLOGICAL PARAMETERS OF RESIDENTIAL BUILDINGS

N. P. Merkusheva

Tambov State Technical University, Tambov, Russia

*e-mail: natasha\_monastyreva@mail.ru*

**Abstract:** A problem of monitoring the parameters of walling which influence the ecology of habitation is considered in the article. Ways of solving the problem are shown.

**Keywords:** monitoring; walling; residential buildings; ecological parameters; building

Ecological parameters of habitation are defined to a large extent by the quality of walling. That's why the fulfillment of requirements imposed to walling in the context of hygiene and ecology is necessary in its designing, building and exploitation. The providing of these requirements is possible under the condition of the presence of the reliable system of the monitoring of walling. Nowadays such monitoring either

doesn't exist or it isn't fulfilled completely from the perspective of providing ecological requirements.

The purpose of monitoring the building envelope at the operation stage is the organization of a permanent or periodic monitoring for changes in the status of protection. At the same time the measurement and evaluation of various indicators of constructions should be carried out, which are the main elements of the building and determine the operational safety of fencing in concordance with various parameters. The examples of such controllable indicators for heat-shielding constructions are the reduced total thermal resistance of fencing, air permeability resistance, water vapor permeability resistance. In some cases, the assessment of change in the moisture content of the insulant, the assessment of change in the layer thermal inertia, etc. may be carried out. As for the sound-insulating constructions, such indicators are the index of isolation of the air noise, the index of the reduced impact noise under the overlapping. [1]

Ongoing monitoring shouldn't be just a fixed quantity of controlled actions, but the analysis of the dynamics of these changes should be also carried out during the entire measurement period. The availability of information on the dynamics of changes makes it possible to obtain reliable information about the causes of the deterioration of monitored indicators and to take the necessary actions on its basis for controlling and completing the elimination of the changes, both at some certain construction facility and at the future constructed facilities.

The negative change of controlled parameters can be individual and peculiar just to some certain construction facility. They may occur, for example, because of blunders of a designer who is designing a certain walling, or due to blunders of builders performing this construction. The result obtained in these cases is important only for the given construction and has a little effect on the overall improvement of the quality of these enclosing structures at other construction facilities.

The shortcomings which negatively influence the future exploitation of the walling may frequently occur because of the systematically happening violations in constructing buildings, such as technical regulations, the requirements of standards of building constructions, recommendations on their organization, on carrying out specific conditions of constructing and so on. [2]

In the construction process it is necessary to provide the control for ensuring the quality of constructed facilities by the monitoring which is carried out in combination with the research-and-technical support of the construction. [3]

In this case, monitoring is the process of:

- systematic and periodic monitoring of the strain-stress state structures, or the deformations of buildings as a whole, the state of soil and groundwater bases in the construction zone;

- the timely capture and evaluation of deviations from the project, the requirements of regulations;

- comparing the results of forecasts of the mutual influence of the construction facility and the environment with the results of observations for the purpose of the operational prevention or the elimination of the identified negative phenomena and

processes.

Nowadays the monitoring of environmental requirements during the construction of buildings is carried out just in isolated cases. There are at least three important reasons to explain this situation.

The first reason is the lack of a regulatory framework and guidance papers allowing to organize this type of monitoring efficiently.

The second reason is the technical difficulties that are caused by deficiency, and sometimes even the complete lack of the necessary instrumentation required for monitoring.

The third reason is connected with the need of creating some specific conditions in the process of monitoring, which artificially recreate the conditions of exploitation of the walling.

The exclusion of these reasons may encourage the organization of environmental monitoring at all stages of the building, create favorable environmental parameters inside the premises and, ultimately, provide a comfortable environment for human life.

Nowadays the system of monitoring the walling is developed not only at the stage of building exploitation, but also at the stage of their construction within the framework of the research of civil buildings' walling technical state SETS "TSTU" - NIISF RAASN. As a result, nowadays the system of evaluating the sound insulation qualities of walling and, in particular, translucent window fillings is proposed. The proposed assessment method is used in TSTU and NIISF of building physics of RAASN.

#### **References:**

1. Diagnostics of constructions. Available from: <http://aprioris.ru/about/blog/diagnostika-stroitelnyh-konstrukcij-metodom-infrakrasnoj-termografii.html>. (Accessed 23 October 2016).
2. Allowance for scientific and technical support and monitoring of the construction of buildings and structures, including large-span, high-rise and unique. MRDS 02-08 Moscow, 2008. Available from: <http://files.stroyinf.ru/Data1/53/53995>. (Accessed 23 October 2016).
3. Pat. 2285915 Russian Federation. A method of controlling heat-shielding properties of the walling. Available from: <http://www.freepatent.ru/patents/2285915>. (Accessed 24 October 2016).

## **ПРОБЛЕМЫ И ЗАДАЧИ МОНИТОРИНГА ОГРАЖДАЮЩИХ КОНСТРУКЦИЙ ПРИ ОБЕСПЕЧЕНИИ ЭКОЛОГИЧЕСКИХ ПАРАМЕТРОВ ЖИЛЫХ ЗДАНИЙ**

**Н. П. Меркушева**

Тамбовский государственный технический университет, Тамбов, Россия,

*e-mail: natasha\_monastyreva@mail.ru*

**Аннотация:** Рассмотрена проблема мониторинга параметров ограждающих конструкций оказывающих влияние на экологию жилья. Показаны пути решения проблемы.

**Ключевые слова:** мониторинг, ограждающие конструкции, экологические параметры, жилые здания

## WOOD CONCRETE AS AN ENVIRONMENTALLY FRIENDLY AND ENERGY-EFFICIENT BUILDING MATERIAL

**N. O. Novikova, V. P. Yartsev**

Tambov State Technical University, Tambov, Russia

*e-mail: nota-93@mail.ru*

**Abstract:** *The building material wood concrete, its advantages and disadvantages are considered in the article. Wood concrete successfully combines the best traditions and innovative technologies. As the combination of wood and high-grade concrete provides reliability and durability of any construction built with its use. The use of wood concrete will reduce construction costs. This material is very practical but it is not widely used. We have tried to analyze the main characteristics of this material and prove that it is an environmentally friendly and energy-efficient building material.*

**Keywords:** *building material, energy efficiency, green building, wood concrete.*

### **Introduction**

Currently, such concepts as green building and energy efficiency of buildings, which increase the production of environmentally friendly building materials and constructions made of them are gaining in popularity in our country.

The results of public opinion polls show that more than half of the population of our country would like to improve their living conditions. [1] However, because of the high cost of construction of modern houses and flats not many people can afford do buy then. The cost of residential buildings construction can be reduced considerably by using more fuel-efficient building materials. The use of a material such as wood concrete will reduce construction costs.

### **2. Analysis of wood concrete properties**

Wood concrete is a lightweight concrete macroporous structure, which is a result of the mixture of organic cellulose filler, mineral binder, water, and chemical additives. [2]

The production of wood concrete has been known for more than half a century, but with the collapse of the USSR it was forgotten. Today, it is beginning to return to the building market.

There are two types of wood concrete:

- Structural wood concrete. It is used for the construction of load-bearing structures of the building or interior walls.
- Thermal insulating wood concrete. It is used for thermal, acoustic and noise insulation.

The difference of wood concrete from other building materials is shown in Table 1. [3]



Table 1 – The difference of wood concrete from other similar materials.

Material	Density, kg/m <sup>3</sup>	Thermal conductivity, W/(m×°C)	Frost resistance, cycles	Compressive strength, MPa
Wood concrete	400-850	0.08-0.17	25-50	0.5-2.5
Ceramic brick	1550-1700	0.6-0.95	25	2.5-25
Lime brick	1700-1950	0.85-1.15	25	5-30
Expanded clay lightweight concrete	900-1200	0.5-0.7	25	3.5-7.5
Aerated concrete	600-800	0.18-0.28	35	2.5-15
Foam concrete	200-1200	0.14-0.38	35	2.5-7.5
Wood	450-600	0.15	-	1.5-4

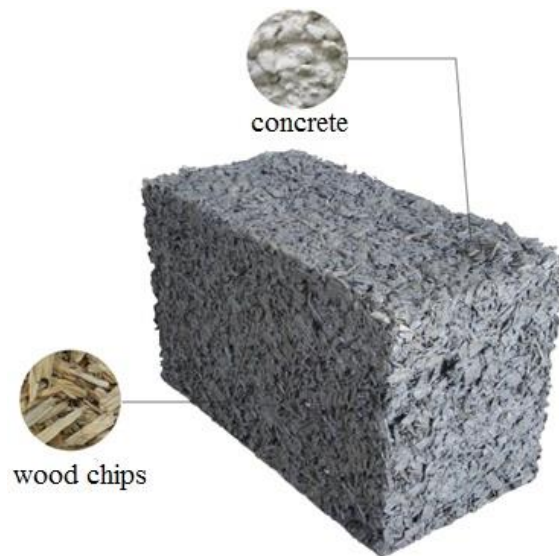
The wood concrete-based construction is currently relevant because it performs several functions:

- it is one of the most economical materials in the production and operation;
- the material which has a low thermal conductivity, high specific heat, which makes it one of the most energy-efficient materials;
- the wood-concrete blocks are convenient to carry and stack, which allow you to work without the use of construction machinery, as a result it greatly reduces the construction time;
- it is light (it is easy to drill and cut it);
- the low specific gravity allows to erect light walls, therefore, a massive foundation isn't needed;
- the wood-concrete block has a rough surface, which gives a better grip on the raster;
- environmentally safe because it does not emit harmful substances during operation;
- permeable (wood concrete absorbs evaporation);
- it is flame-resistant (flammability group – G1; group flammability – B1; smoke-forming ability – D1);
- it has a unique plasticity, which gives it resistance to compressive loads. Upon reaching the limit load of compression wood concrete continues to compress by more than 10%. Then the compression is not so intense, and when the load increases by about 180% of the estimated one, the material is destroyed gently without causing chipping and crumbling. This is explained by the fact that it has a lot of wood components (80% is made up of wood chips) in its composition, which greatly improves the elasticity;
- wood-concrete blocks provide a good sound insulation;
- it is biologically resistant (group 5).

The disadvantages of wood concrete are as follows:

- high moisture permeability (the use of plasters solves this problem);
- wood concrete appearance;

- the high cost of wood-concrete blocks due to the lack of automation of production processes, the degree of elaboration of technology and modest production volumes. [4]



*Fig. 1 – wood concrete block*

Fig.1 shows the wood concrete block.

### **Conclusion**

The application of wood concrete in low-rise construction has many advantages. It is superior to similar construction materials according to techno-economic and operational indicators. Its main advantage is cost savings, both during the construction of the house, and during its operation. [5]

The main advantages of using wood concrete include: low thermal conductivity and high heat capacity; soundproofing; fire-resistance; eco-friendliness; vapor permeability, biological stability. Considering the strength characteristics of the material in compression, there is a possibility of wood-concrete use in buildings in seismic zones.

### **References**

1. Rynok zhil'ya: pokupka i arenda [A housing market: purchase and rent]. Available from: <https://wciom.ru/index.php?id=236&uid=115954>.
2. Nanazashvili I.H. Arbolit – jeffektivnyj stroitel'nyj material [Wood concrete is an efficient building material]. Moscow, Strojizdat Publ., 1984. 121 p. (Rus)
3. Chto takoe arbolit? [What is wood concrete?]. Available from: <http://arbolit-blok.ru/2010/07/chto-takoe-arbolit/>.
4. Arbolitovye bloki – nedostatki, dostoinstva i harakteristiki [Disadvantages, advantages and characteristics of wood concrete blocks]. Available from: <http://srbu.ru/stroitelnye-materialy/223-arbolitovye-bloki-nedostatki-dostoinstva-i-kharakteristiki.html#a10>.
5. Stroim jekologicheski chistyj dom [We build an environmentally friendly house]. Available from: <http://www.arbolit.net/stroim-ekologicheski-chistyj-dom.html>.

# АРБОЛИТ КАК ЭКОЛОГИЧНЫЙ И ЭНЕРГОЭФФЕКТИВНЫЙ СТРОИТЕЛЬНЫЙ МАТЕРИАЛ

Н. О. Новикова, В. П. Ярцев

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: nota-93@mail.ru*

**Аннотация:** Рассмотрен строительный материал арболит, его достоинства и недостатки. Арболит удачно воплощает в себе лучшие традиции и инновационные технологии. Сочетание дерева и высокосортного бетона дают уверенность в надёжности и долговечности любой конструкции, построенной с его использованием. Применение такого материала как арболит позволит снизить стоимость строительства. Этот материал очень практичен, но не пользуется должным вниманием. Попытались проанализировать основные характеристики этого материала и доказать, что он является экологичным и энергоэффективным строительным материалом.

**Ключевые слова:** арболит, строительный материал, экостроительство, энергоэффективность.

---

УДК 69=111

ББК Н 54

О - 17

## EXPERIMENTAL STUDIES OF THE SPATIAL SHEET METAL STRUCTURES

A. Yu. Obukhova

Tambov State Technical University, Tambov, Russia

*e-mail: anna.obuhova94@list.ru*

**Abstract:** Spatial structures are used practically in all sectors of economy and construction, for example in shipbuilding, bridge building and in a variety of industrial and civil objects, including the construction of unique buildings. Spatial structures have creative bases allowing you to diversify the city architecture.

**Key words:** cladding design, experimental studies, production, spatial structures, spatial design.

The purpose of the research is to learn more about spatial structures, their advantages and disadvantages, areas of use and the application in construction. Spatial structures are effective and they should be used in large-scale designs. The possibilities of changing the shape of spatial structures are virtually unlimited. Scientists have a great experience in using spatial structures.

There are three main methods of determining the critical state of spatial plates:

- static method, consisting in the analysis of perturbed equilibrium forms;
- energy method, present to the study of energy integrals;
- dynamic method, present to study the perturbed motion system.

The upper and lower critical loads are taken into account in calculating construction.

The calculations should take into account the effect of the initial distortion known as the shape of the construction.

The equilibrium equations are of the form:

$$D \nabla^4 w + \nabla_k^2 \phi - q = 0;$$

$$\frac{1}{Eh} \nabla^4 \phi - \nabla_k^2 w = 0.$$

$$\nabla^4 = \frac{\partial^4}{\partial \alpha^4} + 2 \frac{\partial^4}{\partial \alpha^2 \partial \beta^2} + \frac{\partial^4}{\partial \beta^4}; \nabla_k^2 = \frac{\partial}{\partial \alpha} (k_2 \frac{\partial}{\partial \alpha}) + \frac{\partial}{\partial \beta} (k_1 \frac{\partial}{\partial \beta});$$

$w$  - deflection of the shell;  $\phi$  - stress function;  $k_1$  and  $k_2$  - the curvature surface of the shell in the direction of coordinate lines,  $\alpha$  and  $\beta$  respectively;  $h$  - coating thickness;  $q$  - in stability problems represented by a fictitious lateral load equal to the sum of the projections of moment-free effort  $N_\alpha, N_\beta$  and  $S$  the direction normal to the curved surface of the shell:

$$q = -(N_\alpha x_1 + N_\beta x_2 + 2S\chi);$$

$x_1, x_2$  the changes of the curvatures along  $\alpha$  and  $\beta$  respectively,  $\chi$  - the change in the curvature of torsion.

The experiments were aimed at:

- identification and analysis effort, strain and stress in the basic elements of the coating under various schemes of loading;
- investigation of the dependence of VAT compliance and tightening the reference circuit;
- study of the effect of pre-membrane voltage in the coating operation.

Theoretical studies in the form of pre-stressed shell gipar carried out on the basis of the nonlinear theory of moment-free shallow shells with the initial efforts of pre-stressing.

Experimental studies of membrane coating in the form of gipar carried out on a large scale model of the coating with a side of 4660 mm, boom slack mm. Steel reference circuit was in the form of a through construction. The shell was made of aluminum sheets of 1.5 mm thick. The package of plates and aluminum sheet were attached to the reference contour tensioning bolts. Connection plates of 780 mm in a continuous spatial membrane were produced by spot welding (with plug) consumable electrode.

This Olympic indoor stadium with a ratio of the principal axes of 1: 1.2, the relative sag coating (1/15 ... 1/18) for the small and large diameters. Scale models 1: 600. Tests were carried out at an average flow  $V_{cp} = 28,35$  m / s speed, the Reynolds number  $Re = 70,5 \cdot 10^4$ .

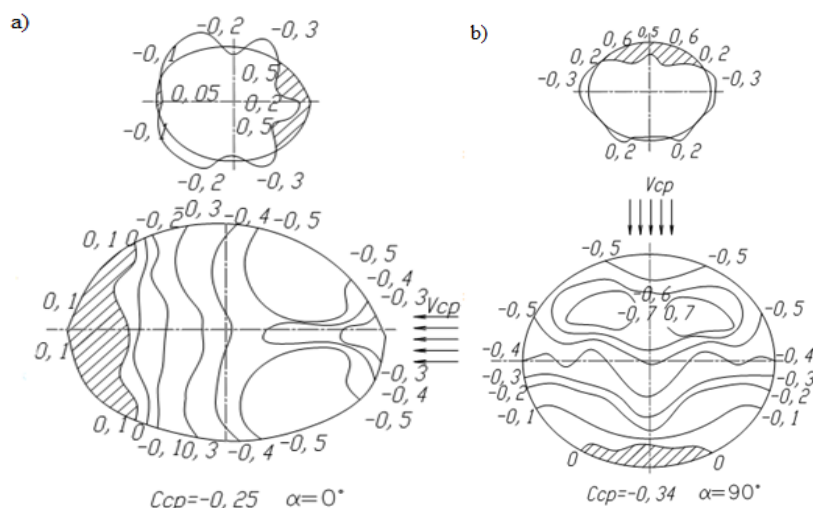


Fig. 1 Lines of equal pressure on the cover of the indoor stadium:  $\alpha$  (degrees): a - 0, b – 90.

The results of experiments determined deflection diagrams, longitudinal forces and bending moments, normal stresses, education zones and folds for different voltage circuits and load levels.

#### References

1. Bezukhov N.CH. Uchebnoe posobie. Zadachi i primery soprotivleniya i dinamiki sooruzheniy. [Study guide. Resistance and dynamics constructions examples and tasks] / N. CH. Bezukhov, O.V. Luzhin, N.V. Kolchunov. M., high school, 1987. 264 p. (Rus).
2. Yeremeyev P.G. Nauchnaya publikatsiya. Prostranstvennye stal'nye metallicheskie konstruksii. [Scientific publication. Spatial steel metal constructions] / P.G. Yeremeyev. M., ACB, 2006.560 p. (Rus).

## ЭКСПЕРИМЕНТАЛЬНЫЕ ИССЛЕДОВАНИЯ ПРОСТРАНСТВЕННЫХ ТОНКОЛИСТОВЫХ МЕТАЛЛИЧЕСКИХ КОНСТРУКЦИЙ ПОКРЫТИЯ

А.Ю. Обухова

Тамбовский государственный технический университет, Тамбов, Россия

e-mail:anna.obuhova94@list.ru

**Аннотация:** Данные конструкции применяются практически во всех отраслях хозяйственной деятельности, таких как судостроение, мостостроение, а также в строительстве разнообразных промышленных и гражданских объектов и уникальных зданий. Пространственные конструкции дают простор для творческой фантазии, позволяют разнообразить архитектурный облик города.

**Ключевые слова:** конструкции оболочки, пространственные конструкции, строительство, экспериментальные исследования.

## REINFORCEMENT OF ASPHALT CONCRETE PAVEMENT WITH GEOMATERIAL

**D. E. Popov, P. S. Chernyakov**

Tambov State Technical University, Tambov, Russia

*e-mail: 364691@rambler.ru*

**Abstract:** *The article focuses on the appropriateness of using geosynthetic materials to reinforce asphalt coatings, depending on road-and-climatic zone. An increase in reserve maintenance periods of asphalt concrete pavement is examined.*

**Keywords:** *geomaterial, professional context, reinforcement of asphalt concrete, road-and-climatic zone.*

### **Introduction**

Asphalt coatings are capable of maintaining high strength characteristics for a long time. However, over time, road evenness and continuity are exhausted under impact of high loads. To increase the strength and extend the service life of asphalt coatings different methods are used. One of the most common methods is the reinforcement of asphalt layers by geosynthetic materials. The result of the study reveals that from among all the different variants geomaterial is the most practical and reliable one.

### **Scheme of reinforcement asphalt coating**

During experiments it was found that when laying geogrid, attention is paid not only to the strength characteristics of the material, but also how it has to be laid depending on the type of repair works and climatic conditions. According to this, there are 5 road-and-climatic zones (RCZ).

When working RCZ in I and II, continuous reinforcement is more effective. For overhaul and cement concrete pavements repair in I RCZ a combined reinforcement pattern with additional laying of reinforcing bars above the transverse and longitudinal seams between the plates can be used (figure 1,2,3)..When selecting a precinct reinforcement pattern the operating experience of asphalt concrete pavement reinforced by this pattern that showed positive results in areas with relatively mild climate should be taken into account [1]. This pattern is not recommended for use in RCZ I and II as after a harsh winter the cracks on the pavement are often formed next to the reinforcing bars.

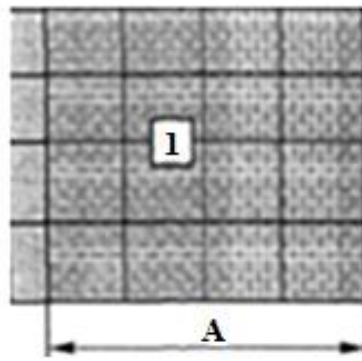


Fig. 1 - Scheme of laying geogrid: A - continuous; 1 - geogrid fabric.

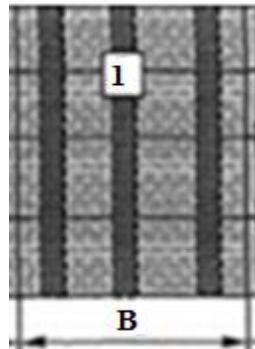


Fig. 2 - Scheme of laying geogrid: B - precinct; 1 - geogrid strip;

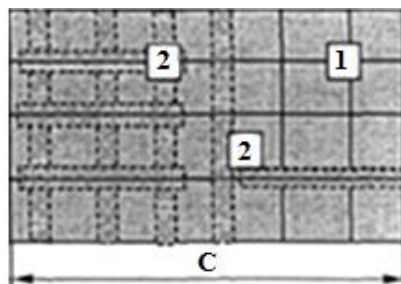


Fig. 3 - Scheme of laying geogrid: C - combined; 1 - "old" cover with seams (cracks); 2 - geogrid strip;

In these cases taking into account a constructive and technological decision on reducing the thickness of the asphalt concrete pavement due to its reinforcement by GM overhaul and pavements repair timing is accepted without change and is defined according to 2. Without reducing the thickness of the asphalt concrete pavement overhaul and pavements repair timing provided for in case 2 should be increased (extension of the timing is not provided for the precinct pattern of GM laying). A longer service life is justified by a slowdown in crack formation, rutting and potholes formation in the reinforced coating, which in turn helps to preserve the evenness of the coating and its distribution capacity.

### Conclusion

Reinforcement of asphalt concrete pavement under the schemes in Fig.1,2,3 promotes redistribution of tensile stresses and prevents excessive horizontal deformation due to the long-term temperature effects, and the impact of multiple vehicles. At present, studies on the cyclic loading of asphalt concrete at positive

and negative temperatures, the effectiveness of the reinforcement in conducting overhaul and reconstructions of the pavement and subgrade are being carried out.

### References

1. ODM 218.5.001\_2009. Metodicheskie rekomendacii po primeneniyu geosetok i ploskih georeshetok dlya armirovaniya asfaltobetonnih sloev usovershenstvovannih vidov pokritii pri kapitalnom remonte i remonte avtomobilnih dorog. [ODM 218.5.001-2009. Methodical recommendations about application of geogrids and flat geogrid for reinforcement of asphalt layers of advanced coatings for repair and maintenance of car roads] / Federalnoe dorojnoe agentstvo \_Rosavtodor. M., 2010. 85 p. (Rus).

2. ODN 218.046\_01. Proektirovanie nejestkih dorojnih odejd. [ODN 218.046-01. Designing of nonrigid road clothes] / Gos. slujba dor. Hoz. Ministerstva transporta RF. M.,Transport,2001. 145 p. (Rus).

## АРМИРОВАНИЕ АСФАЛЬТОБЕТОННЫХ ПОКРЫТИЙ ГЕОМАТЕРИАЛОМ

**Д.Е. Попов, П.С. Черняков**

Тамбовский государственный технический университет, Тамбов, Россия  
*e-mail: 364691@rambler.ru*

***Аннотация:** В статье рассматривается целесообразность применения геосинтетических материалов для усиления асфальтобетонных покрытий, в зависимости от дорожно-климатической зоны. Рассматривается увеличение межремонтных сроков асфальтобетонного покрытия.*

***Ключевые слова:** геоматериал, армирование асфальтобетона, дорожно-климатическая зона, профессиональный контекст.*

---

УДК 1418  
ББК 38

## ENERGY EFFICIENCY IN CONSTRUCTION

**E.O. Sergeev**

Tambov State Technical University, Tambov, Russia  
*e-mail: jogabon95@mail.ru*

***Abstract:** Energy efficiency in construction is particularly relevant now, as all renewable resources of the planet and many minerals used in power generation for homes can dry forever in the near future. Also great prices for utility services inhibit the ability of many people to ensure themselves a normal life, as many spend most of their salary to pay for these services.*

***Keywords:** energy efficiency, energy conservation, resource conservation.*

Natural sources producing thermal energy for the last century are organic and natural mineral materials: oil, gas and coal. These materials are a strategic factor,



as their reserves are gradually being depleted. In our country, 40% of the produced energy is consumed for heating civil and industrial buildings. The most important condition for reducing this figure is to reduce heat loss through the building wall structures during their operation in different geographical areas of the country. At the moment, priority is given to improve the properties of building structures, to increase resource and energy savings both in construction and in operation. Due to the necessity of correct consumption of fuel and energy resources, demands for thermal resistance barriers increase.

You can select different ways to improve the thermal resistance of modern wall materials:

- the use of macroporous concrete (drywall);
- reducing the density fillers used for making wall blocks and panels;
- the use of multi-layer fencing structures, including structural and thermal protection layers;
- increase in the thickness of the fence (although this leads to an increase of material consumption);
- porization light concrete mixture (requires an air-entraining additives);
- use as a filler effective materials (polystyrene, perlite)

All of these methods are used in the modern construction industry, which requires the creation of new high-strength and lightweight building components and structures. Production of these products and structures is directly related to the use of new lightweight materials and development of their structure, based on the increased requirements for heat-shielding properties enclosing structures.

The main advantages of thermal insulation enclosing wall construction method of spraying polyurethane foam is:

- lightweight insulation
- the lack of joints (cracks),
- the absence of cold bridges,
- long service life up to 50 years,
- turnaround time is 10-15 times faster.

Cost-effectiveness of increasing the thermal protection of protecting designs is determined by comparing the non-recurring costs and operating costs for the building envelope with a high level of thermal protection in comparison with the basic design. Reducing operating costs is obtained by reducing heat loss through the building envelope. Additional non-recurring costs are determined by the cost of the heat-insulating facade or installing a window unit. Calculation of economic efficiency is based on the provisions of the "Guidelines on the assessment of investment projects", Moscow, 2000 (approved by the Ministry of Economic Development, Ministry of Finance of the Russian Federation, the Russian State Construction Committee), SNIP 23-02-2003 "Thermal protection of buildings"

- improving the thermal protection of external walls by the device mounted facade system with ventilated air layer;
- improving the thermal protection of windows;
- increase the resistance to air permeability of window units;



The payback period of such energy-efficient implementations is around 20-30 years.

Thermal energy saving in the implementation of energy saving measures reached by the considered houses typical series by an average of 41%, including:

- 25% - by increasing the thermal protection of exterior walls and attic floors in cold attics;
- 10% - by increasing the thermal protection of windows;
- 6% - by reducing the excess air in the apartments;

Energy saving building heating leads to a reduction in carbon emissions in the atmosphere as carbon dioxide.

With a decrease in the air-conditioning energy consumption of buildings as a result of the introduction of these measures comes the release of power-generating facilities. This allows the power consumption of new buildings without the expense of commissioning of new capacities. The latter circumstance significantly affects the decrease of the payback period.

**References:**

1. Dmitriev A.N., Kovalev I.N., Tabunschikov Y.A., Shilkin N.V. Rukovodstvo po otsenke ekonomicheskoy effektivnosti investitsiy v energosberegayushchie meropriyatiya [Guide to

- assess the economic efficiency of investments in energy saving measures]. M., Avoca PRESS 2005.(Rus).
2. Livchak V.I., Tabunschikov Y.A, Ekspress-energoaudit teplopotrebleniya zhilykh zdaniy: osobennosti provedeniya // Energoberezhenie [Express energy audit of heat residential buildings: Energy saving features // Energy savings]. 2009, Issue 2. (Rus).
  3. SNIP 23-02-2003. Teplovaya zashchita zdaniy [Thermal protection of buildings]. (Rus).
  4. Fadeeva G.D., Pyizh E.V., Zheleznyakov L.A. Metody povysheniya energoeffektivnosti zdaniy [Methods to improve energy efficiency of buildings] // *Molodoy uchenyy* [Young scientist]. 2014, Issue 2. P. 214-216. (Rus).

## ЭНЕРГОЭФФЕКТИВНОСТЬ В СТРОИТЕЛЬСТВЕ

**Е.О. Сергеев**

Тамбовский государственный технический университет, Тамбов, Россия  
*e-mail: jogabon95@mail.ru*

***Аннотация:** Энергоэффективность в строительстве особенно актуальна в настоящее время, так как не все ресурсы планеты возобновляемы и в ближайшем будущем многие ископаемые, которые используются в выработке энергии для домов, могут иссякнуть навсегда. Также огромные цены на услуги ЖКХ подавляют способности многих людей в обеспечении себе нормальной жизни, так как многие тратят большую часть от своей зарплаты на оплату этих услуг.*

***Ключевые слова:** ресурсосбережение, энергоэффективность, энергосбережение.*

---

УДК 691  
ББК 38.3

## EXCESSIVE INSULATION OF BUILDINGS AND ITS APPLICATION PROSPECTS

**I.A. Struleva, V.P.Yartsev**

Tambov State Technical University, Tambov, Russia  
*email: irkastrul@gmail.com*

***Abstract:** This article views the possibility of practical application of the excessive heat insulation of enclosing structures and its environmental impact, as well as the possible economic impact of its application. Excessive insulation can reduce energy consumption for heating and air conditioning of facilities. Moreover excessive insulation facilitates project implementation for buildings with "green" technologies such as using of solar energy, wind energy, etc.*

***Keywords:** building industry, economic effect, heat insulation.*

### **Introduction**

In today's economic environment, all participants of the construction process from the customer to the developers seek to reduce their costs and increase profits. Manipulation of the product final value is limited by purchasing power (very low in

the Russian Federation), so more often they go on ways to reduce costs. And if the construction company has sufficient human and technical resources for the optimization of technological processes, the identification of modern high-technology and its critical assessment in order to reduce costs, the customer is often deprived of such an opportunity. Thereby there is a need to popularize modern technologies and materials in the broad masses with the aim of improving the quality of constructed objects, as ultimately it is the customer that determines their basic parameters.

In the contemporary building industry at the cutting edge of science is the development of a number of areas, united by common trends. These include eco-friendly and green building, construction techniques of "smart" homes on active and passive technologies. All of these modern trends of building industry development fit into the global cross-industry trends, designed to decide issues which are common to all mankind. In developed countries, unlike Russia, is a large-scale campaign to promote these areas, including in the construction industry. In Russia recently developed an interest in the issues under consideration [1].

The main constraint of practical application of modern domestic and foreign developments is the lack of awareness of the customer and the number of technical experts of the existence of these technologies, their features and benefits.

### **Methods and materials**

One of the most common methods of achieving the objectives in the implementation of environmental and energy-saving programs in the construction is an excess insulation of inclosing structures. Despite the significant tightening of thermal regulations in Russia at the turn of the millennium, the implementation of the thermal insulation in accordance with current regulations allows only the minimum allowable thermal resistance from the point of view of energy efficiency. Excessive insulation makes it possible to significantly reduce power consumption both for heating and air conditioning at the premises, improve the microclimate and allows to get close to the realization of projects for "smart" technologies using renewable and alternative energy sources. The mass use of this method in addition to the economic benefit of lower maintenance of engineering systems costs can significantly reduce the human impact on the environment.

Measures taken by the Government of the Russian Federation in the field of popularization of such decisions are insufficient and are reduced to the introduction of energy certificates and the development of regulatory documents in that field.

These works, of course, are necessary, but they do not solve the main problem - the customers in Russia are not ready to bear the increased costs for solving environmental problems. It is estimated that losses incurred during the construction phase cannot be compensated and slightly stretched in time benefit from reduced energy costs. Another problem is a lack of adequate information about the possibilities of modern industry available to a wide range of the construction process participants.

*Table 1*

Type of insulation	Thickness of	$Q_h$ , kWh	$q_h$ , kJ/(m <sup>2</sup> ·d °C·days)	$Q_{h,sp}$ , MJ/m <sup>2</sup>	The cost of electricity for
--------------------	--------------	-------------	--	--------------------------------	-----------------------------

material	insulation material, mm				heating, rouble/m <sup>2</sup> · year
Calculation values					
1. Mineral rock wool	150	25,88	211,25	1014	837,56
2. PENOPLEX® 35	100	29,06	237,26	1138,85	940,69
3. PENOPLEX® 35	150	21,75	177,50	852	703,75
4. Non-pressed expanded polystyrene -35	100	37,03	302,26	1450,85	1198,40

Table 1 [2] presents the results of research and energy efficiency of different insulation materials of frame-panel house enclosing structures with a standard (according to building regulations) and with excessive insulation. The calculations used not only insulating properties but the materials and cost of operation and their features in structures, mechanical and physic-chemical characteristics [3,4].

### Results and discussion

Table 1 shows that the selection of different insulation materials (1,2,4) is not equivalent with standard insulation. Use of more expensive materials (2) leads to lower costs and excessive insulation (3) enhances resulting effect. At the present time in Russia they often use mineral wool slabs (1) for the insulation of panel-frame buildings. Replacement of this slabs with more energy-efficient insulator with use of excessive insulation (3) saves 133.81 rubles for 1 square meters per year. Thus, after 10-15 years of service additional investment in the construction associated with the use of more expensive materials, and their excessive installation pays off, and the customer starts to make a profit from the investments made in the form of reduced operating costs for maintenance of the building. Increased operating characteristics [3,4] of used materials (3) make it possible to increase the effectiveness of monetary investments by increasing the interval between maintenance works. Inflationary processes make these investments more attractive.

### Conclusion

If the customer during construction of the object has full information about the possibilities of the modern construction industry, including the benefits of using excessive insulation of enclosing structures in buildings, there will be an increase of the use of modern solutions in construction. On the basis of this analysis it is possible to recommend to use excessive insulation more widely in the construction industry, which will bring economic benefits to the customer and significantly improve the environmental situation in the construction area.

### References

1. Koshkina S.Y., Korchagina O.A., Voronkova E.S. Green building as a major factor in increasing the quality of the environment and human health. Problems of modern science and practice. University named after V.I. Vernadsky, 2013, Vol.47, Issue 3, pp.150-158

2. Yartsev V.P., Mamontov A.A., Strulev S.A. Energy Efficiency Evaluation of enclosing frame-panel designs with a variety of heaters for heating period. Roofing and insulation materials, 2014, Issue 1, pp.26-27

3. Mamontov A.A., Yartsev V.P., Strulev S.A. Humidity analysis of the various insulation materials in enclosing constructions of buildings during operation in the heating. Academia. Architecture and Construction, 2013, Issue 4, pp.117-119

4. Mamontov A.A., Strulev S.A., Yartsev V.P. Influence of the thickness of the plates of extruded polystyrene PENOPLEX on their mechanical properties. Education and science: the current state and prospects of development. Collection of scientific works on the materials of the International scientific-practical conference in 10 volumes, 2013, vol. 6, pp.81-83.

## ИЗБЫТОЧНОЕ УТЕПЛЕНИЕ ЗДАНИЙ И ПЕРСПЕКТИВЫ ЕГО ПРАКТИЧЕСКОГО ПРИМЕНЕНИЯ.

**И.А.Струлева, В.П. Ярцев**

Тамбовский государственный технический университет, Тамбов, Россия

*email: irkastrul@gmail.com*

**Аннотация:** Рассмотрена возможность практического применения избыточного утепления ограждающих конструкций и его влияние на экологию, а также возможный экономический эффект от его применения. Избыточное утепление позволяет снизить энергозатраты на отопление и кондиционирование помещений. Помимо этого, избыточное утепление позволяет реализовать проекты зданий с использованием "зеленых" технологий, таких как использование энергии солнца, ветра и т.д.

**Ключевые слова:** строительная индустрия, утепление, экономический эффект

---

УДК 624.15 = 111

ББК Н 582

S – 94

## THE INFLUENCE OF THE FOUNDATION BASE TILT ON SOIL DEFORMATION

**O. N. Surkova, T. A. Kutsaya**

Tambov State Technical University, Tambov, Russia

*e-mail: surkova-olenka@mail.ru*

**Abstract:** The article focuses on the influence of the foundation base tilt on the soil deformation. The experimental task to study interaction of the sunken foundation and the base under the eccentric and inclined load is set in the article. It also contains the analysis of particular cases in which inclined loads and modified angle of foundation base influence the foundation. Conclusions are made on the base of experimental results.

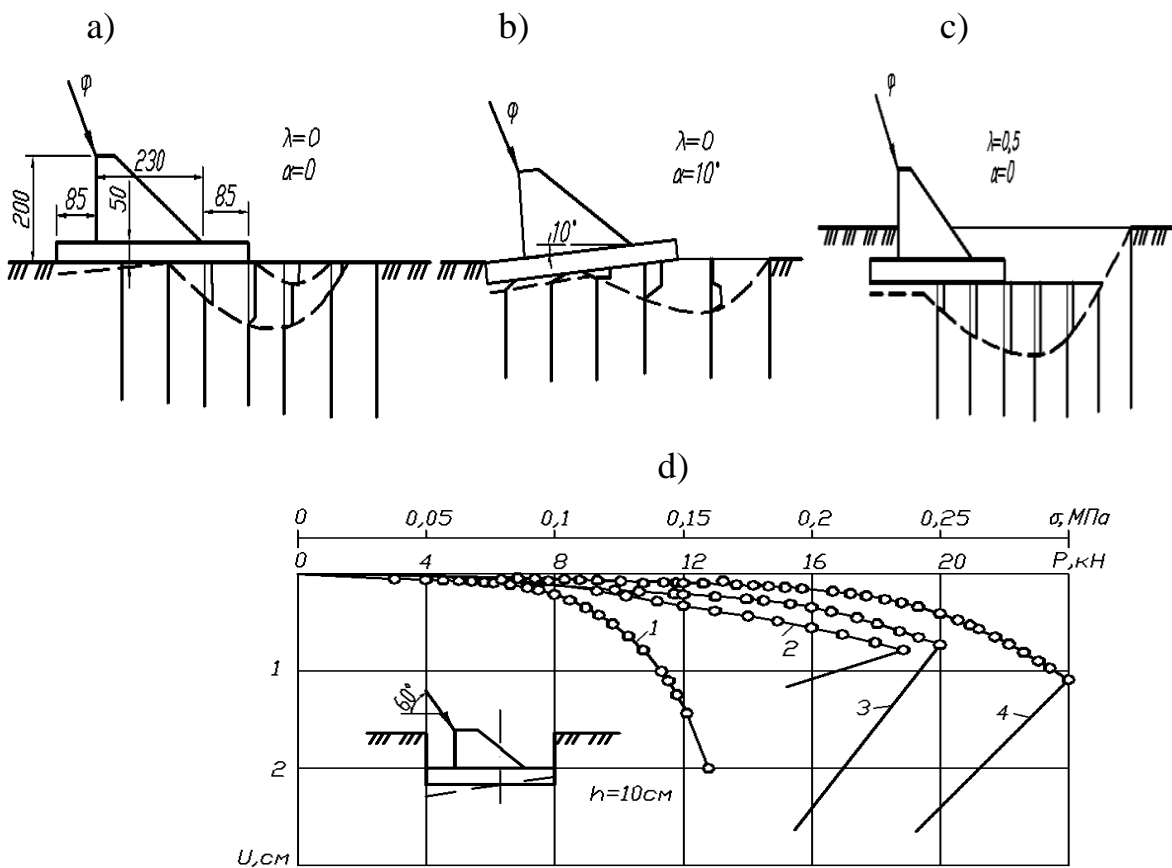
**Keywords:** foundation base, inclined load, soil deformation.

Nowadays there are many cases of base and foundation failure and deformation, which can result in the destruction of the whole building. In many cases, the change

of a tilt angle of foundation base changes natural properties of soils.

The article contains the research of influence of rectangular foundations bases tilt to the horizontal plane and the relative depth of models, load value and the displacement of the base and the foundation. Studying this influence, we made several series of field experiments in which special attention was paid to preservation of natural structure of soil during the process of building foundations. Conducting the experiments, we applied a unified approach to the results of different series of experiments to get a general idea about the interaction of deep foundations and soil at different angles of tilt of model bases.

The angle of load inclination to the horizontal plane  $\beta$  was constant and equal to  $60^\circ$ , and the angle of the model to the horizontal plane  $\delta$  was changing and had the value of  $0, 5, 10$  and  $15^\circ$ . The experiments were carried out with two depressions of the gravity center of the plate:  $h_1 = \ell/2 \operatorname{tg} \lambda$  and  $h_2 = h_1 + \ell/2$  (figure 1). The corresponding relative depth  $\lambda_1 = 0, \lambda_2 = 0,5$ . The averaged limit values of loads are given in table 1



a, b, c – diagrams of models and tracks of sliding surfaces; d – dependence between the horizontal displacements and loads at different angles of models base tilts 1 –  $\delta = 0$ ; 2 –  $\delta = 5^\circ$ ; 3 –  $\delta = 10^\circ$ ; 4 –  $\delta = 15^\circ$

Fig. 1 – Experiment with rectangular foundation models

Table 1 – Averaged limit values of the loads

$\lambda$	Ultimate load (kN) when $\beta = 60^\circ$ and $\alpha$			
	0	5	10	15
1	2	3	4	5
0	10	11.7	15	18
0.5	12.4	18.6	20	22

All experiments show a significant (up to 50 %) drop of load after reaching maximum (peak) value. Let us estimate the influence of a tilt angle of force on the base load-bearing capacity. The extreme load under  $\alpha = 0$  and  $\beta = 60^\circ$  is 4 ( $\lambda = 0$ ) and 8 times ( $\lambda = 0.5$ ) less than this index under  $\alpha = 0$  and  $\beta = 90^\circ$ .

The model settlement in all experiments was not significant and did not exceed 0,5 cm. The limit state was attained at the horizontal movements 1-2 cm and came with continuous structure drift with a certain bank yard. Slide faces were determined by means of a cut of vertical posts of the dyed sand.

The destruction of the base increased the tilt and horizontal displacement. Some cracks coming towards the back edge of the model appeared. The results of the research correlate with the findings represented in [1, 2, 3].

In conclusion, the greater the angle of inclination of the foundation base is, the stronger the destruction of soil is.

### References

1. Sorochan E. A., Druzhinin A. O., Terenetsky L. N. Issledovanie nesushchej sposobnosti osnovaniya fundamentov s naklonnoj podoshvoj [Research of a carrying capacity of foundation of the bases with a sloping base] // Osnovaniya, fundamenty i mekhanika gruntov [Bases, foundation and soil mechanics]. 1980, Issue 1. P. 7. (Rus).
2. Lebeque Y. Pouvoir portant du sol sous une charge incline // Ann de L'Institut Technique du Batiment et des Travaux Publics. Serie Soils et Foundatione. 1972, Issue 88. P. 13. (Rus).
3. Rudnickij N.YA., Malahova K.V. Centrobezhnoe modelirovanie nesushchej sposobnosti nasyshennogo vodoj glinistogo osnovaniya pri naklonnoj nagruzke [Centrifugal model operation of a carrying capacity of the clay basis saturated with water at sloping loading] // Osnovaniya, fundamenty i mekhanika gruntov [Bases, foundation and soil mechanics]. 1978, Issue 4. P. 22. (Rus).

## ВЛИЯНИЕ УГЛА НАКЛОНА ПОДОШВЫ ФУНДАМЕНТА НА ДЕФОРМАЦИИ ГРУНТА

О. Н. Суркова, Т. А. Куцая

Тамбовский государственный технический университет, Тамбов, Россия

e-mail: surkova-olenka@mail.ru

**Аннотация:** Рассматривается влияние угла наклона подошвы фундамента на деформации грунта. Ставилась экспериментальная задача исследовать взаимодействие заглубленного фундамента с основанием при действии внецентренной наклонной нагрузки. Были проанализированы частные случаи при действии наклонной нагрузки и измененного угла наклона подошвы модели фундамента к горизонтали. По итогам экспериментов сделаны выводы.

**Ключевые слова:** деформации грунта, наклонная нагрузка, подошва фундамента



## AVIATION SERVICE IN TAMBOV AND ITS IMPROVEMENT BY REFURBISHING THE AIRPORT BUILDING

N.A. Sheludyakov, M.V. Pronkina

Tambov State Technical University, Tambov, Russia

e-mail: *sheludyakov.na@gmail.com*

**Abstract:** *The flight connection development is the most valuable direction of economic and social evolvement today. The Tambov region is not an exception. The location of Tambov and its population impel the government and investors to find out optimal ways to solve related problems. One of them is insufficient heat transmission resistance of the enclosing structure.*

**Key words:** *airport, calculation of heat transmission resistance, flight connection, pebble-dash plaster, thermal insulation.*

### Introduction

The requirements for the quick and comfortable services, whether it is a visit to the doctor, shopping or a trip to other cities increase with the continuous process of globalization in the world. We have learned to cope with most of these common tasks remotely. Today it is possible to arrange appointment on the Internet, or to browse a list of necessary things in an online store. However, what to do with the services which we cannot receive owing to the lack of conditions for this action.

For example, the trip from our city to another country can take a long time and huge financial expenses. In many respects, it is bound to undeveloped network of air transport in our region. If we turn back to history, we will see that Tambov was connected with 35 settlements by air not long ago but today air traffic is limited to two constant directions (Vnukovo International Airport, Moscow; Pulkovo Airport, Saint Petersburg).

**Problems of the modern airport building. The need for alternative air service.**

Tambov Airport can again become an international one in the next 5 years thanks to the state program "Development of transport system and road economy of the Tambov region for 2014-2020". According to the vice governor, the airport will be able to accept such planes as "Boeing 737" and "Airbus A320". At the same time, the passenger traffic will increase from 20 to 250-400 thousand people per year.

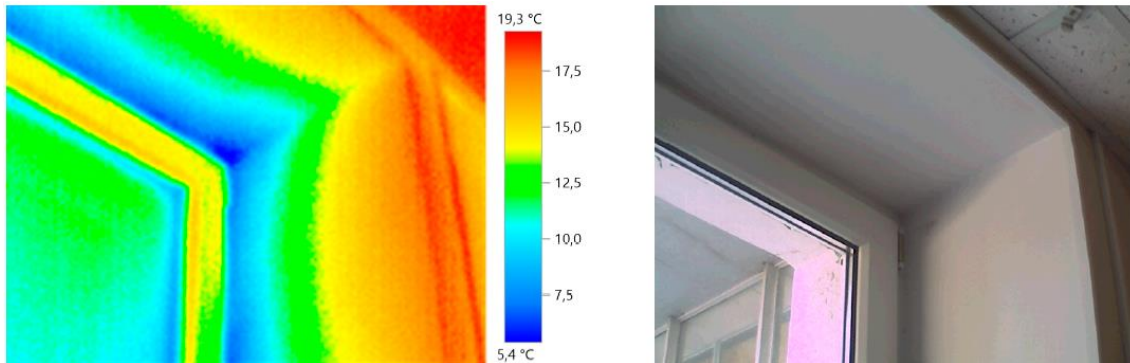
### Thermovision inspection of airport buildings

The airport consists of a group of buildings united by the functional process. The airport building and the maintenance buildings are included into this group. Problems of planning and lack of necessary rooms in this building will be solved on design stages of architectural concepts. However, the second important problem is creation of such a cover of the building, which will allow to minimize thermal losses or to eliminate them at all.

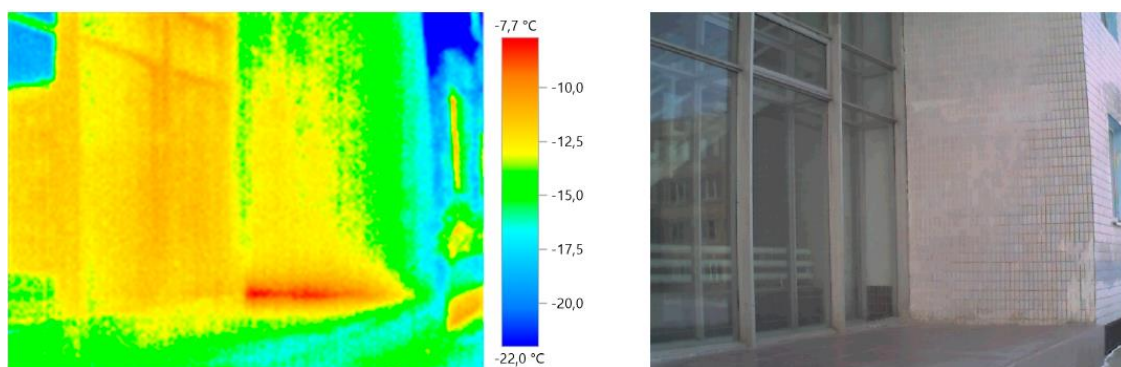
In the modern realities, the group of airport buildings has been considered as an interdependent system of objects influencing each other. The main reason of thermal

losses of the building is continuous window and lack of thermal covering of the protecting designs. However, replacement of inappropriate elements is not enough.

The most important part of thermal research of the building is a thermovision inspection. The specified equipment is necessary for this task. That is why a thermographic camera was taken to explore existing isolation conditions. The result of the thermovision inspection is given below.



*Fig. 2.2.1 - Thermovision inspection. Flanning.*



*Fig. 2.2.2 - Thermovision inspection. Pedestal.*

As we can observe, the greatest heat flow can be noticed under window units, and at the joints of covering walls and covering wall with garret floor.

Overall, it is the main reason of the thermal losses the building. It has been suggested that modern insulation system and materials are necessary for the protection of the negative temperature consequences.

The calculation of the thermal isolation of the coverings was completed to find out optimal solutions for each element. The calculation was made with respect to current Set of Rules 50.13330.2012 – Thermal performance of buildings.

#### **Calculation of thermal insulation of containing walls**

The design of the containing walls is presented in Figure No.2.3.1. TEHNOFAS mineral wool plates are accepted as an insulant.

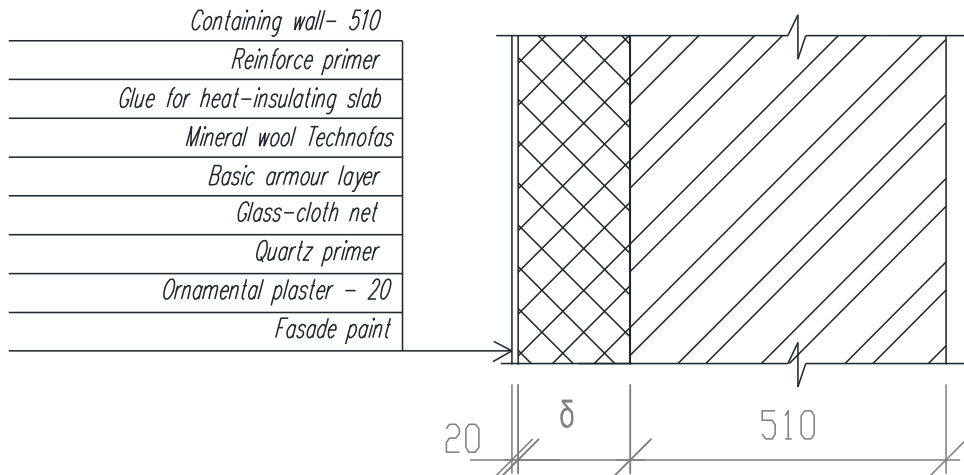


Fig. 2.3.1 - Thermal insulation of the containing walls.

Basic value of the required heat transfer resistance is determined by the formula:

$$R_0^{\text{req}} = a \cdot \text{GSOP} + b, \quad (2.1)$$

where  $a=0,00035$ ,  $b=1,4$  – coefficients are determined by table 3 [5].

GSOP – heating degree-days are determined by the formula:

$$\text{GSOP} = (t_{\text{in}} - t_h) z_h = (22 - (-3,7)) \cdot 201 = 5165,7 \text{ } ^\circ\text{C} \cdot \text{day/year}, \quad (2.2)$$

$$R_0^{\text{req}} = 0,00035 \cdot 5165,7 + 1,4 = 3,208 \text{ (m}^2 \cdot ^\circ\text{C)/W}$$

The normative value of the specified heat transfer resistance of the protecting design:

$$R_0^{\text{norm}} = R_0^{\text{req}} \cdot m_r = 3,208 \cdot 0,63 = 2,03 \text{ (m}^2 \cdot ^\circ\text{C)/W} \quad (2.3)$$

The thickness of an insulant is determined according to the formula:

$$R_0^{\text{rel}} = \frac{1}{\alpha_{\text{in}}} + \sum R_s + \frac{1}{\alpha_{\text{out}}} = R_0^{\text{norm}}, \quad (2.4)$$

where  $R_0^{\text{rel}}$  is conditional heat transfer resistance of the homogeneous part of a fragment of a heat-shielding envelope of the building,  $(\text{m}^2 \cdot ^\circ\text{C)/W}$ ;

$\alpha_{\text{in}}$  is heat-transfer coefficient of an internal surface of the protecting design,  $\text{W}/(\text{m}^2 \cdot ^\circ\text{C})$ ;

$\alpha_{\text{out}}$  is heat-transfer coefficient of an external surface of the protecting design,  $\text{W}/(\text{m}^2 \cdot ^\circ\text{C})$ ;

$\sum R_s$  is the sum of thermal resistance of layers of the homogeneous sites of a design which is determined as

$$\sum R_s = \sum \frac{\delta_i}{\lambda_i}, \quad (2.5)$$

where  $\delta_i$  is thickness of i-layer of the homogeneous site of the protecting design,

$\lambda_i$  is heat conductivity of i-layer of the homogeneous site of the protecting design (application. T [5]).

$$\alpha_{\text{in}} = 8,7 \frac{\text{W}}{\text{m}^2 \cdot ^\circ\text{C}} \text{ (table 4[7])}, \quad \alpha_{\text{out}} = 23 \frac{\text{W}}{\text{m}^2 \cdot ^\circ\text{C}} \text{ (table 4[7])}.$$

$$R_0^{\text{rel}} = \frac{1}{\alpha_{\text{in}}} + \sum \frac{\delta_i}{\lambda_i} + \frac{1}{\alpha_{\text{out}}} = \frac{1}{8,7} + \frac{0,02}{0,7} + \frac{0,51}{0,7} + \frac{\delta_i}{0,038} + \frac{0,02}{0,19} + \frac{1}{23} = 2,03 \text{ (m}^2 \cdot ^\circ\text{C)/W}$$

$$\delta_{\text{insul}} = 0,04 \text{ m.}$$

The heater thickness equal to 0,09 m is accepted.

$$R_0^{\text{rel}} = \frac{1}{8,7} + \frac{0,02}{0,7} + \frac{0,51}{0,7} + \frac{0,09}{0,038} + \frac{0,02}{0,19} + \frac{1}{23} = 3,39 \text{ (m}^2 \cdot \text{°C)/W}$$

$$R_0^{\text{mod}} = 3,39 \cdot 0,63 = 2,13 \text{ (m}^2 \cdot \text{°C)/W}$$

$$R_0^{\text{mod}} = 2,13 \text{ (m}^2 \cdot \text{°C)/W} > R_0^{\text{norm}} = 2,03 \text{ (m}^2 \cdot \text{°C)/W}$$

Let's check a temperature drop between temperature of internal air and temperature of an internal surface of the protecting design. The temperature drop is determined by the formula:

$$\Delta t_0 = \frac{r(t_{\text{in}} - t_{\text{out}})}{R_0^{\text{req}} \alpha_{\text{in}}} = \frac{1 \cdot (22 - (-28))}{3,208 \cdot 8,7} = 1,79 \text{ °C} \quad (2.6)$$

The condition is satisfied as the normative temperature drop  $\Delta t_{\text{in}} = 4,0 \text{ °C}$  for people care facilities between temperature of internal air and temperature of an internal surface of an external wall is provided.

Thus, on the basis of calculation it is established that for providing the condition  $R_0 \geq R_0^{\text{norm}}$  it is necessary to arrange thermal insulation by mineral wool plates with density  $\gamma_0 = 120 \text{ kg/m}^3$  and 90 mm thickness.

### Conclusion

Based on the above statements, it is easy to understand that using pebble-dash plaster as a construction material for the thermal insulation is the most appropriate thermal insulation type for the given purpose. It will allow us create modern view of the building and conform current requirements.

The lack of optimal conditions for targeted flight connections is one of the main problem with air traffic in our region, which gives us a motivation to produce new comfortable and sustainable airport system.

### References

1. Blohin V.I. Osnovy proektirovaniya aeroportov. [The basis of the airport design]. Moscow, Transport, 1985. 208 p. (Rus).
2. Goretskiy L.I., Barzdo V.I., Polosin-Nikitin S.M. Stroitel'stvo aerodromov. [The airfield construction]. Moscow., Transport, 1980. 454 p. (Rus).
3. Goretskiy L.I., Pecherskiy M.A., Romashkov V.M., Samorodov Y.A., Dashevskiy E.M., Pchelkina T.S., Volkov Y.N. Ekspluatatsiya aerodromov. [The airfield maintenance]. Moscow., Transport, 1979. 215 p. (Rus).
4. Glushkov G.I., Trigoni V.E., Mednikov I.A. Izyskaniya i proektirovanie aerodromov: spravochnik. [The exploration and designing of airfields]. Moscow., Transport, 1990. 296 p. (Rus).
5. SP 50.13330.2012 Teplovaya zashchita zdaniy. [Thermal performance of the buildings]. Moscow., Minstroy Rossii, 2012. 139 p. (Rus).
6. SP 131.13330.2012 Stroitel'naya klimatologiya. [Building climatology]. Moscow., Minstroy Rossii, 2015. 124 p. (Rus).
7. The ordinance of Tambov region government № 640. "Ob utverzhdenii gosudarstvennoj programmy "Razvitie transportnoj sistemy i dorozhnogo hozyajstva Tambovskoj oblasti" na 2014-2020 gody". [Development of transport system and road economy of the Tambov region for 2014-2020]. Tambov, 20.06.2013. 68 p. (Rus).

## АВИАСООБЩЕНИЕ ТАМБОВА И ЕГО РАЗВИТИЕ ПУТЕМ РЕКОНСТРУКЦИИ ЗДАНИЯ АЭРОПОРТА

**Н.А. Шелудяков, М.В. Пронкина**

Тамбовский государственный технический университет, Тамбов, Россия.

*e-mail: sheludyakov.na@gmail.com*

***Аннотация:** Развитие воздушного сообщения является одним из важнейших направлений экономического и социального развития на сегодняшний день. Тамбовская область не является исключением. Выгодное географическое расположение, а также заинтересованность населения побуждает как государство, так и иных инвесторов к поиску оптимальных способов решения связанных с этим проблем. Одной из этих проблем является недостаточное сопротивление теплопередаче ограждающих конструкций здания.*

***Ключевые слова:** авиасообщение, аэропорт, опрос, теплоизоляция, «мокрая штукатурка», расчет сопротивления теплопередаче.*

---

УДК 004.942  
ББК 65.237.03

**IDENTIFICATION OF SOLAR FLUX MODEL ONTO A HORIZONTAL SURFACE BY THE EXAMPLE OF TAMBOV**

**A.A. Aristov, I.Yu. Koshelev, M.S. Kuznetsova**  
Tambov State Technical University, Tambov, Russia  
e-mail: lohmatperes@gmail.com

**Abstract:** Engineering design of solar systems of hot water supply starts with obtaining reliable values of the intensity of solar radiation coming onto the surface disposed at an angle to the flow. For the intensity of solar radiation simulation randomly oriented surface it is convenient to use the method of sharing the available reliable experimental data for specific moments in time and computer modeling results for the remainder of the time domain.

**Keywords:** identification; solar flux; solar radiation.

We consider the use of the proposed method for solving the problem of identification of solar radiation onto a horizontal surface model in terms of Tambov (52.430 north latitude). In general terms, the model can be written as

$$\frac{I(t)}{dt} = I_0 K_m \cos \left[ \frac{i(t)}{dt} \right], \tag{1}$$

Where  $I_0$  is the solar energy flux density at the top of the atmosphere to the surface perpendicular to the direction of sunlight (solar constant);  $K_m$  is coefficient taking into account the weakening of the direct solar radiation as it passes through a layer of air mass  $m$ ,  $i$  is the angle of incidence of sunlight on a given surface.

A method of calculating the cosine of the angle of incidence of solar radiation onto an arbitrarily oriented surface is described in detail in a number of publications, for example in [5]. The values of the coefficient of the model (1) were determined by the search, the results obtained by the model were compared with data from the NASA satellites.

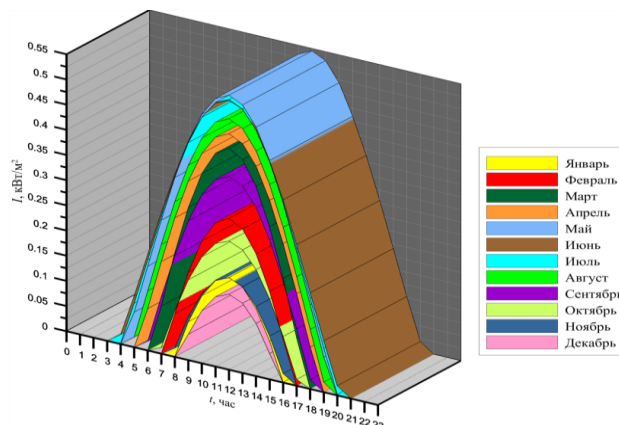


Fig. 1. The hourly average values of solar radiation by month for Tambov

Fig. 1 shows the change of 3D-graphics average hourly solar radiation onto a horizontal surface for months, and Fig. 2 shows a three-dimensional picture of the change in average hourly intensity of solar radiation for the average settlement day of the month throughout the year, resulting from the use of models (1).

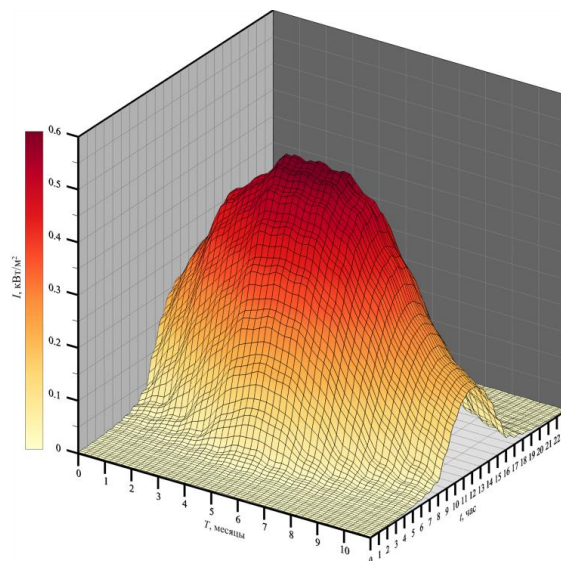


Fig. 2. Model of changes in solar radiation throughout the year for the city of Tambov

The proposed identification method allows using computer simulations with high accuracy for the space-time areas, where due to these or other causes values of solar radiation intensity are absent. The developed method is suitable for any geographical point of observation.

#### References

1. Tjurin I.V. О повышении эффективности двухконтурных систем солнечного нагрева воды [Improving the efficiency of double-circuit solar water heating systems] // Промышленные АСУ и контроллеры. 2012. № 3. С. 29-32. (Rus)

## ИДЕНТИФИКАЦИЯ МОДЕЛИ ПОТОКА СОЛНЕЧНОЙ РАДИАЦИИ НА ГОРИЗОНТАЛЬНУЮ ПОВЕРХНОСТЬ НА ПРИМЕРЕ ГОРОДА ТАМБОВА

**А.А Аристов, И.Ю. Кошелев, М.С Кузнецова**

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: lohmatperes@gmail.com*

**Аннотация:** Инженерное проектирование гелиосистем горячего водоснабжения начинается с получения достоверных значений интенсивности потока солнечной радиации, поступающей на поверхность, расположенную под некоторым углом к этому потоку. Для моделирования интенсивности солнечной радиации на произвольно ориентированную поверхность удобно применять метод совместного использования имеющихся достоверных экспериментальных данных для отдельных моментов времени и результатов компьютерного моделирования для оставшейся временной области.

**Ключевые слова:** идентификация, солнечный поток, солнечная радиация.

## ENERGY SAVING AS ENERGY RESOURCE

**A.O. Danilova**

Tambov State Technical University, Tambov, Russia.  
*e-mail: alena.dan-danilova@yandex.ru*

**Abstract:** *Lack of energy is one of problems of our time. The dynamic and steady functioning of the fuel and energy complex, as well as effective operation of the existing oil and gas fields influences the economic growth and well-being of the population. The energy supply is one of the greatest challenges of the XXI century.*

**Keywords:** *energy saving; energy sector; energy resources.*

Understanding and meaning of the term "energy" in each period of time of development are consistent with our knowledge, our technical capabilities and the level of our responsibility to future generations for lavish spending of natural resources, and therefore are constantly changing with the development of this problem. In conditions of economic crisis, energy saving becomes a government priority because it allows using relatively simple measures of state regulation to reduce significantly the load on budgets of all levels, to restrain the growth of energy tariffs, increase the competitiveness of the economy and increase supply in the labor market.

The purpose of energy conservation is energy efficiency improvement in all sectors, all settlements and in the country as a whole.

It is especially necessary to send all the power to:

- energy efficiency of buildings;
- improving energy efficiency in residential buildings;
- improving the efficiency of production;
- and of course, increasing the energy efficiency of equipment.

These are the priority areas.

The basic principles of energy policy in the Russian Federation include:

- the priority of efficient use of fuel and energy resources;
- implementation of state supervision over efficient use of energy resources;
- mandatory accounting of produced, obtained, or consumed energy resources;
- introduction of efficiency indicators in the standards for equipment, materials and construction, the vehicle energy;
- development of national and regional energy saving programmes and their financing;
- harmonization of normative documents in accordance with the requirements of reducing the energy intensity of material production, services and lifestyle;
- creation of system of financial-economic mechanisms, ensuring economic interest of manufacturers and users in the effective use of fuel and economic resources, involvement in the fuel and energy balance of alternative and renewable energy sources, as well as in investing in energy saving measures;
- implementation of state expertise of energy efficiency of design solutions;



- certification of fuel consuming, energy consuming, energy saving and diagnostic equipment, materials, constructions, vehicles and energy resources.
- the creation and wide dissemination of environmentally clean and safe energy technologies, providing safe population of the state of the environment in the process of using the fuel economic resources;
- implementation of demonstration projects of high energy efficiency;
- information support for energy saving activities and promotion of advanced domestic and foreign experience in this field;
- training of production personnel and population methods of saving fuel and energy.
- the creation of other economic, informational and organizational conditions for the implementation of energy saving principles.

Energy saving is one of the strategic tasks of the state, being both the primary method of providing energy security, and the only real way to maintain high revenues from hydrocarbon exports. Energy resources required for the internal development of can be obtained not only by increasing the extraction of raw materials in remote areas and construction of new power facilities but at a lower cost, due to energy directly to the centers of consumption.

Becoming part of the global economic system, the Russian economy is forced to make a technological breakthrough, otherwise it will finally turn into fuel and raw material at the periphery of the developed countries. Energy saving is the key word of the new economic policy of the country.

The continuing high rate of economic growth of national economy is possible only under condition of increase in the level of energy saving in industry, housing and utilities sector, in the production, transportation and distribution of energy.

Resource efficiency should be considered as one of the energy resources of the future economic growth.

In solving issues of energy saving and energy efficiency it is important to organize efficient interaction with the business community and involve the human factor, providing information and educational support on energy saving and energy efficient use of fuel and energy resources at the international, federal, regional and municipal levels. The continuing high rate of economic growth of national economy is possible only under condition of increase of energy saving level in industry, housing and utilities sector, in the production, transportation and distribution of energy.

### **References**

1. Komolov D.A. Energojefektivnost' [Energy efficiency] / D.A. Komolov // *Ekonomika I TJeK segodnja*. – 2008. - №11. – S.35-45. (Rus)
2. Proekt Gosudarstvennoj programmy energosberezhenija I povyshenija energeticheskoyj effektivnosti na period do 2020 goda na period do 2020 goda [The Draft of national programme of energy saving and improving energy saving and energy efficiency for the period up to 2020 for the period up to 2020]. – M.: Energosovet №4. - 2009. – 14 s. (Rus)
3. Ratnikov B.E. Upravlenie energosberezheniem: Uchebnoe posobie [Energy saving management: Textbook] / B.E. Ratnikov, A.V. Chazov. - Ekaterinburg: UGTU, 1998. - 105 s. (Rus)

# ЭНЕРГОСБЕРЕЖЕНИЕ КАК ЭНЕРГЕТИЧЕСКИЙ РЕСУРС

**А.О. Данилова**

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: alena.dan-danilova@yandex.ru*

***Аннотация:** Дефицит энергоресурсов – одна из реальных проблем современности. От того, насколько динамично развивается и устойчиво функционирует топливно-энергетический комплекс, насколько быстро осваиваются новые и эффективно эксплуатируются действующие нефтегазовые месторождения, зависит в конечном итоге экономический рост и благополучие населения страны. Снабжение энергоресурсами является одной из самых серьезных задач XXI века. От результатов решения этой проблемы зависит экономическое положение страны и уровень жизни граждан.*

***Ключевые слова:** сбережение энергии, энергетика, энергетические ресурсы.*

---

УДК: 542.424=111  
ББК:292-5 + К-96

## ENERGY SAVING OF THERMAL EQUIPMENT

**R.R. Kuzyaev**

Tambov State Technical University, Tambov, Russia

*e-mail: xpyct1994@gmail.com*

***Abstract:** The paper focuses on the importance of energy saving for industrial companies and the country's economy. The types of thermal equipment were selected and compared. The ways of reducing energy consumption are summarized.*

***Keywords:** thermal equipment, heat exchange, exergy analysis, optimal control.*

The problems of energy saving are becoming more urgent with the exhaustion of fuel reserves and increasing tariffs for thermal and electric energy. Thermal equipment is one of the main sources of consumption of energy.

Thermal processes are important in heat power engineering and in other of industrial processes including the manufacture of radio components. They are the most energy-intensive and widely spread in machine-building, metallurgical and chemical industries, etc. Refinery and petrochemical industries keep a leading place, and chemical industry takes the second place in heat consumption, which is 12.6 and 11%, respectively of the total heat consumption in the national economy. The cost of electricity and fuels for industries is crucial and affects the efficiency and competitiveness. A large part of energy consumption falls for heat exchangers, heating installation, furnace and other devices that have thermal processes.

The exergy analysis of heat power engineering plants is used to assess the effectiveness of the optimal control of thermal equipment. This method is the most useful for thermal processes, for example, in the analysis of energy-saving

technologies and assessment of thermal efficiency of fuel usage. This method helps us to calculate the loss of heat.

The research showed that with the optimal control, the decline in energy consumption reaches 20% or more provided that algorithms of synthesis of optimal control are performed by simple and cheap microprocessor devices. The highest level of energy saving is achieved when the following conditions are satisfied:

- 1) optimal control of dynamic modes heating;
- 2) maintaining the required temperature at the set time;
- 3) elimination of deviations of controlled variable from the initial value with a minimum value of energy consumption. [1]

In the market economy there is a tendency for separation of the technological process of heating by creating the structures, which lead to poor service and limitations. Thus, in recent years, the question about the replacement of central heating with individual heating is raised. To evaluate the energy-saving effect of individual heating systems, we need to understand the processes in thermal system from the perspective of heat losses.

The calculation of heat losses is performed by the formula:

$$\eta = \frac{T_1 - T_2}{T_1}, \quad (1)$$

where  $T_1$  is the temperature at the beginning of the process-cycle, °C;

$T_2$  is the temperature at the end of the process-cycle, °C.

This means that the lower  $T_2$  is, the more effective is the heat function, and the higher the ratio of fuel usage is, the less energy is required for pumping heat transfer fluid.

Thus it is necessary to raise  $T_1$  and to reduce  $T_2$ . But if the decrease in  $T_2$  is limited by the temperature environment, the increase in  $T_1$  depends on the development of heat-resistant material.

The important role is played by the division of objects by the type of the energy source and the operation modes. Thermal objects can be subdivided into monoobjects (Fig. 1 a) which use one type of energy source. Also, there is a wide class of thermal objects, which use the products of the combustion of gaseous and liquid fuels for heat exchange.

Recently hybrid objects (Fig. 1 b) have become quite popular. They use a combination of functionals as a weighted sum of the fuel consumption and cost of energy. These include machines with electric drive, heating systems, hot water boilers, operating on the principle of simultaneous use of different energy sources and heating systems, boiler plants working on the principle of sequential use of energy.

Energy costs in the process of heating can be reduced by:

- 1) raising productivity of technological equipment, decreasing downtime in the working condition;
- 2) increasing the reliability of electrothermal equipment;
- 3) improving heat insulation.

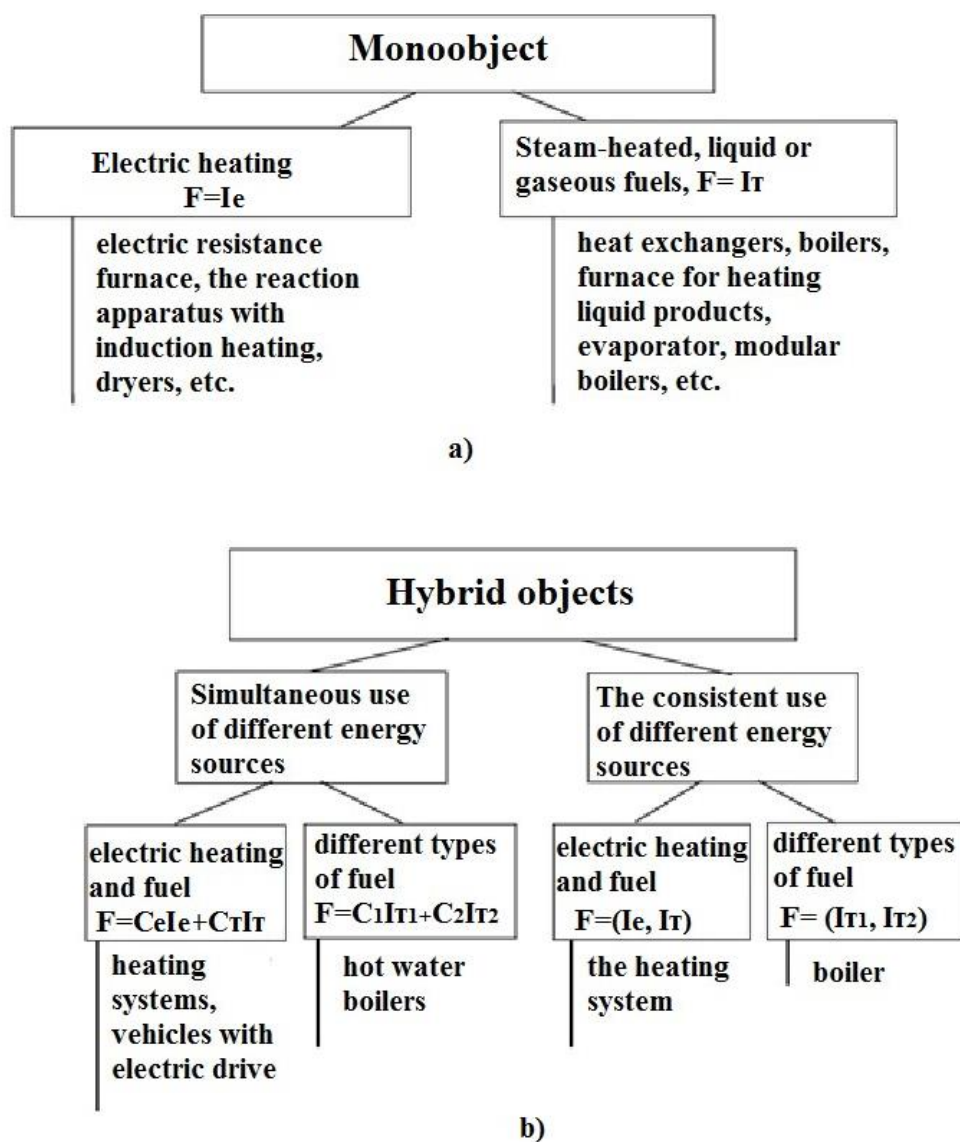


Fig. 1. Classification of thermal objects by types of energy saving:  
 $I_T$  – fuel consumption;  $I_e$  – energy costs;  $C_e$  – the weighting factors;  
 a – monoobject; b – hybrid objects.

### References

1. V.G Matvejkin. [Theoretical foundation of energy saving control dynamic modes of r industrial purposes]: Trans. from English. — M. : Publisher mechanical engineering-1, 2007. – 116 p. (Eng)

## ЭНЕРГОСБЕРЕЖЕНИЕ ТЕПЛОВЫХ АППАРАТОВ

**Р.Р. Кузяев**

Тамбовский государственный технический университет, Тамбов, Россия

e-mail: [хруст1994@gmail.com](mailto:хруст1994@gmail.com)

**Аннотация:** В статье рассмотрены проблемы энергосбережения для промышленных в тепловой сфере производство и экономики страны. Описаны существующие типы тепловых аппаратов. Предложены основные способы решения проблемы энергосбережения.

**Ключевые слова:** тепловые аппараты, теплообмен, эксергетический анализ, оптимальное управление.

УДК 620.179.118.7.05

ББК 30.3

## THE ANALYSIS OF CAPACITIVE METHOD OF NON-DESTRUCTIVE TESTING

**A.A. Bryuzgin**

Tambov State Technical University, Tambov Russia

*e-mail: lexeika08@gmail.com*

**Abstract:** *The paper considers a capacitive method of non-destructive quality control. The article describes the differences between capacitive method and other methods.*

**Keywords:** *capacitive method, non-destructive testing.*

NDT methods are based on observation, registration and analysis of interaction of physical fields or substances with the test object. The nature of this interaction depends on the chemical composition, structure, status structure of the controlled object, etc.

Electrical methods are based on:

- an electric field is generated in the test object, or an electric field is applied to the object
- indirectly, through the impact of perturbations of non-electrical nature (e.g., thermal, mechanical, etc.).

Electrical characteristics of the control object are used as a primary informative parameter.

One of the electrical methods is the capacitive method of non-destructive testing. The capacitive method provides for the introduction of the test object or of the investigated area in the electrostatic field and the definition of the desired characteristics for the resulting back-reaction on the source of this field. Electric capacitor is used as the source of the field, which is also the primary electric capacity converter. The capacitor performs the transformation of the physical and geometric characteristics of the control object in the electrical parameter. The reverse reaction of the transmitter is manifested as a change in its integral parameters. Most often two parameters, the first describes "capacitive" properties of the transducer, and the second characterizes the dielectric loss (e.g., capacitance and tangent of losses in components of the complex conductivity).

Informativity is determined by the dependence of primary informative parameters of the transducer on the characteristics of the control object directly from the electrical characteristics (e.g., dielectric constant and dielectric loss factor) and geometric dimensions (thickness) of the test object.

We study the dielectric characteristics of the material – quantities to be measured and represents the source information for the solution of many problems of

quality control of materials.

The capacitive control method eliminates the shortcomings in the way of its development:

- rigorous theory of calculating the basic parameters of overhead capacitive transducers is absent;
- calibration of measuring devices is carried out by experimentation, without taking into account the actual conditions;
- development of non-contact methods and control provided insufficient attention;
- capacitive method gives a lot of information about the properties of the material of interest to researchers.

The method can determine other physical characteristics of the material indirectly: Density of components in heterogeneous systems, humidity, degree of polymerization and aging, mechanical properties, etc. The most informative geometrical parameters of the test object should include the thickness of the plates, shells and insulating coatings on the conductor and non-conductive substrates, the transverse dimensions of linearly extended conductor and dielectric products (yarn, rods, strips, rods), localization of conductive and dielectric inclusions, and others.

For example, applying for this purpose the ultrasonic method is accompanied by an additional measurement error. By changing the material properties of the damping ultrasonic vibrations occur in the material, dispersion of the signal on uneven surfaces, interfaces and layers of controlled speed change and the wavelength of the ultrasonic vibrations. The electromagnetic method of measuring the thickness of non-metallic materials used in the presence of a conductive layer on the opposite side, which in most cases is equivalent to the requirement of measurement with two-way access.

Thus, the capacitive method has several advantages over other methods. With the improvement of this method, it can be used for a number of solutions to complex problems.

#### **References**

1. Klyuev, V [ Encyclopedia. Izmerenie, kontrol, ispytaniya i diagnostika] / V. Klyuyev. 3-7 T.– М.: Mashinostroenie, 2001. – 160 p.

## **АНАЛИЗ ЕМКОСТНОГО МЕТОДА КОНТРОЛЯ КАЧЕСТВА**

**А.А. Брюзгин**

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: lexeika08@gmail.com*

***Аннотация:** В статье рассматривается емкостный метод неразрушающего контроля качества. В статье описаны отличия емкостного метода от других и его достоинства.*

***Ключевые слова:** емкостной метод, метод неразрушающего контроля, МНК.*

## THE USE OF A VARIABLE FREQUENCY DRIVE TO CONTROL THE SPEED OF THE INDUCTION MOTOR

**A.S. Golub**

Tambov State Technical University, Tambov, Russia  
e-mail: Alexgolub007@yandex.ru

**Abstract:** *The load on Induction Motor is not constant and varies as per load requirement, so speed must be change as per load. If the supply voltage decreased motor torque also decreases, for maintaining same torque, slip decreases hence speed falls and motor speed is directly proportional to supply frequency, hence to maintain a speed, the supply V/F ratio must be vary accordingly. Adding a Variable Frequency Drive (VFD) to a motor driven system can offer potential energy saving in a system in which the load varies with time.*

**Keywords:** *adjustable frequency, inverter, frequency control circuit, single phase induction motor, variable speed drive.*

The induction motor is mostly used in various industrial applications. The loads on induction motor always vary as per its application but the speed of induction motor is constant and cannot match with the load demand. If the load on induction motor decrease, the speed of induction motor cannot decrease as per the load. Hence it takes rated power from supply so the energy consume by the motor is same. Hence there is energy consumption is same during load varying condition also. To overcome this problem a VFD is used in industrial application to save the energy consumption and electricity billing. Variable frequency drive (VFD) usage has increased dramatically in industrial applications. This device uses power electronics to vary the frequency of input power to the motor, thereby controlling motor speed.

Variable Speed Drive (VSD) applies to devices that control the speed of either the motor or the equipment driven by the motor (fan, pump, compressor, etc.). This device can be either electronic or mechanical.

As noted in [1], the speed of induction motor is directly proportional to the supply frequency and number of poles of motor. Variable speed drive by using frequency control method is commonly used to control and change the speed of single phase induction motor. It can vary the desired speed by changing the frequency using switching sequence of Insulated Gate Bipolar Transistor (IGBT).

The VFD includes the following stages of operation:

1 Rectifier Stage. A full wave bridge rectifier converts single phase or three phase 50 Hz power from standard utility supply to either fixed or adjustable Dc voltage. One diagonal pair of rectifier will allow power to pass through only when the voltage is positive. A second diagonal pair of rectifier will allow power to pass through only when the voltage is negative. So two diagonal pair of rectifiers are required for each phase of power.

2 Inverter stage. Electric switches-power transistor or thyristor switch the rectified DC on and off, and a produce a current or voltage waveform at the desired

new frequency. The final section of the VFD is referred to as an “inverter.” The inverter contains transistors that deliver power to the motor. IGBT is a common choice in modern VFDs. The IGBT can switch on and off several thousand times per second and precisely control the power delivered to the motor. The IGBT uses a method named “pulse width modulation” (PWM) to simulate a current sine wave at the desired frequency to the motor.

3 Control stage. An electronic circuit receives feedback information from the driven motor and adjusts the output voltage or frequency to the selected values. Usually the output voltage is regulated to produce a constant ratio of voltage to frequency (V/Hz). Controllers may incorporate many complex control functions. Converting DC to variable frequency AC is accomplished using an inverter. Most currently available inverters use PWM because the output current waveform closely approximates a sine wave. Power semiconductors switch DC voltage at high speed, producing a series of short-duration pulses of constant amplitude. Output voltage is varied by changing the width and polarity of the switched pulses. Output frequency is adjusted by changing the switching cycle time by using microcontroller.

As VFD usage in heating, ventilation and air conditioning (HVAC) applications has increased, fans, pumps, air handlers, and chillers can benefit from speed control. As noted in [2], variable frequency drives provide the following advantages:

1. Energy savings: the primary function of VFD is to provide energy saving. The VFD can save the energy up to 50%.

2. Low motor starting current: at the time of starting the motor start with low frequency so it takes low current at starting therefore VFD can be used as starter.

3. Reduction of thermal and mechanical stresses on motors and belts during starts: by using VFD the thermal and mechanical stress on motors and belts during starting get reduced hence chances of wear and tear of various part get decreased.

4. Simple installation: As VFD is single unit and it does not require any concrete construction so its installation is simple.

5. Lower kVA: as VFD has nearly unity power factor it has lower kVA rating.

Motor-driven centrifugal pumps, fans and blowers offer the most dramatic energy-saving opportunities. Many of these operate for extended periods at reduced load with flow restricted or throttled. In these centrifugal machines, energy consumption is proportional to the cube of the flow rate. Even small reductions in speed and flow can result in significant energy savings. In these applications, significant energy and cost savings can be achieved by reducing the operating speed when the process flow requirements are lower.

Hence we conclude that VFDs provide the most energy efficient means of capacity control. This drive performs in a leading role for energy saving products for the all industries using electrical motors. Adding a VFD to a motor-driven system can offer potential energy savings in a system in which the loads vary with time. The operating speed of a motor connected to a VFD is varied by changing the frequency of the motor supply voltage. This allows continuous process speed control. Motor-driven systems are often designed to handle peak loads that have a safety factor. This often leads to energy inefficiency in systems that operate for extended periods at



reduced load. The ability to adjust motor speed enables closer matching of motor output to load and often results in energy savings. VFD can be used for the number of applications of Induction motor and speed can get control as per load requirement so energy consumption get reduced hence VFD becomes very reliable and economically beneficial.

### References

1. Gopal K. Dubey. Fundamentals of electrical drives second edition. Published by Narosa Publishing Houses, 2001. 392 p.
2. Theraja B.L., Theraja A.K. A textbook of electrical technology. Published by S. Chand, 2005. 807 p.

## ИСПОЛЬЗОВАНИЕ ЧАСТОТНО-РЕГУЛИРУЕМОГО ПРИВОДА ДЛЯ КОНТРОЛЯ СКОРОСТИ ВРАЩЕНИЯ АСИНХРОННОГО ДВИГАТЕЛЯ

**А. С. Голуб**

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: Alexgolub007@yandex.ru*

***Аннотация:** Нагрузки в асинхронном двигателе всегда меняются в соответствии с его применением, но скорость асинхронного двигателя постоянна и может не совпадать с требованием нагрузки. Если нагрузка на асинхронный двигатель уменьшается, то его скорость не может уменьшиться в соответствии с нагрузкой. Излишние затраты энергии на поддержание скорости являются невыгодными. Добавление частотно-регулируемого привода к электромеханическим приводам системы может предложить потенциальную экономию энергии в системе, в которой нагрузка изменяется со временем.*

***Ключевые слова:** инвертор, однофазный асинхронный двигатель, преобразователь частоты, привод с переменной скоростью, управление частотой цепи.*

---

УДК 66.047  
ББК Л113.6-1

## SOME ASPECTS OF THE DUST FILTRATION PROCESS

**A.G. Eltsov, A.S. Shuvaev, N.P. Fefelov**

Tambov State Technical University, Tambov, Russia

*e-mail: sanek-68.1994@mail.ru*

***Abstract:** The description of the main ways of filtering dust is given. The main parameters and modes of process affecting the kinetics of filtration are shown.*

***Keywords:** dust, filtration, kinetics, mode.*

In modern industry, filtration is used for the separation of gas or liquid heterogeneous systems. Cleaning gas or liquid from any suspended particles is more effective than the deposition process, and, hence, it brings a higher yield of the

product (if the product is the solid phase of the suspension) [1].

Most processes are accompanied by some amount of dust or other solid particles. To prevent the pollution of atmosphere by industrial emissions it is necessary to improve the processes, reduce harmful emissions to a minimum and introduce closed non-waste technological processes in the manufacture. To solve these problems is not possible, one should use the most efficient and economical means of purification of gases and air before its emission into the surrounding atmosphere [2, 3].

Special high performance filters and installation are used for industrial cleaning of gases from impurities (ash, dust, and other debris). Their work is based on the use of electrostatic deposition as one of the most effective ways of removing particulate matter from the gas. The quality of filtration through porous layers and partitions, flushing gases and the separation of the particles improves due to the impact of gravitational forces, i.e. inertial separation [4].

When filtering, solid particles contained in the gas or liquid may stick on the surface of the filter walls, thereby forming a precipitate, or may pass through in the depth of the material of the walls, lingering in the pores.

The driving force of filtration is the pressure difference before the filter and after it. If this is the difference created by using any of the devices - a compressor, pump or a vacuum pump, filtering is done by the action of differential pressure. If it is created with the help of centrifugal forces, then there is a centrifugal filtration (different-centrifugation).

One of the promising methods for utilization of stillage is to develop schemes for obtaining dry bards using dryers. To implement this method it is necessary to develop various laboratory filters and test them at specified operating conditions [5].

Thus, the quality of the final product is a task with high practical relevance. In other words, stillage is dried using dryers (spray, vacuum, freeze, etc.) without the use of the evaporation stage with the lowest possible price (i.e., the process and the equipment meets the requirements of the energy resource, sanitary norms and rules) is [6].

Gas cleaning from dust is done by filtration. Gases pass through porous partitions, which have the ability to pass only gas particles and to retain eventual solid particles.

When selecting a porous partition, factors such as temperature and chemical properties of gas and the size of solid particles, from which it is necessary to clean the gas, are relevant.

The filtration rate is determined primarily by the amount of gas passing through the filter wall per unit time. In addition, the rate of filtration depends on the resistance of the filter septum and the gas pressure.

#### **References:**

1. Pakhomov, A. N. Method of determination of adhesion of the film dries distillery grains on the substrate/A. N. Pakhomov, R. Y. Banin, E. A. Chernikh, E. Y. Loviagina, N. A. Sorokina//Proceedings of the 5th International Academic Conference «Applied and Fundamental Studies».-St. Louis, Missouri, 29-30 April 2014. -S.71-73
2. Pakhomov A.N. Formation and behaviour of fluidized bed of inert particles/ Pakhomov A.N., Volostnykh S.G., Eltsov A.G., Shuvaev L.S.//European Applied Sciences: challenges and solutions

- 2nd International Scientific Conference. Stuttgart, Germany, 2015. Pp. 119-120.
3. Pakhomov A.N. The influence of the shape of the dryer to the nature of binary fluidized bed of inert/Pakhomov A.N., Banin R.Y., Chernikh E.A., Loviagina E.Y.// Applied and Fundamental Studies Proceedings of the 8th International Academic Conference. Publishing House Science and Innovation Center. St. Louis, Missouri, USA, 2015. Pp. 121-123.
4. Pakhomov A.N. The effect of feed slurry to the nature of the fluidized bed/ Pakhomov A.N., Banin R.Yu., Chernikh E.A., Loviagina E.Yu.// The Fifth International Conference on Eurasian scientific development Vienna, 2015. Pp. 122-123.
5. Pakhomov A. The observed heterogeneity of the fluidized bed/Pakhomov A., Banin R., Chernikh E., Loviagina E.// В сборнике: Scientific enquiry in the contemporary world: theoretical basics and innovative approach 4th edition. Science editor: A. Burkov. San Francisco, California, USA, 2015. Pp. 70-72.
6. Pakhomov, A.N. Influence of walls of the device on frame of fluidized bed of inert particles/Pakhomov A.N., Banin R.Yu., Chernikh E.A., Loviagina E.Yu.// Europäische Fachhochschule. 2015. № 3. Pp. 67-68.

## НЕКОТОРЫЕ ВОПРОСЫ ПРОЦЕССА ФИЛЬТРОВАНИЯ ПЫЛЕЙ

**А. Г. Ельцов, А. С. Шуваев, Н.П. Фефелов**

Тамбовский Государственный Технический Университет, Тамбов, Россия

*e-mail: sanek-68.1994@mail.ru*

*Аннотация:* представлено описание основных способов фильтрации пылей. показаны основные параметры и режимы процесса влияющие на кинетику фильтрации.

*Ключевые слова:* пыль, фильтрация, кинетика, режим.

---

УДК 621.793

ББК 34.64

## METHODS OF SURFACE PREPARING FOR GAS THERMAL SPRAYING

**S.A. Ereemeev**

Tambov State Technical University, Tambov, Russia

*e-mail: serqes13@gmail.com*

*Abstract:* The current trend of increasing the adhesion properties of sprayed coatings is aimed at increasing the speed of the sprayed particles. However, not enough attention is given to preliminary preparation of the surface. Surface preparation before coating is an essential part of the technological process of applying coatings as it cleans and chemically activates the substrate. To cope better with this challenge, it is necessary to choose the most suitable method of preparing surface for coating.

*Keywords:* preparing for coating, gas thermal spraying, structural materials.

In modern industrial production, one of the solutions to the issue of the creation of new materials with unique properties is the application of special coatings on structural materials. A method of thermal spraying has a significant place among the many known coating methods.

Thermal spray coating refers to a number of processes in which a substrate is coated to improve its functional performance. Many types of coating materials can be applied by thermal spray processes. Coatings can range in thickness from a thousandth of an inch up to an eighth of an inch. Thermal spray coatings have been used to protect parts from wear, abrasion, corrosion, high temperatures, etc. and to build dimensions on undersized parts.

Chemical interaction, intermolecular forces and mechanical gearing determine the connection of the sprayed coating to the base. In this regard, it is greatly influenced by the composition and structure of the basic material; roughness parameters, basic mechanical properties of the surface layer, hardness, density, thermal properties, magnitude and sign of residual stress, thickness and properties of oxide films and adsorbed layers, the presence and basic characteristics of the intermediate sublayers.

Pre-treatment of the substrate surface is one of the main factors for the high strength adhesion of the coating to the substrate, because in most cases the connection of the sputtered coating with the material of the part is the result of a mechanical clutch. Therefore, in order to spray particles that impinge and deform about the basis, firmly bonded with the coating surface, the substrate must have an optimal roughness.

These methods of surface pre-treatment before deposition of thermal coatings include:

- mechanical methods of machining with removal of chips: torn thread cutting, milling cut milling grooves, wedge-shaped, notch grooves with a chisel, cutting ring grooves;

- mechanical processing methods of machining: thread rolling, oblique mesh rolling, processing methods of surface plastic deformation;

- combined methods of machining: threading and stitching, thread-cutting and blasting abrasive;

- processing by free abrasives: vibration, centrifugal, ultrasonic, blasting;

- prior application of the sublayers of molybdenum, Nickel, Nickel alloys, composite powders by means of thermal spraying;

- electrical discharge machining Nickel electrode;

- chemical etching;

- activation of the substrate arc discharge;

- cleaning glow discharge, cathodic sputtering.

In accordance to GOST 9.304-87 as the preferred method of processing for roughening the surface and cleaning of oxides is recommended to subject to jet-abrasive treatment. The recommended surface roughness Ra is 6.3 to 16  $\mu\text{m}$ . The mechanism of formation of a developed roughness by the method of jet-abrasive processing was described in the works of A. D. Dvoeglazova and B. A. Popovkin,

A.Yu. Medvedev, and others. However, the harmful effects on human health and the environment encourages scientists to explore and develop alternative methods of surface preparation for coating, which include: machining, coating layers and electrical discharge machining.

Of course, different ways of handling give different surface roughness, and hence different degree of connection of the deposited layer to the substrate. Table 1 shows the main methods of surface preparation of parts and adhesion of coatings to the substrate.

Table 1

Methods of surface preparation	The purpose of the processing	Adhesion strength MPa	Advantages	Disadvantages
1	2	3	4	5
Knurling	Preparation of steel unhardened parts (HRC $\leq$ 35)	100.0	Manufacturability and simplicity of process	Only suitable for parts with cylindrical shape
Cutting the ripped thread	During deposition of coatings of a thickness exceeding 1 mm to the details working in conditions of high stress	152.0	Manufacturability and simplicity of process	Not suitable for processing hard, soft materials and surfaces of irregular shape
Sandblasting	The increase in roughness	34.5	Low power consumption and high performance	Environmentally "dirty" method
Preliminary application of sub-layers of thermal coating	Applied if there is a big difference of coefficients of thermal expansion of the coating material	33.1	High performance and the ability to use any shapes of details	High cost repairable parts
Electrical discharge machining	Preparation of surfaces of parts made of low carbon steels during the deposition of thick layers on the plane and surfaces of revolution	167.0	Possibility of use for parts of various shapes with surface hardness HRC $>$ 40	Relatively low performance

In electrical discharge machining processing, there is good adhesion between the coating and the substrate by increasing the roughness. Moreover, the method allows processing the surface hardness is HRC $>$ 40, and unlike machining techniques can be used for parts of various shapes and sizes. Spark electrical discharge machining is an environmentally friendly method that allows you to control the adhesion strength of the coating to the substrate not only by increasing the roughness, but also by changing the chemical composition of the surface layer by using different materials as electrodes.

Performance analysis of the basic methods used for surface treatment before deposition of gas-flame coatings showed that the highest adhesion strength of the deposited coating to the substrate provides electrical discharge machining.

The method allows control of adhesion strength in a wide range by changing the chemical composition of the surface layer by using different materials as electrodes.

Electrical discharge machining is an environmentally safe method and allows to handle surfaces with a hardness of HRC>40, which is important for regenerative repair of machine parts.

The solution to the problem of improving the adhesive strength of gas-flame coatings with the base is advantageously carried out by applying an electric spark machining for surface preparation.

### References

1. Kljuev, V.V. Fiziko-himicheskie problemy soedineniya raznorodnyh materialov [Physical and chemical problems of joining dissimilar materials] / V.V. Kljuev. Vol. 3-7– M.: Mashinostroenie, 2001. – 160 p. (in Russian)
2. Terekhov, D. Yu. Sposob podgotovki poverhnosti pered termicheskom napylenii [Method of surface preparation prior to thermal spraying] / the Copyright certificate of the USSR No. 1638198 AI C23C 4/02 30.08.91 bull. No. 32. All – Union scientific production Association of restoration parts "Remdetal". (in Russian)
3. Nadolsky V. O. Sposob podgotovki poverhnosti detaley [Method of surface preparation of parts] / Nadolsky V. O., A. N. Newsnow // the Copyright certificate of the USSR No. 1758082 AI C23C 4/02 30.08.92. Bull. No. 32. (in Russian)
4. Borisov Yu. s. Termicheskogo napyleniya pokrytya of poroshkouyh materialov [Thermal spray coatings from powder materials] / Yu. s. Borisov, Yu. a. Kharlamov. – Kiev: Naukova Dumka, 1987. – 210 p. (in Russian)
5. Kudinov V.V. Primenenie plazmy ogneupornyh pokryty [The Application of plasma refractory coatings] / V. V. Kudinov, V. M. Ivanov. – M.: Mashinostroenie, 1981. – 192 p. (in Russian)

## МЕТОДЫ ПОДГОТОВКИ ПОВЕРХНОСТИ ДЛЯ ГАЗОТЕРМИЧЕСКОГО НАПЫЛЕНИЯ

**С.А. Еремеев**

Тамбовский государственный технический университет, Тамбов, Россия  
*e-mail: serqes13@gmail.com*

**Аннотация:** Одним из путей повышения прочностных характеристик, разного рода поверхностей, является внедрение в производство технологии восстановления и упрочнения деталей с использованием методов газотермического напыления. Получение качественных покрытий возможно только при строгом соблюдении стандартов и технических условий, предусматривающих технологию подготовки металлических поверхностей к газотермическому напылению. В данной работе проведен сравнительный анализ технических характеристик основных методов подготовки поверхности к газотермическому напылению. В результате чего было доказано преимущество электроискровой обработки над другими методами подготовки поверхности.

**Ключевые слова:** газотермическое напыление, подготовка к покрытию, строительные материалы.

## THE RESEARCH INTO THE WELDING POWER SOURCE IN A SOFT SWITCHING MODE

**I.E. Karpenko**

Tambov State Technical University, Tambov, Russia  
*e-mail: nik-oe@mail.ru*

**Abstract.** *This paper discusses the characteristics of welding power supply, and offers the design ideas on the improvement of welding power. A full-bridge configuration of the power source is described.*

**Key words:** *digital signal processor, soft switching, welding inverter, welding power source.*

### **Introduction**

With the advancement of power electronics, microelectronics, intelligent control, and the constant introduction of new devices, advanced control technology, new materials and technology, welding technology is rapidly developing. Advanced control methods, digital signal processor (DSP) as well as the soft switching technology are used in the welding power supply continuously, which makes it possible to decrease the volume and weight of the power source and improve its intelligence.

### **Flow diagram of the welding power source**

The welding inverter is an inverter which can not only realize the conversion from direct current to alternating current but also provide the desired mode for arc welding technology. Fig. 1 shows the flow diagram of the welding power source. Working principle is as follows. First of all, single-phase or three-phase AC is rectified by input rectifier ZL1 and filtered by filter LC1 to form DC with smaller ripple. Then through the high-frequency alternating switch function of inverter NB constituted by IGBT, this DC is inverted into AC. Finally, by a high-frequency transformer T, the AC is declined to dozens of voltages that are suitable for welding. For DC welding, the AC voltage must be rectified by rectifier ZL2.

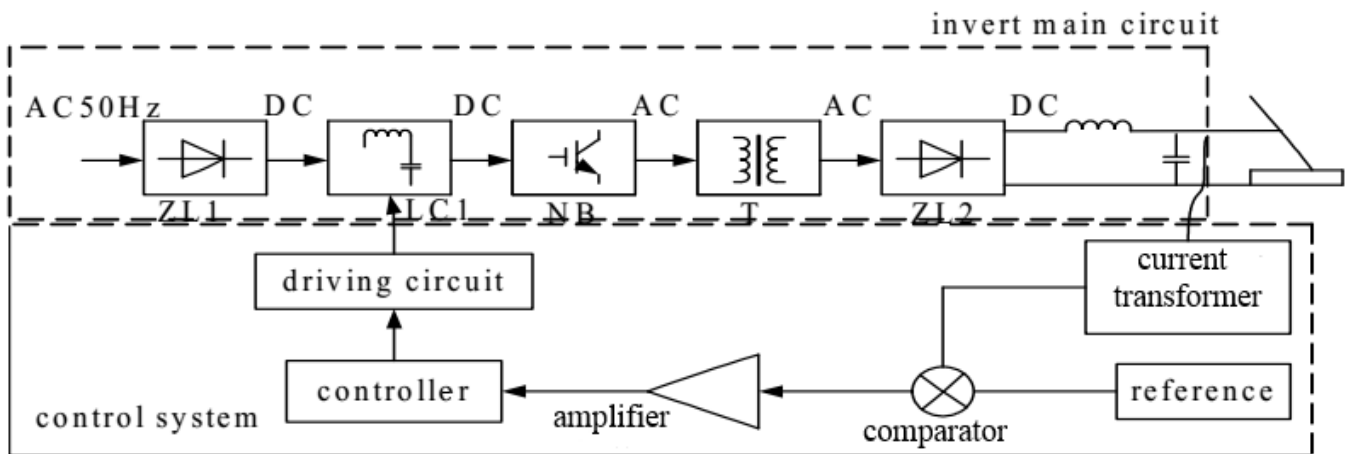


Fig.1 Scheme of welding inverter power source

### Soft switching technology

In the conventional PWM inverter, the power electronic switching device is turn-on or turn-off under the control of gate in high voltage or current conditions. It is the process of forced turn-off, i.e. the hard switching circuit. In the case of high frequency operation hard switching circuit may give rise to the following major issues:

- power consumption and temperature rise;

- electromagnetic interference can occur at in high-frequency, interelectrode capacitances of switching devices and the stray inductance in a circuit, that will affect the work of circuit on the whole.

In order to solve the problems in hard switching circuits, a number of scholars and experts have proposed to change the switches trajectory, so that voltage or current could be reduced to zero or a small value when switching device is turned on or off. This is the so called soft switching technology. This technology allows improving the frequency of switching devices, while the loss is decreased, which makes weight and size of the inverter smaller.

Using the soft switching technology in welding power sources enables to the power switching devices be switch on or switch off under the condition of zero voltage and/or zero current. This can lower the devices junction temperatures in running, decrease electromagnetic interference (EMI), break the limit of working frequency of hard switching and overcome the hard switching of PWM inverter circuit shortcomings fundamentally.

### Control Strategy of Inverter Welding Machine

Due to the continuous requirements for improved performance of modern production, the traditional controlled methods can not satisfy the demands well. The direction of the intelligent control research can be divided into: fuzzy control technology, neural control network and expert system.

### Conclusion

This paper described the soft switching inverter main circuit, and analyzed its working principle. Due to efficient and rapid dynamic response of the soft switching welding power source, it is one of the most promising in this class. The development



will relate to power electronic technology, digital signal processing and computer controlling technology in the future.

### References

1. Andrej Wiktor Mnich, Power Supply with Extended Output Voltage Intended for the Electric Welding and Cutting, (2016), p. 444 – 449.
2. V. Meleshin, D. Ovtshinnikov, Upravlenie tranzistornymi preobrazovateljami jelektrojenergii [Control of the transistor power converters], Technosfera, Moscow, 2011, p.71-74.(Rus)

## ИССЛЕДОВАНИЕ ИСТОЧНИКА СВАРОЧНОГО ТОКА В РЕЖИМЕ МЯГКОГО ПЕРЕКЛЮЧЕНИЯ

**И.Е. Карпенко**

Тамбовский государственный технический университет, Тамбов, Россия  
*e-mail: nik-oe@mail.ru*

*Аннотация.* В данной статье рассматриваются характеристики сварочного источника тока, а затем даются технические идеи улучшения источника тока. Описывается мостовая схема источника питания.

*Ключевые слова:* источник сварочного тока, мягкое переключения, сварочный инвертор, цифровой сигнальный процессор.

---

УДК 536.2.083  
ББК 22.31

## TEMPERATURE FIELD VISUALIZATION WHILE TREATING POLYMER-METAL CONSTRUCTIONS WITH HEAT INSULATION COATING MADE OF POLYURETHANE FOAM

**A. Yu. Yarmizina, V.D. Popov, N. F. Mainikova**  
Tambov State Technical University, Tambov, Russia  
*e-mail: teplotehnika@nnn.tstu.ru*

*Abstract:* The paper deals with the temperature distribution in a two-layer polymer-metal constructions as a result of their treatment with the local round heater with the constant power which acts on the surface of the polymer coating made of polyurethane foam.

The obtained numerical results allow for making a conclusion about short-term one-dimensional distribution of heat across the thickness of the polyurethane coating and implementation of the regulation mode of the thermal process for the local area of the constructions.

*Keywords:* method of finite elements; numerical calculation; polymer-metal constructions; polyurethane foam; temperature field.

Polymer–metal constructions with heat-insulating coverings on the basis of polyurethane foam (PUF) are manufactured with the method of filling of PUF in a

mold ("shells" for pipelines, plates, sandwich-panels, etc.). It is possible to exercise non-destructive quality control of such polymeric and metal constructions with a thermal method of treating thermal properties (TP) of layers [1 - 3]. Thermal properties are defined with the use of measuring systems [4 - 7]. TP are shown through a temperature response (thermogram) of the studied constructions to thermal influence to which an object in the organized experiment is exposed [1 - 3].

The purpose of this work is to conduct a numerical study of temperature fields in a method of non-destructive thermal monitoring of double-layer polymeric and metal constructions. The steel constructions in the form of a plate with a polymeric covering from PU Fare investigated.

The design consists of two layers with thermal properties (TP): the first –  $\lambda_1, a_1, \rho_1$ ; the second –  $\lambda_2, a_2, \rho_2$ . Thickness of layers –  $h_1, h_2$ . TP of materials of which a research object is made are shown in the table.

*Table. - Thermal properties of materials.*

Blocktag	Heat conductivity $\lambda, \text{W}/(\text{K}\cdot\text{m})$	Thermal capacity $c,$ $\text{J}/(\text{kg}\cdot\text{K})$	Density $\rho, \text{kg}/\text{m}^3$
Coating (polyurethane foam)	0,041	1470	80
Heater (copper)	400	385	8890
Probesubstrate (ripor)	0,028	1270	50
Plate (Steel 40)	47	462	7800

Thermal impact on a surface of a construction is carried out by means of the heater of constant power which is executed in the form of a disk. It is built into the measuring probe (MP). The MP substrate is made of heat-insulating material – a ripor. Probe radius is  $R_{MP}$  (fig. 1). The sizes of the MP substrate and a metal plate are picked up so that they can be considered semi-restricted. Temperature in points of monitoring of the surface of a polymeric covering is taken by means of thermoreceivers (T1, T2). During measurements, the thermograms showing the dependence of temperature on time are recorded.

Operations of modeling temperature fields for the purpose of identification of the mode of a regularization, is executed by a finite element method with the software package of Elcut Student.

The task (its geometry, properties of environments, heat sources, boundary and other conditions) is described. Creation of a grid of finite elements is executed.

Figure 2 shows the distribution of temperature on thickness of a covering and substrate MP on an instant – 300 s.

MP sizes: substrate height – 20 mm; radius – 25 mm. Double-layer constructions with the thickness: a heat-insulating polyurethane foam covering – 1 mm, the metal basis – 10 mm. The heater from copper: radius – 10 mm, height – 1 mm.

Numerically determined temperature in points which are located on a heater axis: on a demarcation of the MP substrate and a heat-insulating polymeric covering from PUF; in the middle of a coat layer; on a demarcation of the covering and metal.

The results of a research of temperature profiles received in this work allow to draw a conclusion on short-term one-dimensional distribution of heat on thickness of a polyurethane foam covering and realization of the mode of a regularization of thermal process for local area of a constructions.

Thus, there is an opportunity to allocate on thermograms the working sites which are characterized by independence of time of the relation of a heat flux in any point of a covering to heat stream on its surface. The analytical dependences describing a thermogram on working sites are received on the basis of the solution of the corresponding boundary value problems of heat conductivity. Detailed descriptions of algorithms of receiving and application of these decisions for calculation of

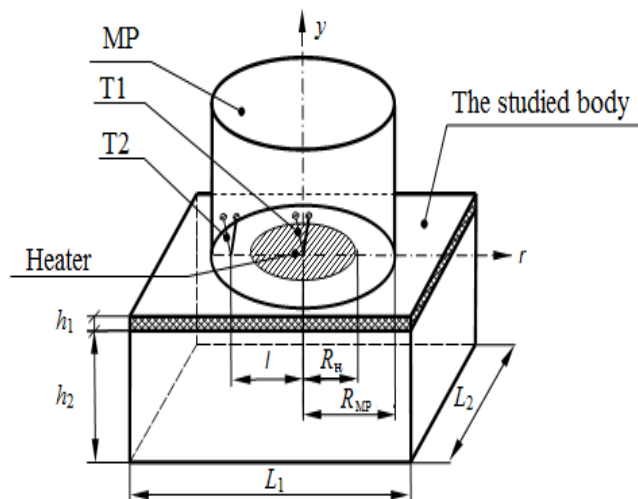


Figure 1. – Metering circuit of a method.

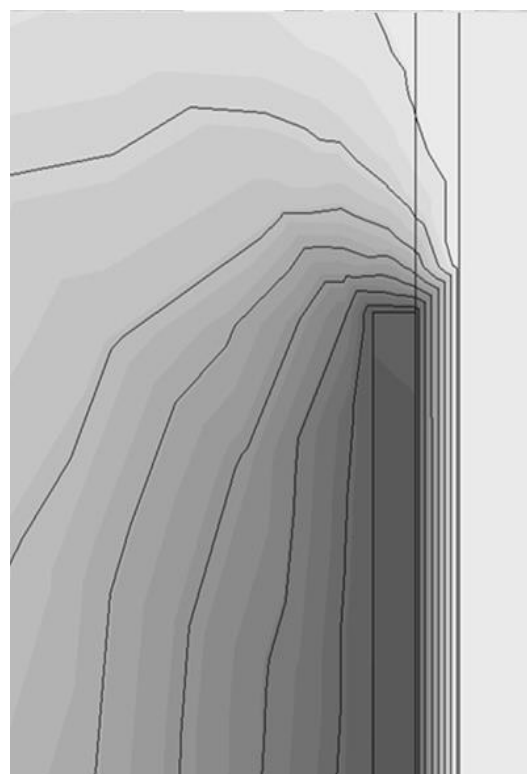


Figure 2. – Distribution of temperature on covering thickness from polyurethane foam and probe substrate thickness from a ripor.

thermal properties of layers and determination of thickness of a covering are submitted in works [8, 9].

### References

1. Zhukov, N.P. The multi-methods and means of nondestructive testing of thermal properties of materials and products / N.P. Zhukov, N.F. Maynikova // M.: Engineering-1. 2004. – 288 p. (Rus)
2. Multimodelmetod of nondestructive determinasion of the termophysical properties of solid material / N.P. Zhukov, N.F. Mainikova, I.V. Rogov, E.V. Pudovkina // Journal of Engineering Physics and Thermophysics. – 2012. – T.85.№1 – P 203 – 209.
3. Zhukov, N. P. Measuring – computer system for non-destructive heat – physical control/ N.P. Zhukov, N.F. Maynikova // Instruments and Experimental Techniques. – 2005. № 2. –P.153 – 154. (Rus)
4. Maynikova, N.F. The measurement system and method for non-destructive testing of structural transformations in polymeric materials / N.F. Maynikova // Instruments and systems. Management, monitoring, diagnostics.– 2006. №1 –P.56 – 61. (Rus)
5. Zhukov, N.P. Measurement computer system of nondestructive testing of thermal properties. / N.P. Zhukov, N.F. Maynikova // Instruments and Experimental Techniques. –2005. – № 4. – P.164 – 166. (Rus)
6. The method, device and system of automated non-destructive testing of thermal properties of composites / N.P. Zhukov, A.P. Pudovkin, N.F. Maynikova, I.V. Rogov, V.V.Orlov, D.Y. Muromtsev // Vestnik Tambov State Technical University. – 1997. – T.3, №3, –P. 298. (Rus)
7. Lykov, A.V. The theory of heat conduction / A.V. Lykov.–M .: Higher School – 1967. – 599 p. (Rus)
8. The theoretical justification of thermal method of non-destructive testing of two-layer products / I.V.Rogov, N.P. Zhukov, N.F.Maynikova, N.V.Luneva // Questions of modern science and practice. University V.I. Vernadsky.– 2009. – №9 (23) –P. 93 – 99. (Rus)
9. Modeling of heat transfer in the method of non-destructive testing of two-layer materials / N.P.Zhukov, N.F. Maynikova, I.V. Rogov, A.O. Antonov // Vestnik Tambov State Technical University. – 2013. – T.19. №. 3. –P. 506 – 511. (Rus)

## ВИЗУАЛИЗАЦИЯ ТЕМПЕРАТУРНЫХ ПОЛЕЙ ПРИ НАГРЕВЕ ПОЛИМЕРНО – МЕТАЛЛИЧЕСКИХ ИЗДЕЛИЙ С ТЕПЛОИЗОЛЯЦИОННЫМИ ПОКРЫТИЯМИ ИЗ ПЕНОПОЛИУРЕТАНА

**А.Ю. Ярмизина, В.Д. Попов, Н.Ф. Майникова**  
Тамбовский государственный технический, Тамбов, Россия  
*e-mail: teplotehnika@nnn.tstu.ru*

**Аннотация.** *Представлено распределение температуры в двухслойном полимерно-металлическом изделии от действия локального круглого нагревателя постоянной мощности, действующего на поверхности полимерного покрытия из пенополиуретана.*

*Полученные численно результаты позволяют сделать вывод о кратковременном одномерном распространении тепла по толщине пенополиуретанового покрытия и реализации режима регуляризации теплового процесса для локальной области изделия.*

**Ключевые слова:** *полимерно-металлическое изделие; пенополиуретан; численный расчет; метод конечных элементов; температурное поле.*

УДК 678

ББК 035.728

## INVESTIGATION OF CURING PROCESS ON PRESS EQUIPMENT

**A.A. Deev**

Tambov State Technical University, Tambov, Russia

*e-mail: ufo.deev @yandex.ru*

**Abstract:** *The main problem of the field is creation of authentic mathematical models of heating of pressure equipment elements and creation on their basis of the engineering calculation, design and optimization procedures allowing lowering of energetic, time and material expenditures. We suppose that such tasks need to be completed with the help of the modern systems of reverse engineering (CAE) in cooperation with automated design engineering systems (CAD). The primary target is development of domestic technologies of supercomputers' design on the basis of a scalable network of microprocessors, detailed predictive simulation by creation of perspective products of mechanical engineering, new power plants, and design process of control systems technologies on the basis of scalable hardware and software complexes. Creation of such technologies considers basic and applied researches in different fields, including math, microelectronics, information technologies, computing systems, informatics and telecommunications. The complex of the listed problems can be watched by design of elements of hydraulic presses for rubber products manufacturing.*

**Keywords:** *design methods, hydraulic press, modeling of the process, rubber products, temperature factor, thermal field, vulcanization accelerator.*

The competitiveness of the Russian manufacturing sector in the global market is nowadays impossible without supercomputing, mass information technologies and nanotechnologies.

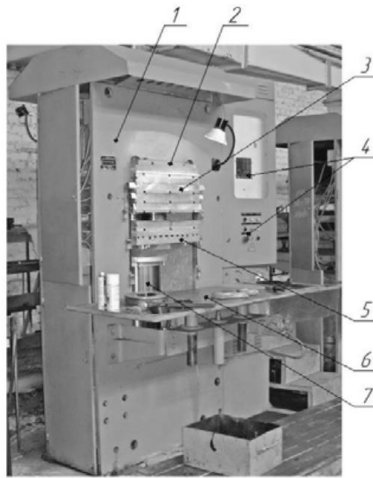
The vulcanization process in molding tools on hydraulic presses with inductive heating plates is more often used by rubber products manufacturing. Furthermore, the temperature conditions of the vulcanization process is paid much attention to, i.a. getting of the temperature fields of special configuration on the working fields of heating plates.

For modeling of the temperature fields of the presses' heating plates, i.e. for temperatures' profiling on their working fields it's possible to use different approaches, differed by the difficulty of mathematical descriptions, established assumptions, computation algorithms etc.

The processes of rubber products manufacturing using the vulcanization of hydraulic press are very power-intensive: the electric power costs are comparable to that of raw materials. An optimal temperature control of press heating plates taking into account the delay is an important reserve of the power consumption' curtailment by production of rubber products. The majority of existing control algorithms do not consider thermal properties of constructions of devices with electroheating and errors in the establishment of initial conditions that results in the considerable energy

overexpenditure in the dynamic modes. The features of a hydraulic press (Fig. 1) for vulcanization with heating plates as a controlled object include:

- the considerable time share of a press operation constitute the heat-up processes;
- the quality of production is defined by the temperature condition of vulcanization during the whole cycle of manufacturing;
- the process of vulcanization belongs to the class of difficult chemical and technological processes;
- the main perturbing factors in case of vulcanization process' control are temperature disturbance and instability of thermophysical properties of raw materials;
- the chemical composition and overall dimensions of the vulcanized product have significant effect on the temperature condition of vulcanization.



*Fig.1. The vulcanization press with inductive heating plates  
1 – case; 2 – entablature; 3 – heating plates;  
4 – dashboard; 5 – sliding table; 6 – recharging table; 7 – ram.*

Therefore, energy saving process control of vulcanization is an urgent and very complex challenge. The main difficulties of its decision are:

1) development of a dynamic model, which, on the one hand, reflects temperature conditions of the environment correctly and, on the other hand, is suitable for the operational analysis and synthesis of optimal control;

2) mathematical description of the thermal properties of the vulcanizing equipment.

The input variables of the considered process are:

- a plate geometry – its length, width, height and height of the cover;
- material of a plate, cover and inductors;
- inductor wire's diameter;
- parameters of an electrical network – tension and frequency.

The output variables are the temperature values in any point of volume of a plate at any moment (a nonstationary temperature field of a plate).

Productivity of the method of molding is defined mainly by the processing rate. Properties of the detail received by molding depend largely on a mathematical model. The form and the size of pressing define the form of a finished detail and the need of

carrying out additional operations that is of great importance by determination of production cost.

### References

1. Karpushkin S.V., Karpov S.V., Glebov A.O. Proektirovanie pressovogo oborudovaniya dlya proizvodstv rezinovyh izdeliy. [Design of the press equipment for productions of rubber products] / TGTU publishing house, 2014. - 120 p. (Rus)
2. Demin E.E., Kosmacheva I.G. Spravochnik po press-formam. [The reference manual on press] / Lenizdat, 1967. - 365 p. (Rus)
3. Muratov A.O., Mezhuev V.V., Nefedov A.S. Oborudovanie dlya proizvodstva formovyh rezinovyh izdeliy. [Equipment for production of shaped rubber products] / Mashinostroenie, 1978. - 228 p. (Rus)
4. Leykin N.N. Konstruirovaniye press-form dlya izdeliy iz plasticheskikh mass. [Constructioning of compression molds for products of plastics] / Mashinostroenie, 1996. - 241 p. (Rus)

## ИССЛЕДОВАНИЕ ПРОЦЕССА ВУЛКАНИЗАЦИИ НА ПРЕССОВОМ ОБОРУДОВАНИИ

**А.А. Деев**

Тамбовский государственный технический университет, Тамбов, Россия  
e-mail: ufo.deev @yandex.ru

***Аннотация:** Основной проблемой в данной области является построение достоверных математических моделей нагрева элементов прессового оборудования и создание на их основе инженерных методик расчёта, проектирования и оптимизации, позволяющих снизить энергетические, временные и материальные затраты. На наш взгляд, решение подобных задач необходимо осуществлять с использованием современных систем инженерного анализа (CAE) во взаимодействии с системами автоматизированного проектирования (CAD). Первоочередной задачей становится развитие отечественных технологий проектирования суперкомпьютеров на основе масштабируемой сети микропроцессоров, детального предсказательного моделирования в процессе создания перспективных изделий машиностроения, новых энергетических установок, а также технологий проектирования систем управления технологическими процессами на основе масштабируемых аппаратно программных комплексов. Создание таких технологий предполагает проведение фундаментальных и прикладных исследований в различных областях знаний, в том числе в математике, микроэлектронике, информационных технологиях, вычислительных системах, информатике и телекоммуникациях. Проявление комплекса перечисленных проблем можно наблюдать при проектировании элементов конструкции гидравлических прессов для изготовления резинотехнических изделий.*

***Ключевые слова:** гидравлический пресс, методы проектирования, моделирование процесса, резиновые изделия, температурный фактор, тепловое поле, ускоритель вулканизации.*

## DEVELOPMENT OF THE AUTOMATED CONTROL SYSTEM FOR DRIED DISTILLERY DREGS PRODUCTION

I.I. Istomina

Tambov State Technical University 392000, Tambov, Russia

e-mail: Inara\_Istomina@mail.ru

**Abstract:** Literature review of existing and prospective distillery dregs processing technologies was performed. Problems of utilization of distillery's industry drains were described herein. Advantages and disadvantages of proposed methods were compared, recommendations on their choice considering the realities of the Russian producers are given.

**Key words:** processing of dried distillery dregs; dried distillery dregs, distillation industry; ecology.

### Introduction

Currently, the demand for these products is high; this is due to the development of livestock and consequently a large need for quality feed. At the same time, these industries do not have a management system that meets modern requirements and ensures stable quality of the product.

Consequently, the development of the automated control system of the process is an urgent task.

**Dried distillery dreg fodder** is a natural high-value protein and vitamin containing feed for livestock and poultry. Solid product in powder form, which can be used as a separate feedstuff or as an additive for an animal feed production.

In the process of alcohol production from grain raw materials there is a significant amount of production dreg - liquid distillery dreg, which causes environmental pollution when discharged into drains. At the same time, the distillery dreg has a certain nutritional and feeding value because the whole grain protein remains in the dreg after processing of starchy components into ethanol.

At present time the automation of technological process of dried distillery dreg production does not meet modern requirements for control quality, monitoring and alarming of some emergency modes of equipment operation takes place. Temperature measurement in dryers is carried out with mechanical thermometers; pressure - mechanical pressure gauges, control of the amount of energy consumed by the technology is absent. Adjustment and control of process parameters performed manually.

The complexity of the process and the use of almost exclusively manual process control often leads to a violation of the codes of technological regulations, appearance of pre-emergency and emergency situations. Automatic control and adjustment of the basic technological parameters will allow reducing the occurrence of adverse factors.

Local Automation Facilities (Local Control System or LCS) can provide a



solution only to problems of stabilization. For processing of more or less complex solutions (solving problems of optimal process control) it is necessary to use modern microprocessor-based automation tools, as well as to apply multi-level automatic process control system (APCS).

The proposed technology:

1. Combined schemes.
2. Functional diagram

Distillery dregs recycling can solve problems of processing of liquid wastes from the alcohol production:

- Inability for complete utilization of distillery dregs and of centrate through the construction of treatment plants. The reason - the absent of developed microorganisms-bacterias cultures for processing of centrate. Question of centrate utilization with the use of treatment facilities has not been resolved in the world practice.
- To purify the contaminated drains (including dregs) in the distillery industry up to date the filtration fields are applied. This leads to infection and pollution of the ground water, open water bodies and the atmosphere. It requires large areas for filtration fields.
- The presence in distillery dreg of solid substances in the range from 8 to 10% of the total volume requires usage of the equipment for separation (filtration) into solid and liquid fractions.
- After the mechanical separation of distillery dreg, the solid fraction has a high moisture content up to 80%. If the cake would not be dried, after short storage the ferment processes will start.
- The resulting humidity in case of separation by decanter - 75-80%, *by the pressing-auger separator* - 60-65%. After separation by decanter the cake is a fluent a clot with a water content of 2,8 times higher than in case of pressing-auger separator.
- Usage of the centrate evaporation technology, as one of solutions for utilization of distillery dreg and centrate, can lead to bankruptcy of virtually any manufacturer. The reason - the 20th century technology with an enormous energy consumption. Without increase of procurement prices of alcohol or objective support from the state, this technology is hopeless.

Automation of distillery dreg production process is one of the decisive means of improving of the technical and economic efficiency of that production.

Development and introduction of the modern automated control system based on using of advanced automation technologies will allow to significantly improve staff working conditions, improve labor discipline, reduce the impact of human factors, reduce the number of accidents, significantly reduce the cost of maintenance and operation of the distillery dreg production process control system.

### **Conclusion**

Automation of technological process of production of dry stillage is one of the decisive means of increasing technical and economic efficiency of this production.

## References

1. Ledenev, V.P. Pererabotka bardy: opyt, real'nost', perspektivy. [Recycling barda: experience, reality, prospects] / V.P. Ledenev // Likerovodochnoe proizvodstvo i vinodelie. – 2008. – #7. – P. 8–11 (Rus).
2. Novikov, V.B. Barda v zakone. [Barda in the law] V.B. Novikov, S.V. Zverev // Proizvodstvo spirta i likerovodochnyh izdeliy. – 2007. – # 2. – P. 20–23 (Rus).

## РАЗРАБОТКА АВТОМАТИЗИРОВАННОЙ СИСТЕМЫ УПРАВЛЕНИЯ ПРОЦЕССОМ ПРОИЗВОДСТВА СУХОЙ БАРДЫ

**И.И. Истомина**

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: Inara\_Istomina@mail.ru*

**Аннотация:** Выполнен литературный обзор существующих и перспективных технологий переработки послеспиртовой барды. Описываются проблемы утилизации отходов спиртового производства. Сравняются достоинства и недостатки предложенных методов, даются рекомендации по их выбору применительно к реалиям российских производств.

**Ключевые слова и фразы:** переработка послеспиртовой барды; послеспиртовая барда; спиртовая промышленность; экология.

---

УДК 636.4.084

ББК 40.7

## A TWIN-SCREW HOPPER

**D.A. Maksimenko, S.Yu. Klochnev, S.M. Vedishchev**

Tambov State Technical University, Tambov, Russia

*E-mail: msh@nnn.tstu.ru, ttamboff@mail.ru*

**Abstract:** The variants of feed dosing into individual and group feeders were studied; the construction of feeding machine with screw hoppers was suggested; the experimental results of the hopper test by dosing into group feeders were quoted.

**Keywords:** dosing, feeder, suspension screw.

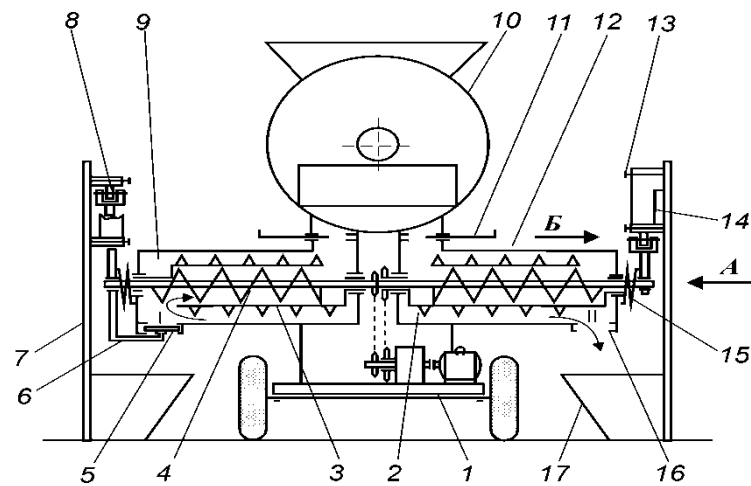
In the feed making and feeding lines of livestock farms dosing by volume hoppers is made in accordance with one of the following principles:

- continuous feed dosing on a predetermined feed level with a small adjustment in time;
- continuous feed dosing with possibility to change feed from peak to peak in the process swiftly;
- portion dosing: a hopper is set on a constant optimal level, a dose is determined by time in use of operating device;

- portion dosing: a dose is changed from point to point by dosing flap position;
- portion dosing: a certain volume of dose is formed in advance and supplied according to a time schedule;
- portion dosing: a certain volume of dose is formed in advance and supplied without time schedule.

The most difficult task is to do a portion dosing with high quality indicators and with possibility to change a dose and comply with a time schedule.

To solve this problem it is introduced a hopper installed on a feeding machine for pigs (Fig.1), which was produced in Tambov State Technical University.



a)

1-mobile cart; 2-screw feed end; 3-rearward motion channel; 4-additional screw; 5-discharging flap; 6-lever; 7-wall; 8-roller; 9-discharging screw part; 10-bin; 11-shut-off flap; 12-distributing screw; 13-pin; 14-plate; 15-spring; 16-discharging port; 17-feeder;

a) scheme of feeding machine.

Fig. 1. The feeding machine

In this variant of the feeding machine a running gear is used. Its scheme is shown in Fig. 2.

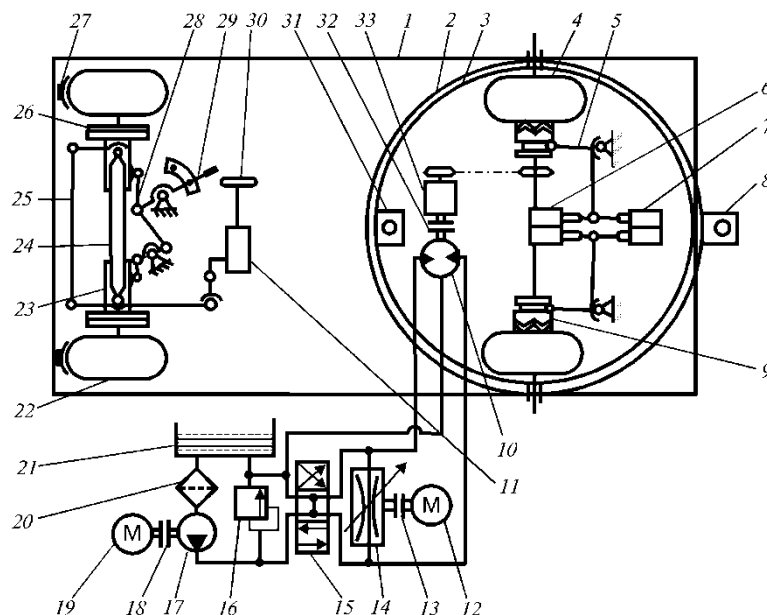


Fig.2. Scheme of a running gear of the feeding machine.

1-frame; 2-lower disc; 3-drive wheels; 5.28-lever system; 6-electromagnets of operating stroke; 7-electromagnets of no-load operation; 8-grip; 9-clutches; 10-hydromotor; 11-steering tube; 12-actuator; 13.18.32-clutch; 14-throttle; 15-hydraulic distributor; 16-safety valve; 17-hydropump; 19-electromotor; 20-filter; 21-tank; 22-driven wheels; 23-sliders; 24-bridge; 25-steering geometry; 26-trunnion; 27-brake; 29-detent lever; 30-steering wheel; 31-clamper; 33-reduction gear.

The application of the running gear on pneumatic-tire wheels with steering control on driven shaft and with electrohydraulic mechanical drive on control shaft helps the feeding machine move along a feeding line independently. The electrohydraulic mechanical drive of control shaft that was taken from the hay mill IRT-165 helps the feeding machine start pull-free and change forward speed of movement gradually.

#### References:

1. Vedischev, S. M. Analiz dozirovaniya kormov. [Analysis of dosing of feed] / S. M. Vedischev, A. Y. Glazkov, A. V. Prokhorov // Questions modern science and practice. University named after V. I. Vernadsky. - 2014. №1 (50). 103-108 p.
2. Vedischev, S. M. Klassifikatsiya bunkernyh kormushek dlya sviney. [Classification of bunker feeders for pigs] / S. M. Vedischev, A. V. Prokhorov, A. V. Milovanov, N. O. Milyukov // Questions modern science and practice. University named after V. I. Vernadsky. - 2014. №2(51). 43-48 p.
4. Vedischev, S. M. Kontrol' pitaniya katushki dozatora [Control of the supply reel dispenser] / S. M. Vedischev, N. O. Milyukov, N. In. Halshaw // Science in Central Russia. - 2015. - №1(13). 5 -12 p.
5. Tishunina, N. P. Eksperimental'nye issledovaniya rabocheho processa sistemy avtomaticheskogo regulirovaniya raspredeleniya suhogo korma. [Experimental researches of working process of automatic control system of distribution of dry food]. / N.P. Tishaninova, A. G. Allianz, O. A. Kropotkin // Bulletin of all-Russian scientific research Institute of mechanization of animal husbandry. - 2011. T. 22. № 3. 80-85p.

## ДВУХШНЕКОВЫЙ ДОЗАТОР

Д.А. Максименко, С.Ю. Ключнев, С.М. Ведищев

Тамбовский государственный технический университет, Тамбов, Россия

e-mail: msh@nnn.tstu.ru, ttamboff@mail.ru

**Аннотация:** Рассмотрены варианты способов дозирования корма в индивидуальные и групповые кормушки; предложена конструкция кормораздатчика со шнековыми дозаторами; приведены результаты экспериментальных исследования дозатора при выдаче в групповые кормушки.

**Ключевые слова:** дозирование, кормораздатчик, ходовая часть шнека.

## FEATURES OF THE DESIGN AND EXPLOITATION OF THE SPIKE-TOOTH AND SPRING-TOOTH HARROW IN RESOURCE-SAVING TECHNOLOGIES

V.A. Myskin, A.Y. Nefyodov

Tambov State Technical University, Tambov, Russia

e-mail: nefyedov@yandex.ru

**Abstract:** *The article analyzes the design of the teeth and spring harrows, as well as the introduction of resource saving and soil conservation technologies. It discusses the advantages and disadvantages of different types of harrows.*

**Keywords:** *loosening, resource conservation, soil surface treatment, spike-tooth harrows, spring-tooth harrows.*

The analysis of modern Russian and foreign resource-saving technologies in crop production reveals the important role of technical equipment of agricultural enterprises of machines and mechanisms, characterized by high performance, reliability, high performance and ease of maintenance [1, 2, 3].

We have identified and analyzed the particular features of the structure and spike-tooth harrow and harrows aggregates of the variety of tillage machines. That allows identifying the factors that determine the trend in the construction of power harrows and make recommendations for their use in the realization of various farming systems.

Harrows aggregates have traditionally been widely used to keep moisture in the ground of plowed fields and fallow fields, to level fields and crush lumps, to destroy the soil crust and destruct weeds in the process of pre-emergence and germination harrowing of crops, taking care of meadows and pastures, etc.

Reduction of employees engaged in agricultural production, new technologies of cultivation of agricultural crops, the need to conserve resources - have changed the requirements for machines used for harrowing. First, agricultural enterprises cannot spend a much money on resources recruitment on aggregation harrows aggregates, harrows transportation to remote fields, maintenance and repair of harrows.

Crop management technologies, which do not reduce the amount of plant resources on field (green manure, straw), make it impossible to use traditional harrows that clog plants and make the process of purification extremely difficult.

Thus, the disadvantages of traditional spike-tooth harrow:

- the complexity of aggregate acquisition;
- problems of moving aggregates from one field to another one and impossibility of using public roads for such operations;
- inability to use the harrow on the fields with many plant residues;
- problems with sticking soil on fields with high humidity;
- the need to all time-consuming work to restore worn teeth;
- unsuitability for use in case soil conservation technologies are applied;

- the minimum possibility to regulate the influence of teeth on the ground.

However, the towed spike-tooth harrows are successfully used in traditional technologies, and some designs are used to overcome their disadvantages.

For small farms, it is advisable to use a folding frame design with sections of spike-tooth harrows, mounted on the tractor hitch.

The use of spring-tooth harrows is becoming popular nowadays. Taking into account today's technologies and harrows labor shortages, spring-tooth harrows are gradually replacing traditional hard-harrow teeth. Spring-tooth harrows are more productive, they can be used in any cropping system with conventional, minimum or zero tillage. Spring-tooth harrows, which have a large working width can be compactly folded into the transport position and are serviced by only one tractor driver (Fig. 1).



*Fig.1 - Spring-tooth harrow at work and transport position*

Long spring teeth vibrating in the longitudinal plane, better loosen topsoil, can clean adhering soil and crop residues, have less wear, do not require maintenance and repair, have a wide range of fine adjustment of the pressure on the soil and loosening intensity.

The impact of the spring-tooth harrow on soil depends on the thickness of the tooth [4]. In connection with this spring harrows can be used not only for intensive loosening and leveling the soil when soil is harrowed and moisture is kept (heavy harrows), but also for the harrowing of crops of grain and weed control in crops of cultivated crops (light harrows) (Fig. 2). The latter is especially important for reducing the number of row cultivation and the chemical load on the ecosystem.



*Fig. 2 - The harrowing of cultivated crops*

Spring-tooth harrows used to keep moisture have a number of significant advantages over conventional teeth: greater productivity due to high speed movement of the unit and the efficient use of working time, the opportunity to work even on wet and sticky soils, as well as reducing clogging of working bodies with plant residues.

Spring-tooth harrow, are effectively used in soil conservation technologies for

leveling straw, pre-emergence soil tillage, harrowing crops with simultaneous application of fertilizers, herbicides, and for seeding small-seeded crops, sowing grass and green manure (Fig. 3).



*Fig.3 - Spring-tooth harrows with fertilizers*

They are used together with modern combined tillage machines for crumbling and leveling of the soil.

Thus, the modern farmer has a wide range of spike-tooth harrows, depending on the use of crop cultivation technologies, the volume of work performed, the availability of human and financial resources [6].

#### **References:**

1. Innovatsionnyiy opyt proizvodstva selskohozyaystvennoy produktsii [Innovative experience in the production of agricultural products]. М .: FGBNU "Rosinformagroteh" - 2014 - 132 p. (Rus)
2. Zavrazhnov, A.I. Sovremennyye problemy nauki i proizvodstva v agroinzhenerii [Modern problems of science and industry in the Agricultural Engineers]: Textbook / Ed. A.I. Zavrazhnova - SPb .: Publishing house "Lan", 2013 - 496 p. (Rus)
3. Fedorenko V.F. Povyishenie resursoenergoeffektivnosti agropromyshlennogo kompleksa [Increasing resursoenergoeffektivnosti agribusiness] / М .: FGBNU "Rosinformagroteh", 2014.- 284 p. (Rus)
4. Tyazhelye zubovyye borony: preimuschestva primeneniya [Heavy Toothed harrows: the advantages of using] [electronic resource]: Web Access: <http://agrospring.ru/v-spring.php?id=2>
5. Spring Harrows "Striegel" [electronic resource]: Web site: -Access: [http:// www. Hatzenbichler.ru/tech/44/2606/](http://www.Hatzenbichler.ru/tech/44/2606/)
6. Fedorenko V.F. Resursosberezhenie v APK [Efficient use of resources in the AIC] / М .: FGBNU "Rosinformagroteh", 2012.- 384 p. (Rus)

## **ОСОБЕННОСТИ КОНСТРУКЦИИ И ЭКСПЛУАТАЦИИ ЗУБОВЫХ И ПРУЖИННЫХ БОРОН В РЕСУРСОСБЕРЕГАЮЩИХ ТЕХНОЛОГИЯХ**

**В.А. Мыскин, А.Ю. Нефёдов**

Тамбовский Государственный Технический Университет, Тамбов, Россия

*e-mail: nefyedov@yandex.ru*

*Аннотация:* В статье проанализированы конструкции зубовых и пружинных борон, а также их внедрение в ресурсосберегающие и почвозащитные технологий; рассмотрены преимущества и недостатки бороновальных агрегатов разных типов.

*Ключевые слова:* зубовые бороны, поверхностная обработка, пружинные бороны, ресурсосбережение, рыхление.

## FACILITY FOR RESEARCH INTO NOISE INSULATION PROPERTIES OF COATING BASED ON POLYMER SOLUTIONS

**S.A. Ovchinnikov, A.O. Danilova**

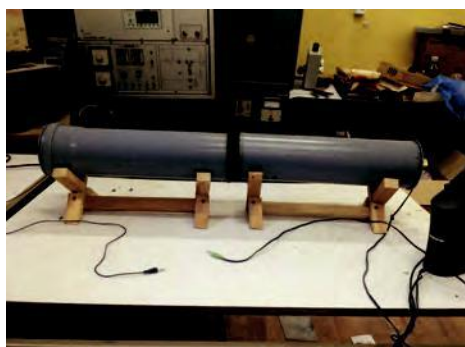
Tambov State Technical University, Tambov, Russia

*e-mail: fobos689@yandex.ru*

**Abstract:** *Noise in a passenger compartment is a constant problem of many domestic cars. In this article, we consider the materials developed for improvement of noise isolation of the car and installation for check of everyone on sound absorptivity. Pluses and minuses of the proposed technology are considered. Also, we will note that this compounding has a wide range of properties which are capable to improve noise-absorbing of bodies of cars*

**Keywords:** *polymer, facility for the study of noise-insulating properties, composite materials*

Any car contains a lot of different sources of noise of different nature. If manufacturers of business-class cars pay a lot of attention to comfort and noise insulation for their cars, more affordable cars have only factory manufactured noise insulation system that is not enough. That is why many Russian car owners complain about poor noise insulation of the vehicle and about annoying sounds which are called «crickets». This is a huge problem of Russian car industry. Noise insulation is one of the main factors of comfort and features of luxury cars. The low level of noise insulation of the passenger compartment affects drivers attention and increases his or her fatigue. This is especially noticeable at high speeds, when the general buzz in the car cabin gives the impression that the car will take off. That is why you do not feel a speed in luxury cars. Good noise insulation allows the car to reveal its sound audio system. Very often clients notice that the sound becomes better after it's been repaired. Literature review (1-6) showed there are few approaches to the preparation of noise insulation compounds. We developed and manufactured the original facility for experimental research into anti-noise properties of polymer composites (Fig. 1)



*Fig. 1 - Experimental facility for noise insulation properties based on polymer solutions*

The facility contains:

Ritmix RCMmicrophone - 101, SmartBuyFest speaker, PVC pipe with 100 millimetres diameter, rubber seals and plug.



The microphone characteristics are as follows:

Condenser Microphone;

Directional type is omnidirectional;

Sensitivity is up to 110 dB;

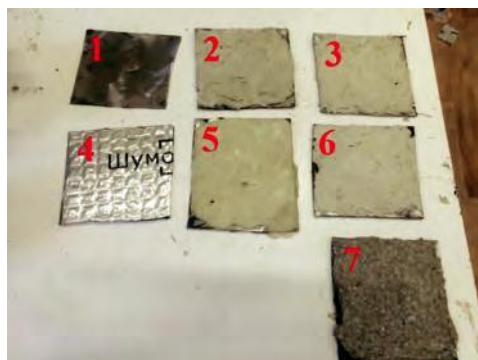
The type of connection is wired

The speaker characteristics are as follows:

A power of 2 W;

Power is based on 220V

Line input (stereo), mini jack connector.



*Fig. 2 - Experimental samples: Sample 1 100% ABS plastic; Sample 2 60% ABS + 30% UHMWPE+ 10% talc; Sample 3 60% ABS + 30% fluoroplastic + 10% talc; Sample 4 SOUND OFF; Sample 5 48% ABS + 32% UHMWPE + 20% talc; Sample 6 38% ABS 29% UHMWPE + 15% talc + 18% fluoroplastic.*

The operating principle of this facility is as follows. As shown in Fig. 2, samples are successively placed between two parts of the pipe. The microphone and the speaker are connected to a personal computer. This computer has installed «Decibel meter» program that is made publicly available, which measures the volume in decibels. For the research, we also used «Sound Generator» that is also available in the public domain. In this program, we used the frequency range from 20 to 2000 Hz and took readings from the microphone at the same time. We prepared a solution based on BSA plastic for creating our noise insulation composition. We used "Acetone" as a solvent. The polymer solutions for experimental studies were prepared as follows: we put a predetermined amount of the polymer solution and the calculated amount of additives into measured capacitance. In order to obtain the desired viscosity of noise insulation composition you need to add the solvent. Then add the obtained compositions to the prepared pre-metal samples. Those samples sound insulation characteristics are being investigated on this particular facility.

#### References:

1. Kobzev D.E., Osnovyi remonta i vosstanovleniya detaley mashin i mekhanizmov. Tverdogaznyie metodyi polucheniya detaley iz polimernyih materialov. [Bases of repair and restoration of details of cars and mechanisms. Solid-phase methods of receiving details from polymeric materials] / D.E. Kobzev, G.S. Baronin, P.V. Kombarova, Yu.E. Glazkov, A.V. Prohorov // Uchebnoe posobie. Tambov. Izd- vo Pershina R.V., 2015. - 100 s. (Rus)
2. Panimatchenko A.D. Pererabotka plastmass. [Processing of plastic] / izd. Professiya, Spb 2005

(Rus).

3. Karyakina M.I., Poptsov V.E. Tehnologiya polimernyih pokryitiy: Uchebnoe posobie dlya tehnikumov. [Technology of polymeric coverings: The education guidance for technical schools] / M.: Himiya, 1983 – 336s. (Rus).

4. Yakovlev A.D., Zdor V.F., Kaplan V.I. Poroshkovyie polimernyie materialyi i pokryitiya na ih osnove. [Powder polymeric materials and coverings on their basis] / Himiya, 1979. 254 s. (Rus).

5. Royh I.L., Kaltunova L. N. Zashitnyie vakuumnyie pokryitiya na stali. M.: Mashinostroenie. [Protective vacuum coverings on steel] / 1971. – 280 s. (Rus).

6. Krasovskiy A.M., Tolstopyatov E.M. Poluchenie tonkih plenok raspyleniem polimerov v vakuume. [Receiving thin films dispersion of polymers in vacuum] / Belogo V.A. - Mn.: Nauka i tehnika, 1989. – 181 s. (Rus).

## УСТАНОВКА ДЛЯ ИССЛЕДОВАНИЯ СВОЙСТВ ШУМОИЗОЛЯЦИОННЫХ МАТЕРИАЛОВ НА ОСНОВЕ РАСТВОРОВ ПОЛИМЕРОВ

**С.А. Овчинников, А.О. Данилова**

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: fobos689@yandex.ru*

***Аннотация:** Шум в салоне автомобиля является постоянной проблемой многих отечественных автомобилей. В данной статье мы рассмотрим материалы, разработанные для улучшения шумоизоляции автомобиля и установку для проверки каждого на звукопоглощаемость. Будут рассмотрены плюсы и минусы предлагаемой технологии. Так же отметим, что данная рецептура имеет широкий круг свойств, которые способны улучшить шумопоглощение кузовов автомобилей*

***Ключевые слова:** полимер, установка для исследования шумоизоляционных свойств, композитные материалы.*

---

УДК 621.384.3

ББК 32.97

## MACHINE ELEMENTS AND COMPONENTS STANDARDIZATION

**M.S. Cherkasov, D.I. Chugay, D.E. Volchenkov**

Tambov State Technical University, Tambov, Russia

*e-mail: wolf080195@rambler.ru*

***Abstract:** Standardization is of great importance both for machine industry and national economy. Standardization ensures uniformity and quality of products by introduction of special binding reference documents called standards.*

***Keywords:** standardization, constructions, details, mechanisms, devices*

Standardization of machine parts and components includes:

- design rules - general rules, classifications, glossaries, calculation methods and drawings rules;
- structures - basic parameters, mounting and overall dimensions;
- manufacturing process parameters- engineering procedure and tools;
- quality level and usage environment – materials, drawings, technical requirements and testing methods.

Machine parts standardization ensures:

- a) quantity production of standard elements; labor intensity in the quantity production is far less than that in the small-scale and individual production;
- b) standard cutting, deforming and measuring tools;
- c) easy replacement of broken parts;
- d) great saving of labour;
- e) design quality upgrading.

It is difficult to imagine the great amount of labour to be spent to work out individually all screws, rolling element bearings, lubricating arrangements and other standardized elements and components for every machine.

It is important to design machines taking into account the possibility of components and parts unification with other machines, which are similar in size and design. That is why the integrated design of machines size spectrum is actually efficient.

Experience in the machine industry proves a great efficiency of machines' building block design, i.e. machines' manufacturing by using special standardized elements called aggregates and assemblies. Machines' building block design is generally used for small-scale machines and individual productions that provide commercial manufacturing of aggregates, thereby making the production cheaper and faster.

The great efficiency of the quantity production in contrast to that of the small-scale and individual productions makes the designers use the aggregates and even machine parts which have been already manufactured massively.

Machine parts cannot be manufactured with absolute accuracy and always have some deviations from nominal dimensions. However, interchangeability of parts is crucial for operation, manufacturing and design of machines.

Interchangeability is the ability of independently produced parts to take their places in the car and provide good-quality work without additional processing. Interchangeability allows independent processing of parts by means of high-performance techniques (as it eliminates the need to fit a mating piece to another), the effective application of the production and assembly-line, high-performance, easy and reliable control of products using calipers, fast replacement of defective machine parts by prefabricated spare, acceleration design, etc.

Interchangeability (full or partial) depreciating standard system limit of tolerances and landings.

Size tolerance is the difference between the largest and smallest size limit values. Zone between the sizes of the field is called tolerance. Tolerances are

established in accordance with the ten classes of accuracy: 1, 2, 2a, 3, 3a, 4, 5, 7, 8 and 9.

The 1<sup>st</sup> accuracy class is used:

- a) for part determining the work accuracy of special precision machines, precision machines, separating machines;
- b) for particularly stressed parts in high-speed machines where accuracy largely determines the distribution of the load or stress;
- c) for parts in noiseless high-speed mechanisms if necessary.

The 2<sup>nd</sup> accuracy class is considered to be the prevalent one in modern production.

The 3<sup>rd</sup> accuracy class is characteristic for parts in medium-speed machines and other machines and mechanisms of average accuracy.

The 4<sup>th</sup> accuracy class is used for elements, parts and machines of low precision, mainly low-speed ones; it provides for the possibility of partial use of the parts made without chip removal from bright-drawn round steel and pipes, cold-formed elements etc.

The 5<sup>th</sup> accuracy class is used in the most minimal requirements for accuracy, generally, for auxiliary devices, it is focused on the manufacture of elements without chip removal.

The 7<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup> accuracy classes are for parts of free size, i.e. the size of mismatching surfaces and workpieces for sizes after pretreatment. These classes of accuracy are formed as a result of stamping, drawing, casting in a mold, the rough turning and milling etc.

The numerical values of tolerances in the range of generally 1-500 mm size are taken proportional to the cube root of the size.

The connection of the mating parts is determined by the fit, which limits the value of tightness or gaps in the joint.

Landing is divided into three groups: interference fit, landing with a gap and transitional.

An interference fit (pressed) is mainly used for the fixed connection of the parts without additional fastening.

Transitional planting, i.e. planting, which can be both interference and clearance (depending on the combination of the actual sizes of the mating parts), is used for the fixed connection of the parts with additional mounting dowels, pins and screws. These plantations are mainly used for centering of the mating parts.

Landing with a gap (sliding) is used in mobile mates (kinematic pairs); the fit of the slip is also used in fixed connections while the machine is working, but it is subject to frequent assembly and disassembly.

Landing of the 2<sup>nd</sup> (main) accuracy class is arranged in order to decrease the preload and increase the gap:

1. With interference
2. Transitional
3. With a gap
4. Hot

5. Deaf
6. Slip
7. Press
8. Tight
9. Sliding
10. Light-press
11. Tense
12. Running
13. Push
14. Free-running
15. Coarse clearance
16. Thermal running gear

Landing are selected by calculation or by experience.

For press fits, interference is calculated by the condition of the required load transmission, and for running fits, the most appropriate gap fluid friction is based on thermal strains. The gap is often limited by accuracy requirements.

Various planting is carried out by varying tolerances of only one of the mating parts, and tolerances for the second part of the nominal size and accuracy class remain constant. This reduces the required number of tools (reamers, broaches and gauges).

If the tolerances are stored (for a given diameter and accuracy grade) constant in the female part - holes, then the system of tolerances and fits is called the hole system, and if the male part - the shaft, this system is called the shaft system.

The nominal size in the hole system coincides with the lower limiting size of the hole and the hub tolerance zone is located in the hub body. The shaft system, the nominal size coincides with the greatest limiting size of the shaft and the shaft tolerance zone is located in the shaft body.

The main application in engineering has the hole system provides for a reduction range of expensive tools for machining of the holes.

Application of the shaft system is caused by the following:

- 1) use of a bright-drawn calibrated shaft material without further processing (in the agricultural and textile engineering and some areas of the instrument engineering);
- 2) implementation of the seating surfaces of the outer rings of rolling bearings for shaft system (to avoid the release of bearings with different permissible deviations on external diameter);
- 3) the ability to deliver a smooth shaft instead of a stepped one.

Tolerances and landing are put on the drawings behind the designation of the nominal size. At planting assembly, drawings are denoted by fraction, the numerator refers to the hole, and the denominator to the shaft; on the working drawings, the tolerance is represented in a line with the size. In the hole system, the letter A is used for the hole, and the symbol of the corresponding tolerance is used for the shaft. In the shaft system, the letter B is used for the shaft, and the symbol of the corresponding tolerance is used for the hole.

By using non-standard tolerances and landings, as well as by the absence of the

required limit gauges it is possible to put numerical values of permissible dimensional deviations on the drawing.

It's important to design machines given the possibility of components and parts unification with other machines, which are similar in size and design.

### **References**

1. Gorbatsevich A.F. Kursovoe proektirovanie po technologii mashinostroenie/, V. A. Shkred.
2. Spravochnik tehnologa mashinostroitela. / A. M. Dalski, A.G. Kosilova
3. Tkachev A.G. Technologia mashinostroenia / I. N. Shubin

## **СТАНДАРТИЗАЦИЯ ЭЛЕМЕНТОВ И КОМПОНЕНТОВ МАШИН**

**М.С. Черкасов, Д.Э. Волченков, Д.И. Чугай**

Тамбовский Государственный Технический Университет, Тамбов, Россия

*e-mail: wolf080195@rambler.ru*

***Аннотация:** Огромное значение в машиностроении, как и вообще в народном хозяйстве, имеет стандартизация. Стандартизация — это обеспечение единообразия и качества продукции введением специальных обязательных для применения нормативных документов — стандартов*

***Ключевые слова:** стандартизация, конструкция, детали, механизмы, устройства*

---

# ELECTRONICS, RADIO ENGINEERING AND COMMUNICATION SYSTEMS

---

УДК 621.396.967  
ББК 32.95

## ADAPTIVE FILTERING BACKGROUND RETURNS IN THE RADAR AIR TRAFFIC CONTROL SYSTEMS

**V.S. Panfilov**

Tambov State Technical University, Tambov, Russia  
*e-mail: ponfak@gmail.com*

**Abstract:** *The paper considers the problem of implementation of adaptive filtering of radar signal in the presence of background returns within range of the radar system.*

**Keywords:** *Adaptive filtering, background returns, radar, air traffic control systems.*

Radar automated air traffic control (ATC) systems are one of the main tools that gain access to the information on the traffic situation. Monitoring and control procedures, implemented with that systems, must provide the safety of aircrafts, while maintaining their regularity and cost-effectiveness. On the other hand, the ATC radars operate under the impact of various types of background returns, which are radar signals reflected from hydro/meteo-formations underlying surface, and sporadic reflection. The presence of clutter affects the quality of information provided by ATC radar. Listed clutters have various characteristics that may hinder their subsequent identification and filtering. For these reasons, the choice of optimal radar signal processing algorithms, especially considering adaptive algorithms.

Filtering procedure implies the presence of a radar signal of the useful signal and interference signal. Useful signal contains information about the observation objects (aircraft), which, in general, may include both the coordinate and non-coordinate information.

Surveillance and aircraft control procedures include the implementation of the various stages of processing radar information. Each stage characterized by a unique set of parameters. Filtration solutions clutter reducing by a certain time interval, during which the measurement is an average of the radar signal. For the selected time interval the statistical characteristics of the desired signal and the interference amount can be regarded as quasi-stationary, i.e. not different from those of known characteristics at a steady process.

The problem of choice of the radar signal averaging interval can be reduced to the optimum detection threshold is exceeded initially given squares of the 1st and 2nd primary moments and instantaneous process values.

A necessary condition for quasi-stationary process is the synchronous exceeding of both of these thresholds. Failure detection of at least one of these characteristics deteriorates the filtration system. If we abandon the definition of

instantaneous values, the possible omission of important information "emission" of the useful signal. Rejection of the analysis of the second moment (average power) process can lead to a "pass" important information from the point of view of the slow and insufficiently centered intensive variation of the desired signal [1,2,3].

Adaptive filtering process is as follows. At the time of establishing, the desired signal the current averaging interval integrator takes a minimum value, and then begins to increase linearly. This procedure realized by calculating filter parameters, which fed to the data inputs of the threshold calculator. The inputs of the subtractor serves both signals. Process, obtained at the output, used to analyze subtractor stationarity. With the integrator and squarer the system produce first initial moment. With the help of the other integrator and squarer stands second initial moment. The output of the second squarer signal used to detect instantaneous emission. Comparator detects the excess of these parameters over the rapids. When exceeding at least one threshold comparator outputs a signal to the calculator thresholds As a result, node resets filter parameter calculator and all the integrators to the initial condition and the evaluation process repeated in the same sequence.

The characteristics of the adaptive filtering procedure compared with other possible algorithms for adaptive filtering background returns. It shows that the adaptive filter have more flexible characteristics, for example, in comparison with the filtration method of "sliding windows".

#### References

1. Krasheninnikov V.R., Tashlinsku A.G, Krasheninnikov I.V. An adaptive algorithm for the identification of fingerprints. Pattern Recognition and Image Analysis. — Birmingham, USA, 1996, Vol. 6, Issue 2, p. 277.
2. Pudovkin A.P., Danilov S.N. Panasyuk Y.N. Advanced information processing methods in radio systems. Scientific Publication. — SPb, Russia, 2014. p. 256.
3. Panasyuk Y.N, Pudovkin A.P. Information processing in radio systems: tutorial. TSTU — Tambov, Russia, 2016, p. 84.

## АДАПТИВНАЯ ФИЛЬТРАЦИЯ МЕШАЮЩИХ ОТРАЖЕНИЙ В РАДИОЛОКАЦИОННЫХ СИСТЕМАХ АС УВД

**В.С. Панфилов**

Тамбовский Государственный Технический Университет, Тамбов, Россия

*e-mail: ponfak@gmail.com*

*Аннотация:* рассмотрена задача реализации адаптивной фильтрации радиолокационного сигнала в условиях наличия мешающих отражений в зоне действия радиолокационной системы.

*Ключевые слова:* адаптивная фильтрация, мешающие отражения, радиолокационные системы.



## PROSPECTS FOR THE APPLICATION OF ULTRA-WIDEBAND PRINTED VIVALDI ANTENNAS IN 5G STANDARD NETWORKS

**A.G. Ryazanova, O.O. Grigorov, S.D. Erokhin, O.A. Belousov**  
Tambov State Technical University, Tambov, Russia  
*e-mail: alexandra.ryazanova@yandex.ru*

**Abstract:** *Features of the fifth-generation networks are considered and their main advantages identified. The design of UWB printed Vivaldi antenna represented, its parameters are analyzed, as well as its electromagnetic characteristics are shown.*

**Keywords:** *5G standard; broadband antenna; directional pattern; information transfer; SWR, UWB printed antenna; Vivaldi emitters.*

The rapid development of new technologies of information transmission increases every year. But even modern storage and transmission of information are not able to meet the full extent of all the needs of today's digital society. The existing resources are being depleted due to their restrictions on the volume and speed of data transmission.

Information transmission method using radio waves is not fully utilized. Despite the load of the radio spectrum, there are wide bands which can be remain for the developed using of technical facilities: circuitry devices, antennas and other things [1].

Modern 4G network standard designed for the operating range of 2665 MHz, capable of providing data transfer rate up to 100 Mbit/s, which is an acceptable result for most users. But as mentioned above, progress does not stand still and is projected 4G network resource professionals can no longer be sufficient in the coming years.

Using millimeter-wave radio waves to create an ultra-high performance wireless transport networks 5G mobile network traffic is the most promising at the moment. Such networks are now capable of providing data rates up to 10 Gb/s, using a simple modulation methods without the use of additional coding algorithms [2].

High data rates are hundreds of times more than the existing indicators and the possibility of reducing the dimensions of antenna systems, resulting in decrease wind load on the antenna, which is very significantly affects the cost of the communication system, can be attributed to the benefits of the fifth-generation network standard. Also, the transmission and / or reception of data based on a narrow directional beam, refers to the positive parameters of ultra-wideband access systems. Due to this, interference between adjacent base stations will be absent, power will be increased, and the range of the millimeter-wave communication channel will be increased.

Therefore Vivaldi emitters can be recommended as a primary radiator for a given range. Along with the traditional radiators of this range, it has a number of advantages, such as weight and size parameters, improved electrodynamic characteristics over a wide frequency band and ease of manufacture and tuning, which is an important parameter for this type emitters.

As the authors of the article "Features of designing millimeter-wave communication systems radio waves" E.V. Omelyanchuk, A.V. Tikhomirov, A.V. Krivosheev, broadband and the ability to create on their basis of compact and practical design is the main feature of Vivaldi antennas. In drawing up the lattice of these antennas and sufficiently small (less than half the wavelength at the highest frequency operating range), the distance between them, their mutual relationship improves the matching of the antenna as a part of the antenna array [3]. This feature allows you to build ultra-wideband DF ring lattice with a good matching and satisfactory directional properties in ultra-wide band [3].

Working band of this type of antennas is capable cover the frequency range between 300 MHz to 15GGts. A schematic view of the transmitter is presented in Figure 1.

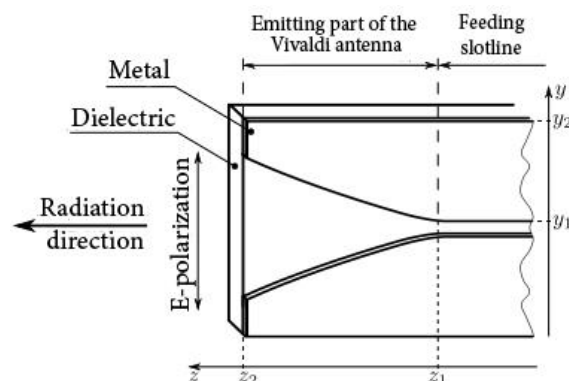


Fig. 1 - Schematic view of the Vivaldi antenna (transmitter)

UWB printed antenna has a fairly good agreement between the input resistance and starts to effectively radiate electromagnetic waves at a slit width  $\geq \lambda / 2$  [4].

Surface wave formed in inhomogeneous slotline which extends simultaneously several types of electromagnetic waves, which can lead to creation of a significant component of polarized stray fields containing up to 20-30% of the radiated power [4]. The level of cross-polarization can be reduced by reducing the thickness of the dielectric substrate, but this will increase the width of the main lobe [4]. The partial removal of the dielectric (eg, creation of holes in it) leads to a reduction of side lobes without broadening the beam [4].

Figure 2 shows the radiation pattern in the far field. The radiation pattern of the Vivaldi antenna addressed to the wide end of its conical gap [5].

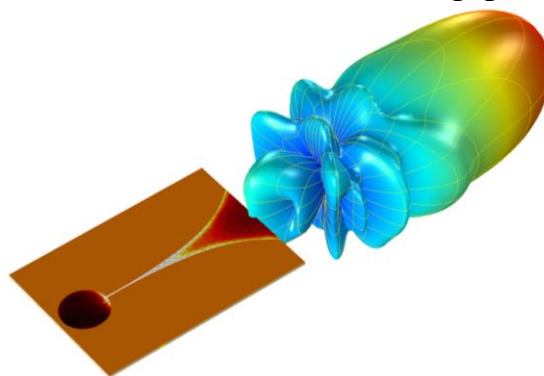


Fig. 2 - Three-dimensional radiation pattern of the Vivaldi antenna in the far zone modeled using COMSOL Multiphysics

SWR graph presented in Fig. 3 shows that Vivaldi antenna has good impedance matching over a wide frequency band and has a bright minima and maxima of the SWR [5]. The ratio is of the form 2:1 for most of the range that is acceptable for use in transmitting radio communication systems [5].

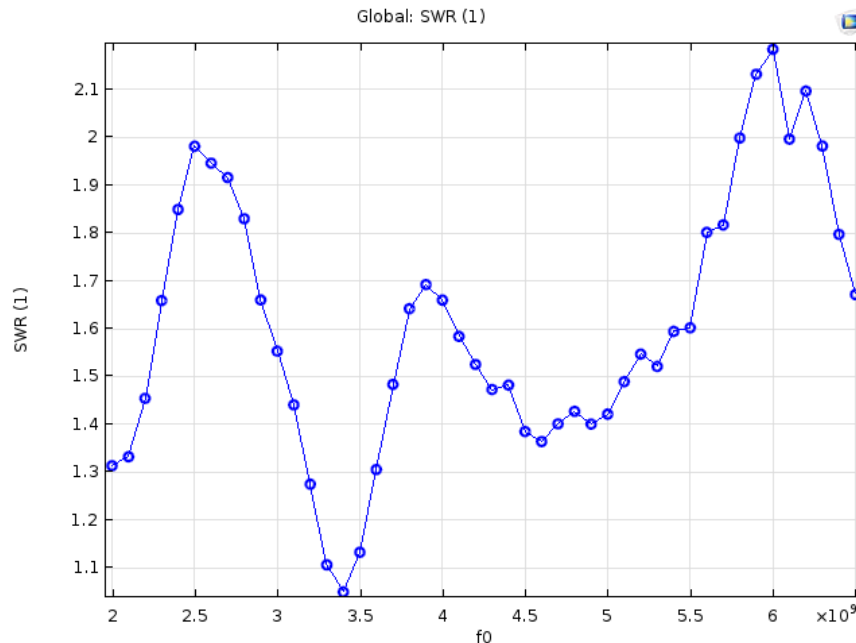


Fig. 3 - The results of the simulation in the form of the CWS schedule in COMSOL Multiphysics

Thus, the use of this type of emitters to 5G standard broadband systems will provide the desired characteristics of high-speed data transmission in a wide range of operating frequencies at relatively low cost to manufacture required equipment.

### References

1. Mikhalev N.E., Bourenkov V.V. Budushhee millimetrovyh voln [The future of millimeter waves] International conference of students, graduate students and young scientists "Information technology, telecommunications and control system": a collection of reports. - Ekaterinburg: [Ural Federal University], 2015. P. 60-64 (in Russian).
2. Omelyanchuk E.V., Tikhomirov A.V., Krivosheev A.V. Osobennosti proektirovaniya sistem svjazi millimetrovogo diapazona radiovoln [Features of designing communication systems millimeter wavelengths] Electronic scientific journal "Engineering Don Gazette" - Vol. 2, 2013 (in Russian).
3. Thomas Milligan. Modern antenna design – 2nd ed. A John Wiley & Sons, Inc., Publication. 2005.
4. Volkov K.O., Pasternak Y.G., Razinkin K.A. Fedorov S.M. Analiz sushhestvujushhih konstrukcij antenyh jelementov pelengatornyh reshetok [The analysis of existing designs of antenna elements DF arrays] Journal "Bulletin of Voronezh State Technical University", 2015, issue №6, Vol. 11, pp. 66-69 (in Russian).
5. Caty Fairclough. Analiz konstrukcii anteny Vival'di [Analysis of Vivaldi antenna design] <https://www.comsol.ru/blogs/vivaldi-antenna-design-analysis/> (Accessed 25 March 2015) (in Russian).

# ПЕРСПЕКТИВЫ ПРИМЕНЕНИЯ СВЕРХШИРОКОПОЛОСНЫХ ПЕЧАТНЫХ АНТЕНН ВИВАЛЬДИ В СЕТЯХ СТАНДАРТА 5G

А. Г. Рязанова, О.О. Григоров, С.Д. Ерохин, О.А. Белоусов  
Тамбовский государственный технический университет, г. Тамбов, Россия  
*e-mail: alexandra.ryazanova@yandex.ru*

**Аннотация:** Рассмотрены особенности сети пятого поколения и выявлены основные их преимущества. Представлена конструкция сверхширокополосной печатной антенны Вивальди, проанализированы её параметры, а также приведены её электродинамические характеристики.

**Ключевые слова:** диаграмма направленности; излучатель Вивальди; КСВ; передача информации; сверхширокополосные печатные антенны; стандарт 5G, широкополосные излучатели.

---

УДК 62-523.8  
ББК 32.988-5

## EDUCATIONAL LABORATORY COMPLEX WITH REMOTE ACCESS

D.A. Fedotov  
Tambov State Technical University, Tambov, Russia  
*e-mail: subs1stem@yandex.ru*

**Abstract:** Currently, the development of distance education in engineering areas is faced with challenges because of the lack of opportunities for full organization of a laboratory practicum. This is explained by the fact that some students live in remote areas. Also, one of the most important tasks of the society is inclusion of people with disabilities in modern life, and that is especially important in the education process.

In view of the above problems, the project of laboratory complex with remote access is proposed.

**Keywords:** laboratory complex, laboratory stand, remote access, remote education, controller

The purpose of the project is the development of an educational laboratory complex to perform remotely laboratory work of students with disabilities, students of distance and correspondence forms of education, the implementation of career guidance activities to a qualitatively new level.

Problems addressed by the Project are as follows:

1. It is worth noting the current activity of the RF government for rehabilitation of people with disabilities and their integration into modern life, including the education process. To address this problem the government supports the program "Accessible Environment" [1,2]. A laboratory complex with remote access solves important social problems. The complex offers an opportunity to citizens with disabilities, or people who for health reasons cannot personally be present in the classroom to get a decent

education.

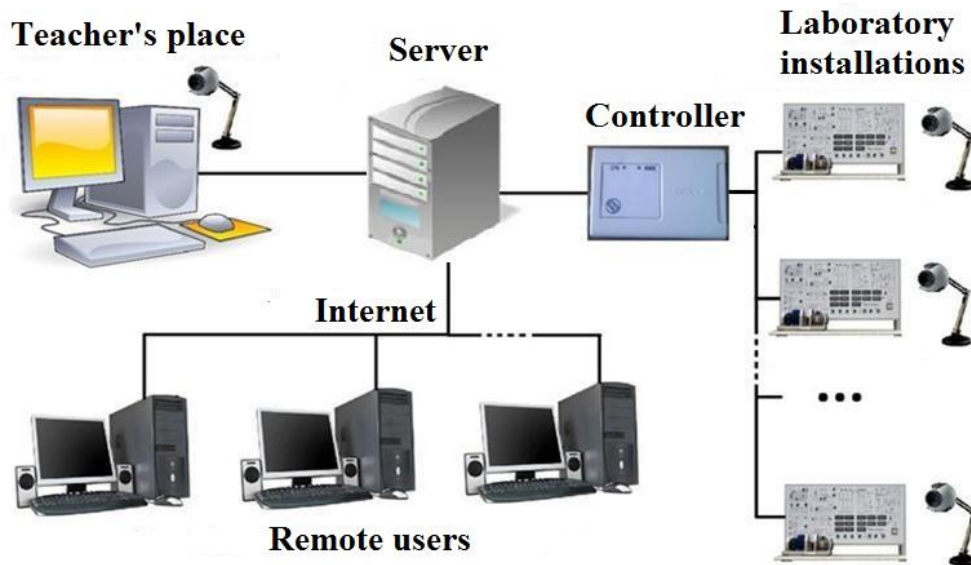
2. Educational goals. The use modern engineering approach in solving educational problems, in particular the remote execution of laboratory work with full visual control and management of laboratory equipment is a promising area of research.

The developed system allows teachers to deliver consultations and lectures in on-line remote access and includes software with algorithmic and methodological function, as well as automated submission of the results of work in electronic form and automatic checking of the results.

The laboratory complex server stores electronic educational publications necessary for the development of lectures, performing laboratory and independent work.

3. Career Guidance. Laboratory complex with remote access allows you to raise the professional work to a qualitatively new level, making it possible for students to work with the university laboratory equipment via remote access using the Internet.

4. Economic goals. This complex reduces the training costs associated with the transportation costs, and compared to similar products it has a significantly lower cost and flexible configuration.



*Fig. 1 Structure of laboratory complex*

The complex (Fig.1) consists of: a personal computer (server), master controller, connected to the server via the USB port, laboratory installations connected to the controller, web-camera, connected to the server, the main computer allows controlling the modes of laboratory complex and students actions.

The controller (Fig. 2), which is based on the complex (Fig. 1), has a redundant power supply system, the ability to connect various sensors, as well as the protection of input and output (isolation and Darlington modules) from static discharges, overloads and short circuits.

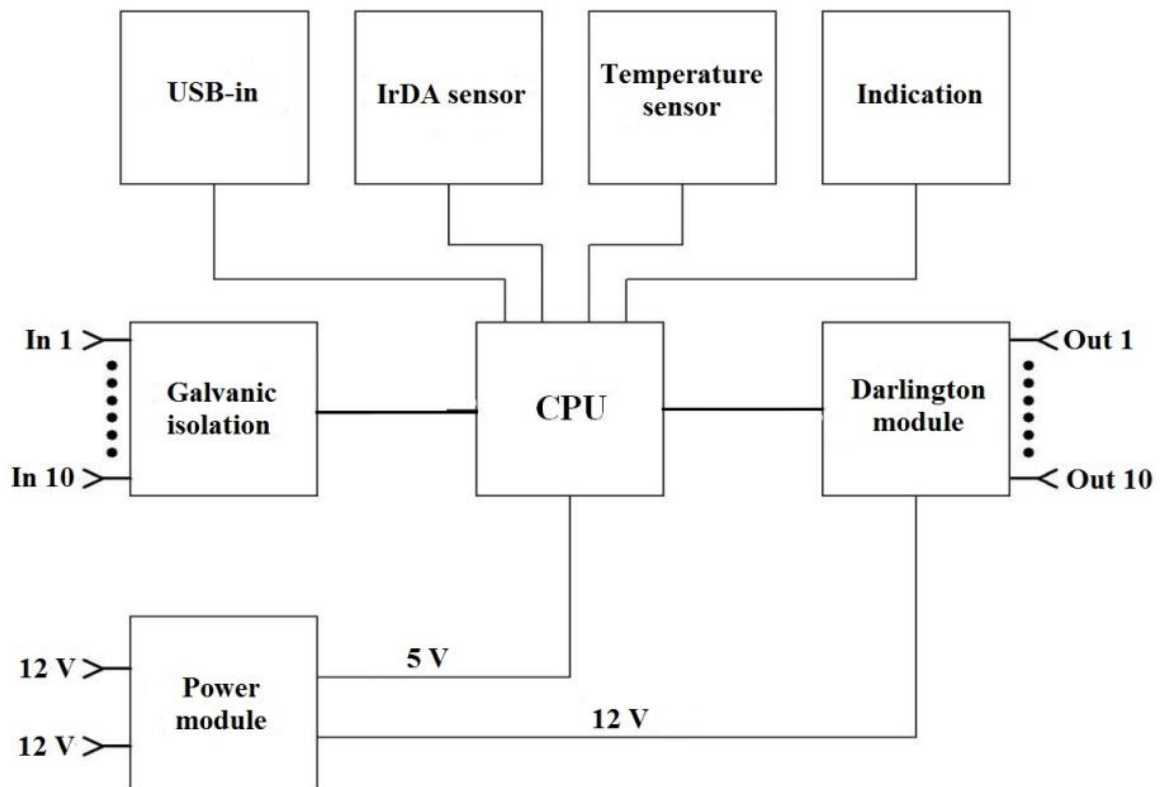


Fig. 2 Block diagram of the controller

The functional principle of the controller is to change the status of the outputs, depending on the input commands received from the computer, the Internet or from the remote control. Software that is installed on the server, together with the controller provides a solution to laboratory equipment management tasks.

The complex has the ability to voice control laboratory equipment, uses advanced technologies and algorithms of recognition and synthesis of human speech that allows people with disabilities to make a minimum of physical effort in working with laboratory equipment. The user has direct visual contact with the stand via a web-camera and broadcast installation work in *the on-line most of the student closer to the real work environment*.

At this stage, the project developed a prototype of the controller and software, as well as the generalized algorithm of educational laboratory complex with remote access (Figs 2, 3).

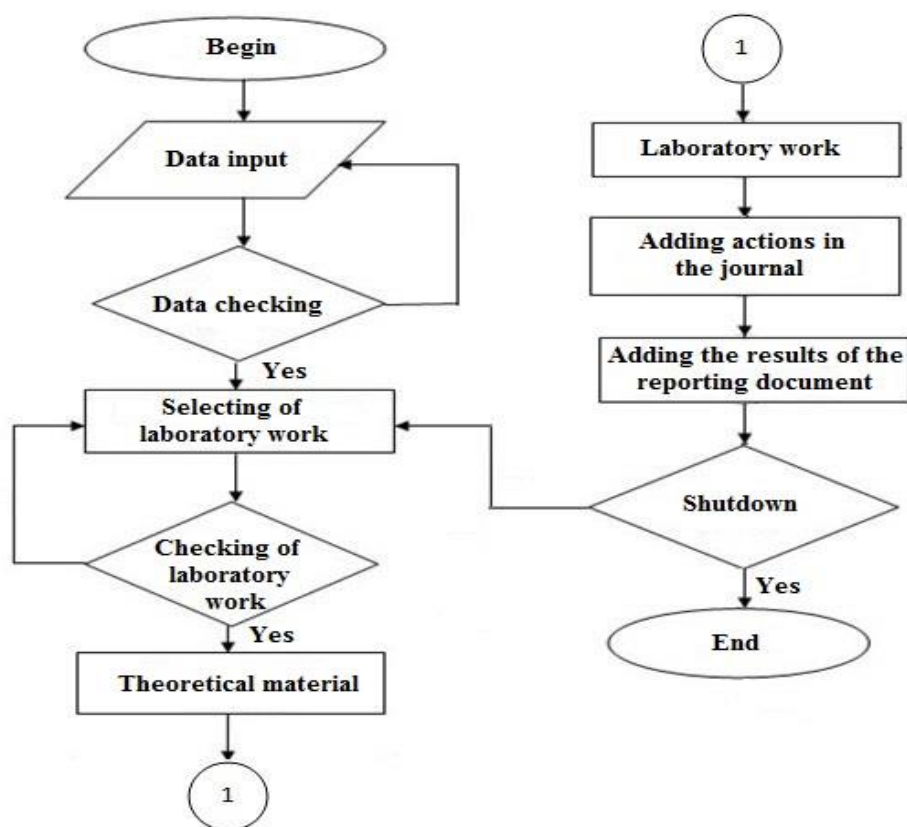


Fig. 3 The algorithm of the laboratory complex

In developing this project, we can improve the quality of engineering education for people with disabilities, students of the remote and distance learning, to reduce the carrying out of training courses costs. Also, the laboratory complex can be successfully used for the research work of undergraduate and graduate students as well as the flexible structure of the complex allows integrating new hardware with minimal effort.

### References

1. S.I. Maslov. Informatizacija inzhenerenogo obrazovanija [Computerization of Engineering Education]. M., 2006. Retrieved from URL [http://mami.ru/science/aa177/scientific/article/s14/s14\\_11.pdf](http://mami.ru/science/aa177/scientific/article/s14/s14_11.pdf) (Access date 01.10.16)
2. Gosudarstvennaja programma Rossijskoj Federacii «Dostupnaja sreda» na 2016 - 2020 gody. [State program of the Russian Federation "Accessible Environment" for 2016 - 2020 years]. Retrieved from: URL <http://www.rosmintrud.ru/ministry/programms/3/0> (Access date 01.10.16)

## ОБРАЗОВАТЕЛЬНЫЙ ЛАБОРАТОРНЫЙ КОМПЛЕКС С УДАЛЕННЫМ ДОСТУПОМ

Д.А. Федотов

Тамбовский государственный технический университет, Тамбов, Россия  
e-mail: [subs1stem@yandex.ru](mailto:subs1stem@yandex.ru)

**Аннотация:** В настоящее время развитие дистанционного образования по инженерным направлениям встречает определенные трудности из-за отсутствия возможности полноценной организации лабораторного практикума. Это объясняется проживанием некоторых студентов в отдаленных регионах, сложным графиком их работы. Так же, одной из важнейших задач общества является интеграция людей с ограниченными

возможностями в современную жизнь, и что особо важно, в процесс образования. С учетом вышеуказанных проблем, предлагается проект лабораторного комплекса с удаленным доступом пользователей.

**Ключевые слова:** лабораторный комплекс, лабораторный стенд, удаленный доступ, дистанционное образование, контроллер

---

УДК 621.376.6  
ББК 32.884

## DECREASING ENERGY COSTS OF THE TRANSMITTER WITH OFDM MODULATION

**O. N. Churilin, S. N. Danilov**

Tambov State Technical University, 392000, Russia  
e-mail: churilin.oleg@gmail.com

**Abstract:** The paper considers the principles of construction of signals in communication systems with OFDM technology. The article describes existing methods of reducing influence of the peak-factor in digital communication systems. The conclusion provides the options of energy efficiency of the transmitter with OFDM modulation.

**Keywords:** digital communication, efficiency, OFDM, peak-factor, transmitter.

The cost of electricity that powers the transmitter is a significant portion of the costs of transmission of radio signals. The operation of the output stage in class C mode is used to increase efficiency of transmitter. But in some cases, the peak factor of the transmitted signal must be reduced. At present, Orthogonal Frequency Division Multiplexing (OFDM) of technology is widely used in digital communication and television. It is one of perspective directions in the field of high-speed systems of radio access. Modern digital communications systems use multi-level types of signal modulation such as m-QAM. but they are prone to intersymbol interference due to multipath propagation. OFDM systems allow solving the problem of frequency-selective signal fading.

The method OFDM is as follows. Carrier frequencies are in-band broadcast channel in the amount of from 2 to 8 thousand. Each carrier is modulated with low rate data stream. Data transfer rate for each elementary stream is equal to the total system rate divided by the number of carrier. The frequency distribution of carrier in the band of the radio channel is provided, that spectral components pass through zero at the center frequency. As a result, group power spectrum is formed, which is close to a rectangular spectrum. This gives the maximum efficiency of radio channel band..

OFDM signals are described by a relatively high ratio of the peak and the average capacity. Two technologies are used which reduce this ratio by about 20%. And this, in turn, significantly reduces energy costs. We are talking about the following two technologies:



1) redundancy of tone. In this case, 1% of carrier remains in reserve, not transferring any data, but can be used by the transmitter for the introduction of signals smearing peaks;

2) active extension of phase constellation. In this case, some of the extreme points of the constellation are moved farther from the center to reduce peaks. As the changes relate only to extreme points, it has no significant effect on the ability of the receiver to decode the data [1].

Distorting and non-distorting methods reduce peak-factor. The method of limiting the amplitude is distorting method. Non-distorting methods include: selective mapping (SLM), tone reservation (TR) and tone injection (TI). The increase dynamic range of linear power amplifier reduces its efficiency. The use of non-distorting methods requires reducing the bandwidth of the system, because a small part will be used to transmit information.

The SLM method requires the transmission of additional information. The TR method requires you to keep part of the unmodulated pilot-tones. The TI method requires increased power for the injected tones.

Thus, reducing the value of the peak-factor in OFDM systems is possible only by degradation of any characteristics of the system. For example, the introduction of additional reserve strengthening will reduce the efficiency of the transmitter. Reservations the carrier frequency will reduce the speed of transmission. The non-linear restriction will reduce the noise immunity. The combination of error-correcting codes and methods to reduce the peak-factor are parameters for obtaining the maximum energy saved and the efficiency of the transmitter.

#### References

1. Sklar, B. Digital communications. The theoretical basis and practical application, 2nd edition. : Trans. from English. — М : Publishing house "Williams", 2003. – 1104 p.

## СНИЖЕНИЕ ЭНЕРГЕТИЧЕСКИХ ЗАТРАТ ПЕРЕДАТЧИКА С OFDM МОДУЛЯЦИЕЙ

**О.Н. Чурилин, С.Н. Данилов**

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: churilin.oleg@gmail.com*

**Аннотация:** Рассмотрены принципы построения сигналов в системах связи с технологией OFDM. Описаны существующие методы снижения действия пик-фактора в системах цифровой связи. Приведены варианты повышения энергоэффективности передатчика с OFDM модуляцией.

**Ключевые слова:** OFDM, передатчик, пик-фактор, цифровая связь, энергоэффективность.

УДК 574  
ББК 0145

### THE NEED FOR APPLICATION OF FUZZY VALUES IN MATTERS OF STRUCTURAL AND PARAMETRIC OPTIMIZATION OF INFORMATION SECURITY IN NETWORK INFORMATION SYSTEMS

**S.N. Vikhlyaev**

Tambov State Technical University, Tambov, Russia

*e-mail: helpsergejj@yandex.ru*

**Abstract:** *The article refers to a fundamentally new approach to the taxonomy and information security methodology. This approach will be discussed in detail and applied to post-graduate thesis.*

**Keywords:** *fuzzy values, information security, Network Information System, optimization models.*

The problem of modern society is a non-optimal use of resources. This problem is relevant to information security. Modern methodology involves solving optimization problems by using explicit variables, but this approach limits the scope of the study.

The dissertation proposes the methodology of the formation of information security. The novelty of the work lies in two features:

- application of fuzzy variables instead of clear;
- using of fuzzy approach as a key in the formation of the methodology.

Considered studies with sufficient consideration may lead to the development of a new concept of information security.

Information security of the state – the state of preservation of information resources of the state and the security of the legitimate rights of the individual and society in the information sphere. Information security – is the process of ensuring the confidentiality, integrity and availability of information.

At the moment the main resource of accumulation of information is the Internet, hence information security issues are being resolved in the network security issues.

The Internet as a network of networks originally is an association of local networks. Structured and organized in a certain way a local network can be considered as a network information system.

Network Information System (abbreviation: NIS) is an information system for managing networks, such as electricity network, water supply network, gas supply network, telecommunications network. Implementation issues in optimal information security model is a most important at the present time.

Research methods and information security algorithms confirmed that the secure information system may be represented as structure-parametric model.

In 2012 Arkov PA, graduate student of Volgograd Technical University presented the information system in the form of structural-parametric model. The classification

of information security techniques was given in this paper. Thus, the author proposed the following hypothesis: security model of network information system can be protected by a "wildcard".

This dissertation aims to expand the knowledge of the study area through the introduction of fuzzy variables.

The following hypothesis was formed in the course of the study: fuzzy variables can expand the scope of their original values without classification. The main advantage of fuzzy variables is not trivial description of the input parameters. It also gives the opportunity to work with no concrete solutions, and ranges of acceptable values.

The membership function of a fuzzy set is a generalization of the indicator function in classical sets. In fuzzy logic, it represents the degree of truth as an extension of valuation. Degrees of truth are often confused with probabilities, although they are conceptually distinct, because fuzzy truth represents membership in vaguely defined sets, not likelihood of some event or condition. Membership functions were introduced by Zadeh in the first paper on fuzzy sets (1965). Zadeh, in his theory of fuzzy sets, proposed using a membership function (with a range covering the interval  $(0,1)$ ) operating on the domain of all possible values.

In mathematics, fuzzy measure theory considers generalized measures in which the additive property is replaced by the weaker property of monotonicity. The central concept of fuzzy measure theory is the fuzzy measure which was introduced by Choquet in 1953 and independently defined by Sugeno in 1974 in the context of fuzzy integrals. There exists a number of different classes of fuzzy measures including plausibility/belief measures; possibility/necessity measures; and probability measures which are a subset of classical measures.

The study revealed a new property network information system – alterability. The peculiarity of this parameter is changed in the manner, the structure of the system property, hence parametric optimization at all levels must constantly readjust. To do this, must to create an algorithm of parametric optimization of resources in advance. Optimization of information security resources system should own, at the level of the algorithm, implement the reorganization. Optimization of information security resources system should happen like algorithm.

The simplest example of an information system structure changes - changes in routing inside. This can occur for various reasons including fatal failures in the network. In this situation, routing, and security settings change is reflected in the router.

A router is a networking device that forwards data packets between computer networks. Routers perform the traffic directing functions on the Internet. A data packet is typically forwarded from one router to another router through the networks that constitute the internetwork until it reaches its destination node.

The problem of modern algorithms is that their use is highly dependent on the certainty of the incoming values. That is why it is important to develop intelligent optimization-parametric methodology, which will be to choose not only a new route (as a router). The transition from the fuzzy variables to develop an algorithm enables

precise. This algorithm will be translated into machine language and put into operation microcontrollers, software and network tools.

At the moment, there is a formation of the algorithm of structural and parametric optimization. The results of this work will be presented in a separate article in the international scientific-practical conference.

The dependence of the choice of optimization models from the initial parameters and priorities has been studied and analyzed.

Problem of the lack of techniques to identify and eliminate non-optimal use of information security resources is studied.

The advantages of the all popularly method are outlined.

Found a brand new setting network information system.

Considered area of research is of particular importance in the field of information security. On the one hand, any information system should automatically prevent occurrence vulnerabilities on the other hand – when creating intelligent system reorganization resource information security will is done, professionals will lose their jobs.

#### **References**

1. Solovyov, A.V. Informatsionnoe obschestvo [Information society]. M: 2007, 132-156 (Rus).
2. Astakhov, L. Informatsinnaya bezopasnost [Information security] M: 2010, 185 p (Rus).

## **НЕОБХОДИМОСТЬ ПРИМЕНЕНИЯ НЕЧЕТКИХ ЗНАЧЕНИЙ В ВОПРОСАХ СТРУКТУРНО-ПАРАМЕТРИЧЕСКОЙ ОПТИМИЗАЦИИ ИНФОРМАЦИОННОЙ БЕЗОПАСНОСТИ В СЕТЕВЫХ ИНФОРМАЦИОННЫХ СИСТЕМАХ**

**С.Н. Вихляев**

Тамбовский государственный технический университет, Тамбов, Россия  
*e-mail: helpsergejj@yandex.ru*

***Аннотация:** В статье говорится о принципиально новом подходе к систематике и методологии информационной безопасности. Этот подход будет подробно рассмотрен и применен в диссертации аспиранта Тамбовского государственного технического университета – Вихляева С.Н. Особенность предлагаемого подхода заключается в использовании нечетких значений, что позволяет расширить не только саму область познания в области методологии применения принципов информационной безопасности, но и в области определения входящих значений, на основе которых и происходит выбор модели и алгоритмов структурно-параметрической оптимизации ресурсов информационной безопасности в сетевых информационных системах.*

***Ключевые слова:** информационная безопасность, нечеткие значения, оптимизационные модели, сетевая информационная система.*

## ROBOTIC CONTROL SYSTEM OF TECHNOLOGICAL PARAMETERS FOR MASSIVE PRODUCTS FROM THE HEAT-SHIELDING MATERIALS

**M. V. Kirina, A. A. Churikov**

Tambov State Technical University, Tambov, Russia

*e-mail: marykirina@rambler.ru*

**Abstract:** *Currently, much attention is paid to energy conservation, which is due to high energy prices. Solving the problem of minimizing heat losses for facilities producing, transmitting, or using heat energy depends on the quality of applied thermal insulation materials. One of the most important quality characteristics of these materials are their thermophysical properties such as specific heat, thermal conductivity and thermal diffusivity [1].*

*Modern methods allow determining promptly thermophysical properties without material destruction. To determine the quality of the products it is necessary to measure thermophysical properties of a few areas that are prone to damage and loss of thermal properties.*

*As a rule, the record of thermophysical properties evidence involves manual labor. Therefore, our task is to develop a robotic system for monitoring of process parameters for massive products from the thermal protection materials.*

*This requires elaborate manipulator that is moved to the desired path across the surface the material for recording sensor readings.*

**Keywords:** *nondestructive testing, heat-shielding material, thermophysical properties.*

At present, many publications are devoted to the development of methods of measuring and control devices, thermophysical properties of solids and disperse materials. Numerous methods for measuring of thermophysical properties differ in the methods recording of heat compensation, shape and size of samples, placing heaters, methods of registration and processing of measurement information.

Modern thermophysical methods and devices are based on the fact that the sought thermophysical properties are shown through the test sample temperature response to the external heat impact, which the sample is subjected to at a special experiment. [2]. One of the main conditions for improving the efficiency and quality of complex thermophysical experimental and computational research are their planning, which involves selection of main factors in the experiment, depending on the type and number of the desired parameters of the control method and the specified accuracy of their determination. Modern level of computer technology brings new products to address the control of the thermal protection of material, namely to fully automate management of the course of the experiment, its precision and promptness.

Thus, the development of new and effective methods of investigation of thermophysical properties of devices and products made of thermal protection materials it is necessary to address the following key issues:

1. Reasonable choice of mathematical models of the thermal process in the sample while testing, formulation and solution of non-stationary boundary value problems of heat conduction.

2. Possibility of software experiment on newly developed techniques.

The present level of computer technology allows solving nondestructive testing problems, namely: fully automate the management of the course of the experiment, automatically produce a thermal mode adapting to the changed conditions of nondestructive testing, carry out the continuous collection and processing of information on several measurement channels with high accuracy and efficiency.

The main criterion when designing the installation is the maximum automation of the process of the experiment.

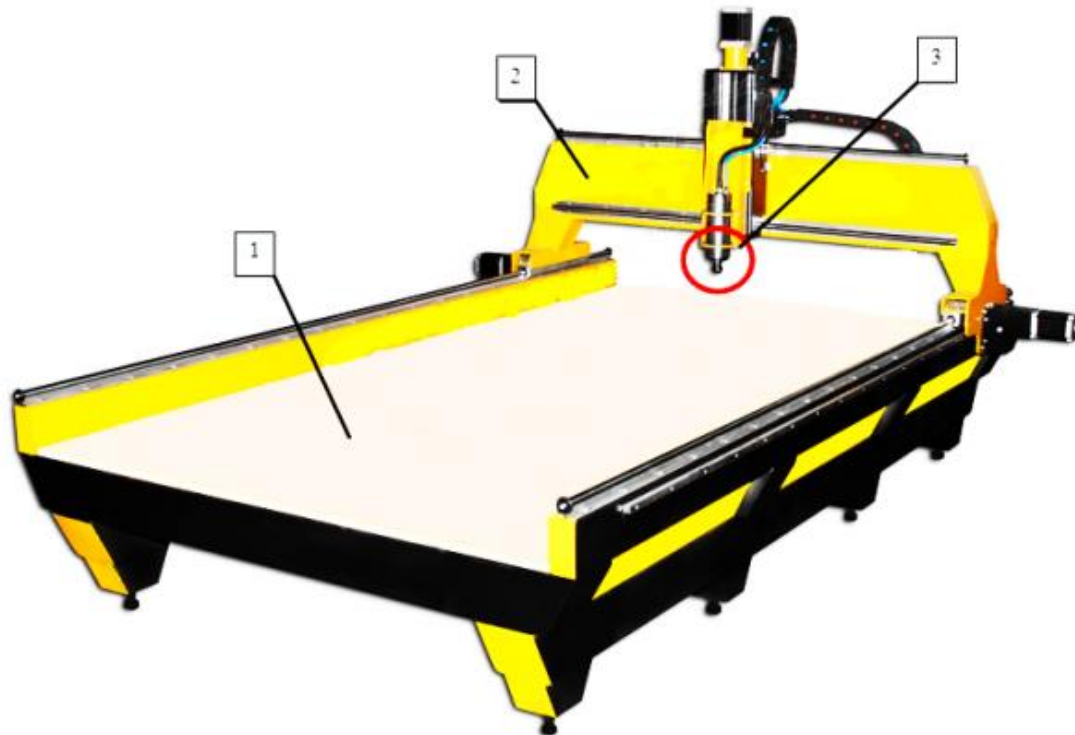
Availability of the Russian high-precision digital instrumentation allowed for the development of the installation based on them.

The machines are designed on the basis of the following requirements:

- Fully automated heating process and the collection of information during the experiment;
- Use of modern tools of measuring and computing, automation and electronics components;
- Installation of control with absolute ease.

To implement the method of control of heat-insulating materials, a robotic installation "a probationary table", shown in Fig. 1 was designed.

The basis of the robotic installation was a table manufactured at the plant «Twitte».



*Fig. 1. A probationary table.  
1 - table, 2 - axis movement, 3 - mobile probe [3].*

Using robotic manipulators of automated measuring system, there is no need to use manual work of the operator who can make errors in the carrying out of control.

## References:

1. Gradetsky V.G., Rachkov M.U. Roboty vertikalnogo peremescheniya. / V.G. Gradetsky. M.: Tip. Min. Obrazovaniya RF, 1997. - 223 p. (Rus)
2. Churikov A.A. Razrabotka i issledovanie metodov i ustroystv dlya avtomaticheskogo nerazrushayushchego kontrolya temperaturozavisimyh teplofizicheskikh svoystv tverdykh teplozaschitnykh materialov, M.: MIHM, 1980. (Rus)
3. Kirina M. V., Churikov A. A., Raschetnye zavisimosti absolyutnogo i otnositelnogo metodov opredeleniya teploprovodnosti tverdykh i dispersnykh materialov. / M. V. Kirina. Vol. 41 Tambov: TGTU, 2015, pp. 42-46. (Rus)
4. Kartashov E. M. Analiticheskie metody v teorii teploprovodnosti tverdykh tel. M.: vysshaya shkola, 2001. – 280 p. (Rus)
5. Russell R. Andrew; Paoloni, Frank J.A. Robot Sensor for Measuring Thermal Properties of Gripped Objects. IEEE Transactions on (Volume: IM-34, Issue: 3 ). 1985. pp. 458—460.

## РОБОТИЗИРОВАННАЯ СИСТЕМА КОНТРОЛЯ ТЕХНОЛОГИЧЕСКИХ ПАРАМЕТРОВ ДЛЯ МАССИВНЫХ ИЗДЕЛИЙ ИЗ ТЕПЛОЗАЩИТНЫХ МАТЕРИАЛОВ

**М. В. Кирина, А. А. Чуриков**

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: marykirina@rambler.ru*

***Аннотация:** В настоящее время большое внимание уделяется проблеме энергосбережения, что обусловлено, в первую очередь, высокими ценами на энергоресурсы. Решение проблемы минимизации тепловых потерь для объектов, производящих, передающих или использующих тепловую энергию, напрямую зависит от качества применяемых теплоизоляционных материалов. Одними из важнейших качественных характеристик этих материалов являются их теплофизические свойства (ТФС), такие как теплоемкость, теплопроводность и температуропроводность [1].*

*Современные методы позволяют оперативно определять теплофизические свойства, не подвергая материал разрушению. Для определения качества изделий необходимо измерение теплофизических свойств в нескольких участках, подверженных повреждению и потере тепловых свойств. Как правило, снятие показаний ТФС предусматривает ручной труд, при этом человек длительное время совершает монотонную работу, что сказывается на его утомляемости и снижению эффективности работы в целом. Поэтому наша задача разработать робототехническую систему контроля свойств участка горизонтальной и вертикальной поверхности изделий и автоматизировать данный технологический процесс.*

*Для этого требуется разработать манипулятор, передвигающийся по заданной траектории по поверхности материала для снятия показаний датчика.*

***Ключевые слова:** неразрушающий контроль, теплозащитный материал, теплофизические свойства.*

## PROTECTIVE MECHANISM OF IDENTIFIER BASED ON THE QR-CODE

A.N. Mazalov, A.V. Yakovlev

Tambov State Technical University, Tambov, Russia

e-mail: alexmazalov2293@yandex.ru

**Abstract:** *The article reviews the process of authentication of users in access control system based on two-factor authentication graphics. We made a comparative analysis of the currently existing technologies used in access control systems. We determined the most efficient technology of creating identifiers for ACS - QR-code. We created a unique mechanism of protection from counterfeiting identifier with an additional invisible QR-code. We developed an algorithm of work for ACS applying the identifier. We found the optimal hash algorithm for storage of information on the pass in ACS. We showed the most promising areas of application of this technology. We conclude that the ACS based on two-factor authentication graphic is promising solutions for safety on site.*

**Keywords:** *authentication, access control, two-factor graphical authentication, QR-code, user ID, pass, one-time pass, security, protection of identifier.*

Today, the relevance of the installation of access control systems (ACS) is evident. Even within a single company there is a need to limit a range of eligible employees who work with information or documents, depending on the position. There are many remedies that will not only prevent the leakage of sensitive data, but also avoid serious financial losses.

At present, there exist the following technologies: contactless RFID cards and tags, magnetic cards, Wiegand cards, touch memory, linear and multi-dimensional barcode labels.

The current research analyzed the currently existing technologies, such as the RFID, barcode, QR - code. The analysis of these technologies shows that IDs performed by QR-code technology have significant advantages compared with the others. These identifiers have a minimum value, are not subject to interference by electromagnetic fields, which is a significant problem RFID-technology can operate at label damage.

Reed-Solomon code with an 8-bit code word is used for correcting errors in the QR-codes. There are four levels of redundancy: 7, 15, 25 and 30%. Due to error correction, it becomes possible to consider the code, even if it is damaged by 30%, which is not possible when working with his peers. [3]

On the basis of the conducted researches for the production of IDs, we chose the technology of QR code.

One disadvantage of QR-codes is the possibility of their counterfeiting as a QR-code itself is not directly protected. In this paper, we propose a new method that allows you to avoid it.

User ID protection will be carried out in the following manner.

The front side of the pass (Fig. 2) contains identification characteristics of



organization and QR1-code comprising an identifier (ID) of the user.



Fig. 2 – The front side (the left side), the reverse side pass in the visible (the right side ) and infrared (bottom)

It is not possible to find any information in the visible range on the reverse side of the pass. However, if its scan is in the infrared range, it is possible to detect the second QR2-protection code pass from forgery.

Protective QR2-code is applied to pass special infrared ink from the printer. It will carry a value of SALT and Hash (PIN) cards that are unique for each pass. In fact, this specific information confirms the authenticity of the card in the access control system.

User authentication is performed in the ACS calculation using the hash value from two QR-codes, but because QR2 will not take both meanings, but only SALT card.

$$QR1 + QR2 \rightarrow hash(ID + SALT)$$

As a result of comparing the value Hash (ID + SALT) with the value Hash\*(ID + SALT), stored in the database server, the authentication result gives permission or prohibition of entry into the controlled area.

#### Work algorithm

To use the system a user should be registered in the database (DB) organization. Adding user data in the database holds the system administrator. Thereafter, a registered user can be recognized.

At the beginning of the system it is necessary to bring the user ID to the reader device. There will be reading two of QR-codes from different sides of the identifier. As a result, QR1 will be obtained from the identifier (ID) the user, and is extracted from SALT QR2 and Hash (PIN) card.

When the system is in normal mode, the server sends a request passing the authentication procedure. This query is sent to the server Hash () - maps generated by adding the user ID, extracted from QR1 and SALT, extracted from QR2.

The server checks the data received from the terminal, with the data stored in the database.

After the check procedure, the server sends a response, allowing or denying access in the controlled area.

If you experience problems on the network, that is, when sending a request to the server is not possible, the second mode of the system begins to function.

The user presents their ID. The system, knowing that it cannot send the request to the server, asks the subject to enter the PIN, which can be known only to the authorized user of the system.

The terminal calculates the hash value from the PIN entered by the user.

Thereafter, it compares it with the Hash value (PIN), QR2-stored in the code. Terminal authentication result issued is to enable or disable the input of the controlled area.

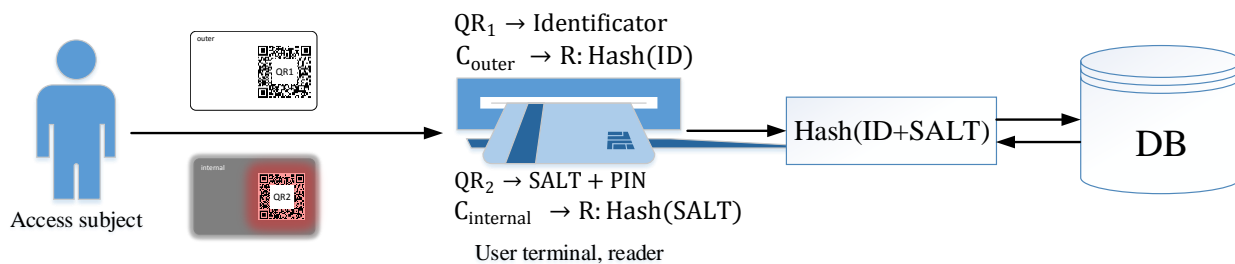


Fig. 3 – A fragment of the block diagram of ACS algorithm based on two-factor authentication graphics

The hash function used in the system should have a minimal set of collisions. His choice fell on the functions of the length of the message digest of 512 bits. Let us analyze some of the existing hash functions (Table 1).

Table 1. Comparing the hash-functions

	Digest sizes	Block size	Rounds	Algorithm complexity	Max message size
MD6	Variable, $0 < d \leq 512$	512	Variable. Defio $r=40+d/4$	$O(1)$	$2^{64}-1$
SHA-2 (SHA-512)	512	1024	80	$O(1)$	$2^{128}-1$
SHA3-512	512	576	24	$O(1)$	Is't limited
GOST-34.11-2012	256/512	512	12	$O(1)$	Is't limited
BLAKE-512	512	1024	12	$O(1)$	$2^{128}-1$

Based on the study in ACS we use the hash-function GOST 34.11-2012. It meets the necessary requirements, and it is made with a minimum number of iterations, and thus has a minimum set of mismatches.

As part of the development of a two-factor authentication system graphic, the approach of using technology as a subject identifier of QR-codes was proposed. This technology allows you to protect a pass from forgery, while making a minimum of material, physical and financial costs.

The implemented approach makes it possible not only to increase the degree of identity protection, but also to solve the problem of the cost of the implementation of security systems, as it is cheaper.

## References

1. Vorona V.A., Tikhonov V.A. Sistemy kontrolya i upravleniya dostupom [Access control system]. Moskva, Goryachaya liniya-Telekom, 2010. 272 s. (Rus)
2. Shelupanova A.A. Autentifikatsiya. Teoriya i praktika obespecheniya bezopasnogo dostupa k informatsionnym resursam [Authentication. Theory and practice of secure access to information]

- resources]. Moskva, Goryachaya liniya-Telekom, 2012. 550 s. (Rus)
3. QR code. Available from: <http://www.qrcc.ru/qrcode.html>. (Accessed 15 December 2016).
4. Tanenbaum A. S., Woodhull A.S. Operating Systems. Design and implementation. New Jersey, Prentice Hall, 2006. 1071 p.
5. Shangin V.F. Zashchita informatsii v kompyuternykh sistemakh i setyakh [Protection of information in computer systems and networks]. Moscow, DMK Press. 2012. 592 s. (Rus)
6. Gromov U.U., Tikhomirova A.A., Shcherbinin P.A., Yakovlev A.V. Dvumernyy shtrikhkod kak identifikatsionnyy znak v sistemakh kontrolya i upravleniya dostupom. [The two-dimensional bar code as an identifying mark in the access control] / U.U. Gromov. «Izvestiya akademii inzhenernykh nauk im. A.M. Prokhorova»: ezhekvartalnyy nauchno-tekhnicheskiy zhurnal. – M.: Nauchtekhlitizdat. 2013. №1. (Rus)
7. Tikhomirova A.A., Yakovlev A.V. Dvumernyye kody kak istochnik nositelya identifikatsionnogo priznaka v sistemakh kontrolya i upravleniya dostupom [Two-dimensional codes as the source of the media identifier for access control] // Materialy XIII mezhdunarodnoy nauchno-metodicheskoy konferentsii «Informatika: problemy, metodologiya, tekhnologii», 7-8 fevralya 2013. Vol.3 – Voronezh: IPTs VGU. 2013. (Rus)

## **ЗАЩИТНЫЙ МЕХАНИЗМ ИДЕНТИФИКАТОРА НА ОСНОВЕ QR-КОДА**

**А. Н. Мазалов, А. В. Яковлев**

Тамбовский государственный технический университет, Тамбов, Россия  
*e-mail: alexmazalov2293@yandex.ru*

***Аннотация:** Рассмотрен процесс аутентификации пользователей в системах контроля и управления доступом (СКУД) на основе двухфакторной графической аутентификации. Произведен сравнительный анализ существующих на сегодняшний день технологий, применяемых в СКУД. Определена наиболее рациональная технология создания идентификаторов для СКУД – QR-код. Создан уникальный механизм защиты идентификатора от подделки при помощи дополнительного невидимого QR-кода. Разработан алгоритм работы для СКУД, применяющих данный идентификатор. Найден оптимальный алгоритм хеширования для хранения информации на пропуске в СКУД. Приведены наиболее перспективные области применения данной технологии. Проведенная работа позволяет сделать вывод, о том, что СКУД на основе двухфакторной графической аутентификации представляет собой перспективное решение для создания безопасности на объектах.*

***Ключевые слова:** аутентификация, двухфакторная графическая аутентификация, защита идентификатора, идентификатор пользователя, одноразовые пропуска, системы контроля и управления доступом, QR-код.*

## REVIEW OF EXISTING METHODS OF DESIGNING AND OPTIMIZING THE LOGICAL STRUCTURE OF RELATIONAL DATABASES

**P.A. Trefilov**

Tambov State Technical University, Tambov, Russia

email: 9889@inbox.ru

**Abstract:** High rates of informatization of modern society lead to tightening of requirements for the methods and information of storage technologies. The paper deals with existing methods of designing and optimizing of relational database (RDB), as well as the existing shortcomings and limitations of RDB.

**Keywords:** relational database, designing database.

High rates of informatization of modern society lead to tightening of requirements for the methods and information storage technologies. One of the most popular data storage technology is the relational database (RDB) [1]. RDB is a set of related tables each containing a set of records (rows) according to the logical structure of the table. Growing number of rows in the table increases requests processing time, which leads to a problem of slowing down the entire information system, which often cannot be solved by increasing the computing power of the database server. In this regard, it becomes relevant to accelerate query performance in a relational database.

### Design methods of RDB

The main objectives of the database design include [2]:

- provision of data and links between them, necessary for all the major applications of the system and any groups of its users;
- creation of a data model that can support the implementation of any required data requests;
- development of the preliminary version of the project, the structure of which can satisfy all the basic requirements for system performance.

Design of the logical structure of a relational database is based on the model "entity-relationship" by P. Chen [3] or extended relational model by E. Codd [4].

### "Entity-relationship" model

Design based on the model "entity-relationship" is as follows: the same type of object classes called entities are allocated of the subject area. Each entity has a set of properties called attributes of the entity. Each instance of an entity adopts the specific values for each attribute of the set of possible values for this attribute. For example, the essence of "Man" has attributes "Gender" and "Age", which for each instance of the entity (for each person) will take values from the set values:

- gender: male or female;
- age: integer 1-150 (in years).

Each entity in this case is not an excessive set of attributes called the primary key. The primary key can uniquely identify any entity instance.

After separation of entities and their inherent attributes, links between entities, resulting in a semantic network, are established.

#### Extended relational model

Post-relational data model is an extended relational model, which abolished the requirement attributes atomicity. Therefore, post-relational model is called "non-first normal form" (NF2) or "multi-dimensional database." It uses a three-dimensional structure, allowing you to store other table fields. Thereby the possibilities for the description of complex real-world objects are expanding. The query language uses several advanced SQLs, allowing to retrieve complex objects from one table without connecting operations.

#### Normalization of relationships

When designing the database by the "entity-relationship" to ensure data integrity and the lack of redundancy relations normalization method is used. The normal form is a requirement for the structure of tables in the relational database theory to eliminate the excess of base functional dependencies between the attributes (fields, tables) [5]. Relations normalization involves decomposition of relations in line with the requirements of normal forms. There are the following normal forms: First Normal Form (1NF), Second Normal Form (2NF), Third Normal Form (3NF), Boyce-Codd Normal Form (BCNF), Fourth Normal Form (4NF), Fifth Normal Form (5NF), Domain-key Normal Form (DKNF) and Sixth Normal Form (6NF).

#### Optimization of SQL-queries

Optimization of SQL-queries to the database is an important part in ensuring the performance of the information system. The query optimization techniques are as follow [6-8]:

- Optimizing SELECT queries (limiting the number of returned attributes, use LIMIT, etc.);
- Optimization of INSERT / UPDATE queries;
- Other "tips" (not to use queries in a loop, not to use the sort ORDER BY RAND and others).

All modern DBMS provide the design, enabling to see the query execution plan, the optimizer built database. For example, in MySQL the keyword is EXPLAIN [9]. EXPLAIN can determine the non-optimal part of the request (absence of non-optimal table index, the presence of extra unions, non-optimal type of binding tables, etc.).

#### Indexing

Indexes are a special table, which allows the database to speed up the search strings in the database. Index field in this table is stored in sorted order, which greatly accelerates the necessary data search process. The indexes should be used for those attributes that are involved in the ORDER BY clause and WHERE. The disadvantage of using the indexes are:

- An increase in size of the database by creating additional index tables;
- Reducing the speed of INSERT and UPDATE requests, as you add or change the record, you must make changes in an index table followed her resorting.

The paper discussed the main methods of database design and existing methods of optimization and analysis of SQL queries. Firstly, the use of a particular method of

optimization of queries depends on the logical structure of the database and its applications. If the database is mainly used to record (for example, log data, statistical data, etc.) rather than to read, you should not use the indexing fields. Secondly, the logical structure of the database depends on the subject area, with the result that there are situations when small de-normalization of relations not only slows down the information system, but also accelerates it. A typical example is the binding RANGE-tables (search values included in the range), which can denormalize, duplicating linkable identifier tables in the linking table. The third subject area can be represented by the temporal data, i.e., change over time, for example, exchange rates. It is necessary to have more than one (last) attribute value for each instance of the essence, and a set of values for the analysis and statistics (e.g., dynamics of exchange rates), which further complicates the problem domain in terms of design and simulation.

To date, there is no universal method of designing a database for any subject area, so the problem is relevant for consideration and solution.

### References

1. Krenke D. Teorija i praktika postroenija baz dannyh [Theory and practice of database processing] - 9-e izd. - SPb. : Piter, 2005. - 859 s (Rus)
2. Popov F. A., Maksimov A. V. Podhody k proektirovaniyu baz dannyh dlja avtomatizirovannyh sistem [Approaches to designing databases for automated systems] // Izvestija AltGU. 2003. №1. Available from: <http://cyberleninka.ru/article/n/podhody-k-proektirovaniyu-baz-dannyh-dlya-avtomatizirovannyh-sistem> (Rus)
3. Chen P. P.-S. The Entity-Relationship Model - Toward a Unified View of Data // ACM TODS. March 1976. - 1, №1.
4. Codd E. F. Extending the Database Relational Model to Capture More Meaning // ACM TODS. - December 1979. - 4, №4
5. Six normal forms [electronic resource]. – Available from: <https://habrahabr.ru/post/254773/>

## ОБЗОР СУЩЕСТВУЮЩИХ МЕТОДОВ ПРОЕКТИРОВАНИЯ И ОПТИМИЗАЦИИ РЕЛЯЦИОННЫХ БАЗ ДАННЫХ

**П.А. Трефилов**

Тамбовский государственный технический университет, Тамбов, Россия

*email: 9889@inbox.ru*

***Аннотация:** Высокие темпы информатизации современного общества приводят к ужесточению требований к методам и технологиям хранения информации. В работе рассматриваются существующие методы проектирования и оптимизации реляционных баз данных, а также с*

***Ключевые слова:** проектирование базы данных, реляционная база данных.*

УДК 6252  
ББК 3086

## CLASSES OF OBJECT IDENTIFICATION MODELS

**T.Yu. Dorohova, S.A Tatarintsev, V.P. Nguyen, D.K. Chan**  
Tambov State Technical University, Tambov, Russia  
*e-mail: sergey.tatarincev@mail.ru*

**Abstract.** *This article discusses the mathematical model of the dynamic objects of the information model. We describe the behavior of objects using differential equations and superposition principle.*

**Key words:** *identification, optimal control, mathematical models, principle of superposition.*

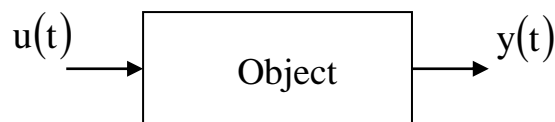
### Introduction

Addressing issues of energy and resource saving, as well as manipulate objects in real time is especially important. One of the stages of development of the system optimal control problem is the problem of mathematical modelling of control objects. Also, selected models of knowledge representation are created by mathematical models of dynamic objects and the managed processes.

### Identification

Identification is usually regarded as a separate phase of the implementation of a major project to develop a control system that uses a mathematical model of the object. In the design of radio-electronic means a mathematical model is necessary not only to control, but also perform calculations on thermal mode, mechanical loads, reliability, etc.

The mathematical model of the object is used to solve the problem of identification of dynamic objects. Here, the object is usually presented in the form of a dynamic system input  $u(t)$  and the output  $z(t)$ , a diagram of which is shown in Fig.1.



*Fig.1 The structure of the object identification*

Description of the behavior of objects using of differential equations is borrowed from classical mechanics. The connection between the input variable  $u = u(t)$  and output  $y = y(t)$  is expressed by the equation:

$$a_0 \frac{d^n y(t)}{dt^n} + a_{n-1} \frac{d^{n-1} y(t)}{dt^{n-1}} + \dots + a_n y(t) =$$

$$= b_0 \frac{d^n u(t)}{dt^n} + \dots + b_{n-1} \frac{du(t)}{dt} + b_n u(t) + c$$

In place of the initial conditions for the  $d^i y(0)/dt^i$ ,  $i=0,1,\dots,n-1$ . If the object has a clear lag, then  $u = u(t-\tau)$ . One of the coefficients can be chosen arbitrarily such as  $a_0=1$ .

In the linear case, the coefficients  $a_j$ ,  $b_j$  are independent of  $u$  and  $y$  and their derivatives. In addition, if they do not depend on the time, we get an equation with constant coefficients. This is the simplest case. If these factors are time dependent, then the equation is called a linear equation with variable coefficients, linear or non-stationary. If any of these coefficients are dependent upon their derivatives, the object is called nonlinear.

### Linear and nonlinear objects, superposition principle

The main difference between linear and non-linear objects is that for the superposition principle it does not hold the latter. According to this principle, if  $y_1$  is the output signal, which is input  $u_1$ , then  $y_2$  is the output signal due to the input  $u_2$ . So when transmitting for  $\alpha u_1 + \beta u_2$  signal to the object, we observe signal  $\alpha y_1 + \beta y_2$  at the output.

As an illustration, it can be given the following simple example:

Linear differential equation	Nonlinear differential equation
$y' + ay = u.$ <p>Hence we have</p> $y'_1 + ay_1 = u_1;$ $+ y'_2 + ay_2 = u_2$ <p><math>(y'_1 + y'_2) + a(y_1 + y_2) = u_1 + u_2</math></p> <p>If you put <math>u_1 + u_2 = u_3</math>, <math>y_1 + y_2 = y_3</math>, from whence</p> $y'_1 + y'_2 = y'_3, \text{ the } y'_3 + ay_3 = u_3$	$y' + ay^3 = u.$ <p>Hence we have</p> $y'_1 + ay_1^3 = u_1;$ $+ y'_2 + ay_2^3 = u_2$ <p><math>(y'_1 + y'_2) + a(y_1^3 + y_2^3) = u_1 + u_2</math></p> <p>If you put <math>u_1 + u_2 = u_3</math>, <math>y_1 + y_2 = y_3</math>, from whence <math>y'_1 + y'_2 = y'_3</math>, the <math>(y_1^3 + y_2^3) \neq (y_1 + y_2)^3 = y_3^3</math> and <math>y'_3 + ay_3 \neq u_3</math></p>

In the linear case, the amount of signals is the subject to the same differential equation as the original signals, but in the nonlinear case it doesn't work. The principle of superposition is performed with respect to both initial conditions (general solution) and input signals (partial solution). We note that the superposition principle holds for linear equations with variable coefficients. However, in engineering terms the presence of variable coefficients results in insignificant differences.

### Conclusion

We described the development of dynamic objects. The creation of



mathematical models needs control systems, perform calculations on thermal modes, mechanical stress and reliability. The development will relate to the issues of resource conservation, control of objects, signal processing and computer technology control in the future.

### References

1. Jejkhoff P. Osnovy identifikacii system upravlenija [Fundamentals of identification of control systems], Mir, Moscow, 1975, 684 p. (Rus)
2. Ju. Muromcev, V. Pogonin, R. Grebennikov. Analiz energosberegajushhego upravlenija mnogomernymi ob'ektami. [Analysis of energy-efficient management of multidimensional objects], TSTU, Tambov, 2007, P. 838-846. (Rus)

## КЛАССЫ МОДЕЛЕЙ ИДЕНТИФИКАЦИИ ОБЪЕКТОВ

**Т.Ю. Дорохова, С.А Татаринцев, В. Ф.Нгуен, Д.К. Чан**

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: sergey.tatarincev@mail.ru*

*Аннотация.* Рассмотрены математические модели динамических объектов, информационные модели. Дано описание поведения объектов с помощью дифференциальных уравнений и принципа суперпозиции.

*Ключевые слова:* идентификация, математические модели, принцип суперпозиции, системы оптимального управления.

---

УДК004.9

ББК32.988-5

## STRUCTURING OF DECISION-MAKING PROBLEMS IN DIAGNOSTICS OF INFORMATION CONTROL SYSTEMS

**N. Ju. Nuriahmetova**

Tambov State Technical University, Tambov, Russia

*e-mail: Natusik4576@mail.ru*

*Abstract:* In order to improve operation efficiency of information control systems (ICS) the formalization problem of the description of the goals and the means of the decision-making problems (DM) in determining ICS status are considered because these problems are needed to be structured and their formulation is needed to be corrected.

*Key words:* information control systems (ICS), decision-making task (DM).

In different sources [3, 4, 5] DM objectives are represented by tuples of different lengths, determined by the complexity of the problem, consisting of properties of the medium DM classes and their mutual mappings. In the classical formulation [5] DM task is represented as a twos  $\{\Omega, OP\}$ , containing a set of alternatives ( $\Omega$ ) and the principle of optimality (OP). The presence of multiple alternatives determines a representation implicitly purpose, which leads to the problem of choosing the best

alternative according to a selected optimality principle. Elementary DM tasks we'll assume three  $\{G, S, f\}$ , where  $G$  – is the goal of solving the problem,  $S$  – is a set of tools to achieve the objectives and  $f$  - are rules of using the means of achieving objectives. This presentation reflects a meaningful statement and a verbal description of the problem. Description of goals should include all the requirements, restrictions and other conditions that must be taken into account in the decision. It is very important to have the description of the complete list of all available  $S$  means, because the availability of funds is the basis for the successful achievement of objectives. DM Task occurs when some elements of the troika are not specified or are not completely defined [7]. The most common problems are solved by DM with unknown rules of selection tools and their use, so the bulk of the work on the DM is dedicated to the identification, modeling and construction of these rules with the participation of decision makers (decision maker). In order to improve operating efficiency of ICS formalizing description of objectives and resources in decision-making problems (DM) status is considered in determining ISC since it is necessary to structure these objects and their correct setting, as well as the possibility of using the computer in the process of decision.

We assume that in the initial position we have a meaningful verbal description of the DM problems. Structuring will be considered complete when the goals and means of achieving them will be presented in the form of formal variables and will be found to match between them, indicating funds which can or should be used for purposes. Structuring tasks can be divided into several stages. On the first stage of construction there is an unstructured model of the problem in the space properties. To do this, we need to make the analysis of meaningful description of the problem, resulting in the formation of the set of ends properties and means used in the problem, and built compliance (D) between the sets:

$$\Gamma : X \rightarrow G, \quad (1)$$

where  $X$  - are property assets,  $G$  – is a properties goal. To display this it is possible to formalize the laws (D), the properties of the  $X$  and  $G$  which should be presented in a measurable form. Every property is expressed in its manifestations. For the analysis of measurability it is necessary to identify and list all the manifestations of the property in question, i.e., to determine

$$X = \{x_1, x_2, \dots, x_i, \dots, x_h\} \quad (2)$$

The property is an alternative, if all its manifestations are mutually incompatible. This property can be represented by a variable, whose range is the set of alternative manifestations, i.e.

$$X = \{x^1, x^2, \dots, x^i, \dots, x^h\} \quad (3)$$

In mathematics, the measurability is associated with the job on a set of manifestations of non-negative (I), the additive (II) and monotonic (III) function, as well as (IV) - units, which, like all mathematical objects, are the idealization of real-life action in real systems [3]. For a description of the actual properties of the medium PR we use the weakest notion of measures for which only the condition (IV) is obligatory and which actually corresponds to the requirement of alternativity of manifestations. Consequently, the property is measurable if its display is alternative.

Many manifestations will be considered as complete medium DM if, in principle, the property cannot be other than those listed, or generated by a given law, manifestations. Alternativity, manifestations indicate the complexity of the properties. In this case, a variable presentation of realized classification X is compatible displayed, and regarded as the equivalence of (E), i.e.

$$\begin{aligned} X &= \{x^1, x^2, \dots, x^j, \dots, x^t\}; \\ x^j &= \{x_1^j, x_2^j, \dots, x_{S_j}^j, \dots, x_{\Gamma_j}^j\}; \\ x_{S_j}^j E x_1^j; S_j &= \overline{1, \Gamma_j}; \overline{j=1, t}; \sum \Gamma_j = h. \end{aligned} \quad (4)$$

As you can see, a complex property has complex meanings given classes of compatible displays. Compatibility is the most subtle manifestation of equivalence on the set. Based on the terms of the problem, it can be given a rough equivalence, an extreme case of which is the equivalence of all manifestations. Then the property is expressed by the two alternative variables.

$$\begin{aligned} X &= \{x^0, x^1\}; \\ x^0 &= \emptyset, x^1 = \{x_1, x_2, \dots, x_i, \dots, x_h\}; \\ x_i E x_1; i &= \overline{1, h}. \end{aligned} \quad (5)$$

Compatibility indicates that the values are different manifestations of components  $x_i$  of the complex X property. Components can be identified by the analysis of meaningful description of the feature and by its decomposition

$$X = \{X_1, X_2, \dots, X_i, \dots, X_k\} \quad (6)$$

Structuring properties of X is carried out by decomposing it into measurable components and aggregation of these components (if necessary) back into a single variable X, as in the expression (6) components  $X_i$  may be measured in the different scales. The only possible method of aggregation is the Cartesian product

$$X = \{X_1 * X_2 * \dots * X_i * \dots * X_k\} \quad (7)$$

If components (6) are in the ranges

$$X_i = \{x_i^1, x_i^2, \dots, x_i^{j_i}, \dots, x_i^{n_i}\} \quad (8)$$

the variable X will have a range of values

$$\begin{aligned} X &= \{x^1, x^2, \dots, x^j, \dots, x^n\}; \\ x^j &= \{x_1^{j_1}, x_2^{j_2}, \dots, x_i^{j_i}, \dots, x_k^{j_k}\}; \\ |X| &= \prod_i n_i = n \end{aligned} \quad (9)$$

The order of relation  $R_i \Rightarrow$  designates the Cartesian product of a partial order on the set of aggregated values  $\{x_j\}$ . If the conditions of the problem admit a factorization of these values, their number is reduced to

$$|X| = \sum_i n_i - (k - 1). \quad (10)$$

Equations (9) and (10) are only valid for non-interacting components  $X_i$ . Interaction of the properties is defined by the existence of the relationship between the properties and their values.

Interaction property values are reflected in the fact that the adoption of any values by one or more properties limits the ranges of possible values of the properties of the

other components in Cartesian product. The reason for this is the incompatibility of the components  $x_{ij}$  values in sets (9). Such sets  $x_j$  are impossible and are excluded from the field of  $X$  values.

The interaction of components can be installed if they are defined as the comparability and mutual disparity  $X_i$ , if a strict order is set for  $\{X_i\}$ . This means that on the set of orders  $R_i$  there is the inclusion relation specifying that the  $R_1$  is rougher  $R_2$ , etc. In the limiting case the inclusion relation becomes a membership relation.

At the same time on the set of components of  $X_i$  the lexicographical order is set, which leads to a complete strict ordering of the Cartesian product. The proposed general approach is the basis for the structuring the description of goals and means. However, the degree of complexity, the study of the properties, their role and other factors give rise to a number of features of structuring.

### References

1. Osis Ja.Ja. Topologicheskaja model' funkcionirovanija sistem [Topological model of functioning of systems] // Avtomatika i vychislitel'naja tehnika. — 1969. № 6. - С. 44-50. (Rus)
2. Novozhilova N.V., Markovich 3.P. Obrabotka topologicheskoy graf-modeli ob#ekta i vydelenie diagnosticheskogo optimal'nogo mnozhestva parametrov (DOMPTOGRAM). GosFAP — P006789 [Item Processing topological columns - models of object and allocation of diagnostic optimum set of parameter]. — M.: Gos. Fond algoritmov i programm, 1983. - 150 с. (Rus)
3. Ozernoj V.M. Principy postroenija i ispol'zovanija mnogokriterial'nyh modelej zadach prinjatija reshenij [Principle of construction and use of decision-making models] // Trudy Instituta problem upravlenija. — M.: Institut problem upravlenija, 1974. — Вып. 5.— С. 3-15. (Rus)
4. Modeli prinjatija reshenij na osnove lingvisticheskoy peremennoj [Decision-making models based on linguistic variable] // A.N. Borisov, A.V. Alekseev, O.A. Krumberg i dr. — Riga: Zinatne, 1982. — 256 с. (Rus)
5. Teorija vybora i prinjatija reshenij [Theory of choice and decision-making]: Uchebnoe posobie // I.M. Makarov, T.M. Vikogradskaja, A.A. Rubchinskij, V.B. Sokolov, — M.: Nauka, 1982. — 328 с. (Rus)
6. Dubrovskij L.N. Ispol'zovanie dereva svojstv dlja opisanija ob#ektov diagnostiki [Use of the properties tree to describe the diagnostics objects] // Upravlenie i diagnostika. — Riga: Rzh. politehn. in-t, 1980.— С. 31-36. (Rus)
7. Keeney, R. L., &Raiffa, H. Decisions with multiple objectives: Preference and value tradeoffs. NewYork: Cambridge University Press, 1993 (Eng)

## СТРУКТУРИЗАЦИЯ ЗАДАЧ ПРИНЯТИЯ РЕШЕНИЙ В ДИАГНОСТИКЕ ИНФОРМАЦИОННО-УПРАВЛЯЮЩИХ СИСТЕМ

**Н. Ю. Нуриахметова**

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: Natusik4576@mail.ru*

***Аннотация:** В интересах повышения эффективности эксплуатации информационно-управляющих систем (ИУС) рассмотрен вопрос формализации описания целей и средств в задачах принятия решений (ПР) при определении состояния ИУС, так как это необходимо для структуризации этих задач и правильной их постановке.*

***Ключевые слова:** информационно-управляющая система, задача принятия решений.*

## SIMULATION OF OPTICAL COHERENCE TOMOGRAPHY IMAGES USING VOXEL BASED APPROACH

**D.A. Petrov**

Tambov State Technical University, Tambov, Russia

*e-mail: den794@mail.ru*

**Abstract:** *An algorithm of optical coherence tomography (OCT) images simulation based on voxel approach for object inner structure construction is described. Experimental OCT images were used to determine geometry of an object. Poisson distribution, Henyey-Greenstein scattering function and Beer-Lambert law were used to calculate light propagation inside biological tissue. The comparison of simulated and experimental images demonstrated the efficiency of the proposed algorithm.*

**Keywords:** *Monte Carlo methods, optical coherence tomography, photon transport.*

Optical coherence tomography (OCT) is one of the most rapidly developing methods of medical imaging which uses light to obtain images of object inner structure. The main limiting factor of OCT is relatively small imaging depth, which equals to 1-2 mm in skin examinations and 3-5 mm in ophthalmologic examinations. Small imaging depth is a result of multiply light scattering inside biological tissue, so in order to improve OCT full understanding of this process is to be obtained [1]. In this paper, we present the algorithm that will allow studying light scattering and its influence on OCT images.

The process of light propagation inside biological tissue can be divided into several steps. On the first step we launch a photon packet according to Gaussian distribution:

$$p(r) = \frac{2 \cdot \pi}{\pi \cdot w_0^2} = \frac{2 \cdot r}{w_0^2},$$

where  $w_0$  is source radius,  $r$  is radial position of photon packet. It means that its starting position could be determined as follows:

$$\begin{aligned}x_i &= w_0 \cdot \sqrt{\xi_1} \cdot \cos \varphi_a + A_i \cdot d, \\y_i &= w_0 \cdot \sqrt{\xi_1} \cdot \sin \varphi_a, \\z &= 0,\end{aligned}$$

Where  $\xi_2$  - is a random number uniformly distributed between 0 and 1,  $A_i$  - is current A- scan index,  $\varphi_a$  - is azimuthal angle.

After that we are determine photon packet step size  $s$  of flight between two points of interaction with tissue according to Poisson distribution [2]:

$$s = \frac{-\ln(\xi)}{\mu_a + \mu_s},$$

where  $\mu_a$  and  $\mu_s$  are absorption and scattering coefficients of the media.

The Henye-Greenstein scattering function used to describe scattering angle every time photon travels distance  $s$  :

$$p(\cos \theta) = \frac{1 - g^2}{2(1 + g^2 - 2g \cos \theta)^{3/2}}$$

where  $\theta$  is scattering angle,  $g$  is anisotropy factor of media. After that, statistical weight of the packet was decremented using Beer-Lambert-Bouguer law:

$$W_{i+1} = W_i \cdot e^{-\mu_a \cdot s},$$

where  $W$  is statistical weight of the photon. The whole process was repeated until photon reaches object boundary or its weight dropped below threshold.

The voxelization approach to object representation allows constructing geometry of an object with absolutely complex geometries. The main idea of this technique is to use large amount of cuboids with different optical properties to build object geometry. This approach was considered ineffective because for each iteration of photon packet movement ray-cuboid facets intersection equation should be solved. We are presenting a way to sufficiently improve performance of this approach. The main feature of it is to use the Smith algorithm to voxel boundary intersection problem solving.

$$db_z = \begin{cases} \frac{z + d_z - z_c}{u_z} & \text{if } u_z > 0 \\ \frac{z - z_c}{u_z} & \text{if } u_z < 0 \end{cases},$$

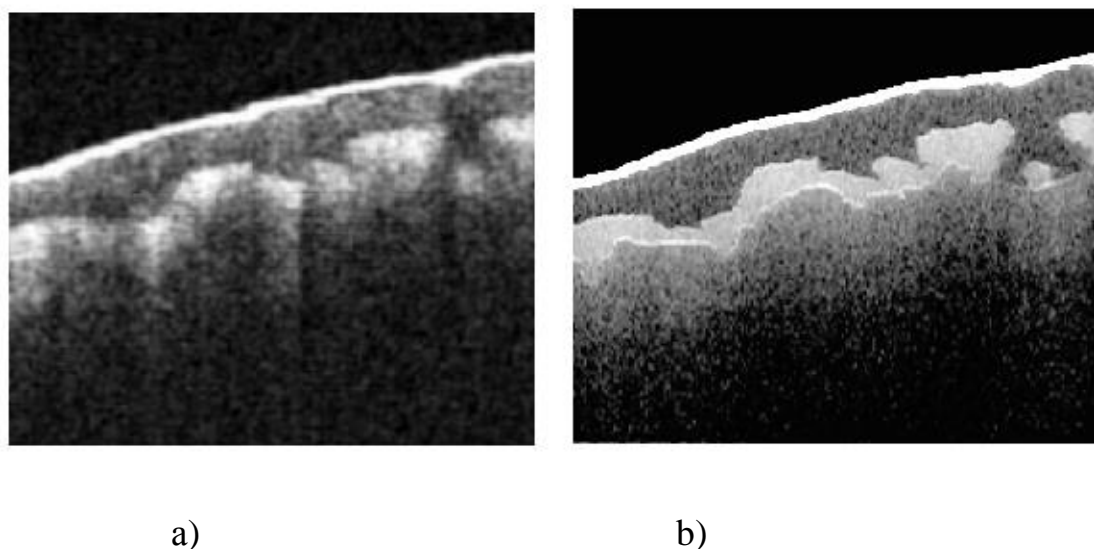
$$db_y = \begin{cases} \frac{y + d_y - y_c}{u_y} & \text{if } u_y > 0 \\ \frac{y - y_c}{u_y} & \text{if } u_y < 0 \end{cases},$$

$$db_x = \begin{cases} \frac{x + d_x - x_c}{u_x} & \text{if } u_x > 0 \\ \frac{x - x_c}{u_x} & \text{if } u_x < 0 \end{cases},$$

where  $db_x, db_y, db_z$  are distances to voxel facet plane,  $x_c, y_c, z_c$  are photon current position,  $d_x, d_y, d_z$  are voxel edge length,  $z, y, x$  are coordinates of lower voxel boundary. Each distance compared and lower values represent step size to intersection point. Resolution of optical properties distribution depends on number of

voxels and their size [2].

Experimental OCT images could be used to construct studied object in simulation after appropriate processing which could be done using layer detection algorithms [11]. Pixelated image where each color represents biological tissue could be transformed to 3D object for simulation using voxelization approach. To study efficiency our algorithm we are performing simulation of OCT images of human skin using appropriate experimental OCT images (figure 1) [3].



*Fig. 1. Experimental (a) and simulated (b) OCT images of human skin.*

Correlation coefficient of images is equaled to 0.87. The total time required for simulation of single image of 400 A-scans (lines) equaled to 6 hours, which was ~3 times smaller than that in the previously presented algorithm [4].

High performance and correlation coefficient of images confirmed the efficiency of the proposed algorithm and possibility of its application in the study of light scattering influence on OCT images.

#### **References**

1. Zimnyakov D. A., Tuchin V. V., "Optical tomography of tissues", *Kvant. electron.*, 2002 Vol. 32(10), P. 849–867 (Rus)
2. Yao G., Wang L. V., "Monte Carlo simulation of an optical coherence tomography signal in homogeneous turbid media," *Phys. Med. Biol.* 44(9) 1999, 2307–2320.(Eng)
3. Proskurin S. G., "Raster scanning and averaging for reducing the influence of speckles in optical coherence tomography", *Kvant. electron.*, 42:6 (2012), P - 495–499 (Rus)
4. Petrov D. A., Galeb K. E. S., Proskurin S.G. "Optical coherence tomography B-scan simulation using Monte Carlo method with voxel geometry representation". *Modern problems of science and education.* – 2016. – № 5 (part 2) – P. 275-278 (Rus)

# МОДЕЛИРОВАНИЕ ИЗОБРАЖЕНИЙ ОПТИЧЕСКОЙ КОГЕРЕНТНОЙ ТОМОГРАФИИ НА ОСНОВЕ ВОКСЕЛЬНОГО ПОДХОДА

Д. А. Петров

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: den794@mail.ru*

**Аннотация:** Представлен алгоритм моделирования изображений оптической когерентной томографии (ОКТ) на основе воксельного подхода к описанию внутренней структуры объекта. Представлена возможность использования экспериментальных ОКТ изображений для определения геометрии среды. Распределение Пуассона, фазовая функция Хенни-Гринштейна и закон Бера-Бугера-Ламберта используются для расчета миграции фотонов внутри биологического объекта. Сравнение экспериментальных и смоделированных изображений подтверждают эффективность предложенного алгоритма.

**Ключевые слова:** Метод Монте-Карло, оптическая когерентная томография, миграция фотонов.

---

УДК 53.088.22

ББК 30.10

## METROLOGICAL ANALYSIS OF A NON-CONTACT SENSOR OF DISTANCE

A. P. Savenkov, M. E. Safonova

Tambov State Technical University, Tambov, Russia

*email: selena250893@rambler.ru*

**Abstract:** Indication errors of sensor are considered and formulas derivation is given. Dependences of sensor errors on the angle of incidence of the laser beam are found. Charts of dependences are plotted.

**Keywords:** error, laser, measurement, non-contact, sensor, distance.

A sensor based on the reflection of light from the liquid surface was designed for non-contact measurement of distance to a liquid surface. The sensor can be used in non-contact aerohydrodynamic methods measuring surface tension, density, and viscosity [1, 2].

The sensor may have indication errors which depend on angle of incidence of the laser beam and liquid level change [3]. The aim of this paper is to define these errors.



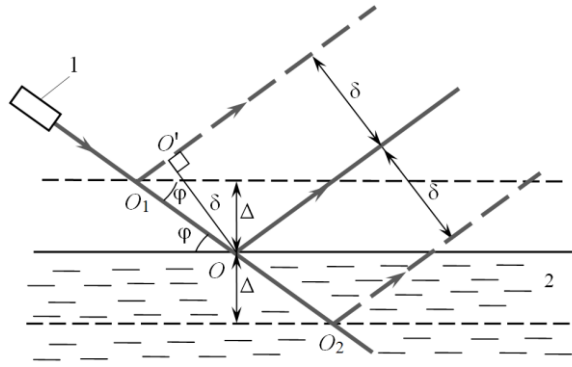


Fig. 1. Scheme of non-contact sensor of distance to a liquid surface  
1 – laser diode, 2 – liquid surface

Within the zone of error when changing the liquid level  $\Delta$  reflection point  $O$  can be moved along light beam from a given point  $O_1$  to  $O_2$ .

Indication error of liquid level  $\Delta$  can be defined as follows:

Consider triangle  $O_1OO'$ , we have

$$OO_1 = \frac{\delta}{\sin 2\varphi}; \quad (1)$$

$$\Delta = OO_1 \cdot \sin\varphi; \quad (2)$$

Using formulas (1) and (2), we get

$$\frac{\Delta}{\delta} = \frac{1}{2\cos\varphi}.$$

By Fig.2, it follows that the smaller the angle  $\varphi$ , the less error; the error increases 1.4 times by changing the angle  $\varphi$  in the range from  $30^\circ$  to  $60^\circ$ .

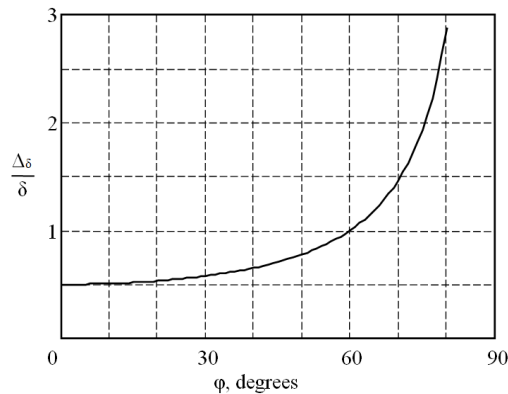


Fig. 2. The dependence of the reduced width of the dead band sensor distance from the incident angle of the laser beam

From analysis of light emission from the sensor the two essential values were found. They are angle  $\varphi$  of incidence and distance  $H$  from the liquid surface to the point photoresistor converter (fig. 3).

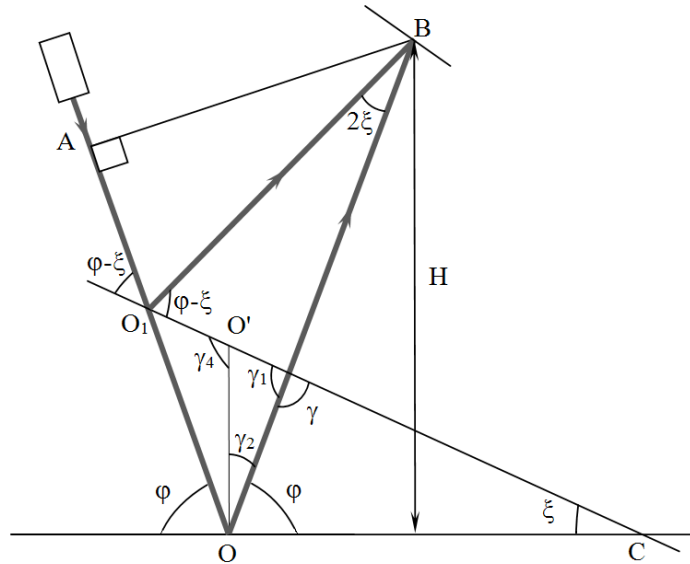


Fig. 3. To definition dependence of the sensor errors of the distance  $H$  on the angle  $\xi$  deviation of optical system from the predetermined position

To simplify the schematic image rotation of the sensor is realized by turning the liquid surface at the angle  $\xi$ . We take vertical distance  $OO'$  as indication error of measuring liquid level. Taking into account fig.3 and sine theorem, we obtain

$$OB = \frac{H}{\sin \varphi}; \quad \frac{OO_1}{\sin O_1BO} = \frac{OB}{\sin OO_1B}; \quad \frac{OO_1}{\sin OO'O_1} = \frac{OO'}{\sin OO_1O'}$$

from where we get

$$OO_1 = \frac{OB \cdot \sin O_1BO}{\sin OO_1B} = \frac{H \cdot \sin 2\xi}{\sin \varphi \cdot \sin(2\varphi - 2\xi)};$$

$$OO' = \Delta_\xi = \frac{H \cdot \sin \xi}{\sin \varphi \cdot \cos(\varphi - \xi)}.$$

Fig. 4 shows errors reduced to  $H$  on the interval  $[-3; 3]$ . The graphics plotted at angles  $\varphi$  equal to  $20^\circ$  and  $70^\circ$  are approximately the same.

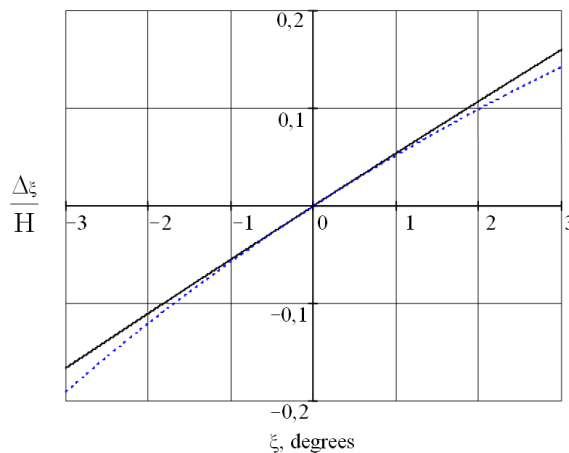


Figure 4. The dependence of the indication error of distance  $H$  the angle  $\xi$  deviation of the optical system of the detector: solid and dashed lines correspond to the values of the angle  $\varphi$   $20^\circ$  and  $70^\circ$

Based on the above, the choice of the angle  $\varphi$  has little effect on the error.

### References

1. Savenkov A.P., Safonova M.E, A Non-contact Sensor of Distance to a Liquid Surface // The World of Science without Borders: Proceedings of the 3rd International Scientific and Practical Conference of Young Scientists. Tambov TSTU Publishing House. Tambov, 2016. Pp. 128-132
2. Mordasov M.M., Savenkov A.P. Contactless Methods for Measuring Liquid Viscosity (Review) // Inorganic Materials. – 2014. – Vol. 50. – № 15. – P. 1435–1443.
3. Huanqi Tao, Shuangbao Ma. Research of the Measurement System of Liquid Displacement based on Angular Tracking //Applied Mechanics and Materials. 2010. Vols. 20-23 Pp. 493 – 498. DOI:10.4028/www.scientific.net/AMM.20-23.493

## МЕТРОЛОГИЧЕСКИЙ АНАЛИЗ БЕСКОНТАКТНОГО ДЕТЕКТОРА РАССТОЯНИЯ

**А. П. Савенков, М. Э. Сафонова**

Тамбовский государственный технический университет, Тамбов, Россия

*email: selen250893@rambler.ru*

**Аннотация:** Рассмотрены погрешности сигнализации детектора и выведенные формулы. Найдены зависимости погрешности детектора от угла падения лазерного луча.

**Ключевые слова:** бесконтактный детектор, измерение, погрешность, лазер, расстояние.

---

УДК 621.384.3  
ББК 0145

### A NEW METHOD FOR NON-INVASIVE MEASUREMENT OF BLOOD SUGAR

**O. K. Abuladze, Yu. B. Sergeeva**

Tambov State Technical University, Tambov, Russia  
e-mail: abuladze94@mail.ru, ulya\_sergeeve94@mail.ru

**Abstract:** *In the present article, we focus on existing methods for non-invasive measurement of blood sugar based on different physical process, consider disadvantages of these methods and propose a new method for monitoring of blood sugar by somatic temperature.*

**Keywords:** *blood sugar control, diabetes mellitus, measurement of blood glucose, non-invasive measurement, somatic temperature*

Diabetes mellitus is a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both. The chronic hyperglycemia of diabetes is associated with long-term damage, dysfunction, and failure of various organs, especially the eyes, kidneys, nerves, and blood vessels.

People with diabetes need to manage their disease to stay healthy. They must change lifestyle and diet, but the main thing is control of blood sugar. Measurement of blood sugar is one of the most frequent biochemical analyses in medicine. According to the World Health Organization (WHO), there are about 422 million people have diabetes worldwide. It's the huge number of patients, which is in want of a daily control of sugar level in blood.

Nowadays almost methods of control of blood sugar are invasive. Nevertheless, these methods are very uncomfortable and painful for a patients and have a lot of limitations: a probability of getting an infection and poor blood circulation. That is why modern scientists try to create a non-invasive method based on different physical process. There are spectrographic, ultrasonic, infrared methods, etc. They can be fast, painless and safe alternative. However, there are explicit disadvantages of these methods. For example, low accuracy of measurement and high influence of the ambient.

The aim of the scientific study is to develop a special method for monitoring of sugar concentration in blood. This method of non-invasive analysis of glucose concentration in blood by somatic temperature of patients is worked out. The proposed invention belongs to the field of medicine, particularly to endocrinology, and can be used to control of blood glucose concentration. Such a method allows to completely increasing accuracy and reliability of analyzing blood at the expense of systematic errors.

To achieve the aim of our research we used different methods such as:

1. Methods of comparison of non-invasive glucose concentration in blood.
2. Method of analytical control
3. Metrological effectiveness improvement

The proposed method included two stages: 1 – calibration of thermogram parameters and 2 – calibration of glucogram parameters. First, we obtained two values of somatic temperature: 1 – on an empty stomach and 2 – with glucose-containing food. Further, we found glucose concentration in the developed program because the level of blood glucose depends on thermogram.

After getting the results, the graphs were made. (Fig. 1, 2, 3)

Fig. 1 illustrates the dependence of somatic temperature on time (thermogram).

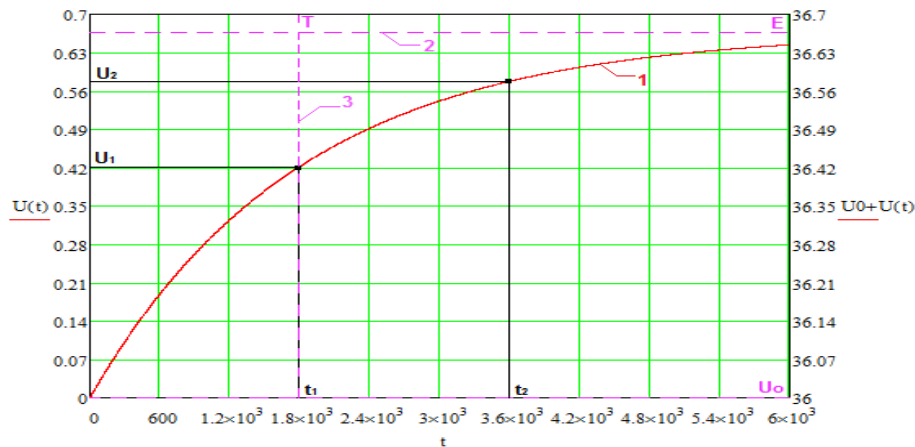


Fig.1. The graph of the measured thermogram values

The ordinate shows the somatic temperature, «U» and the abscissa axis displays time of experiment.

Fig. 2 illustrates the dependence of because level of blood sugar on somatic temperature (glucogram).

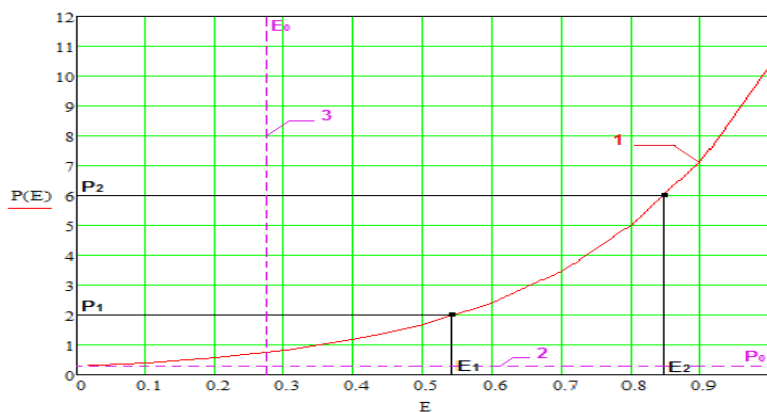


Fig.1. The graph of the measured glucogram values

The ordinate shows the somatic temperature, «P» and the abscissa axis displays time of experiment.

This graph shows the curve «1» which is the monitoring done with the proposed method and curve «2» is the monitoring done with the help of a prototype.

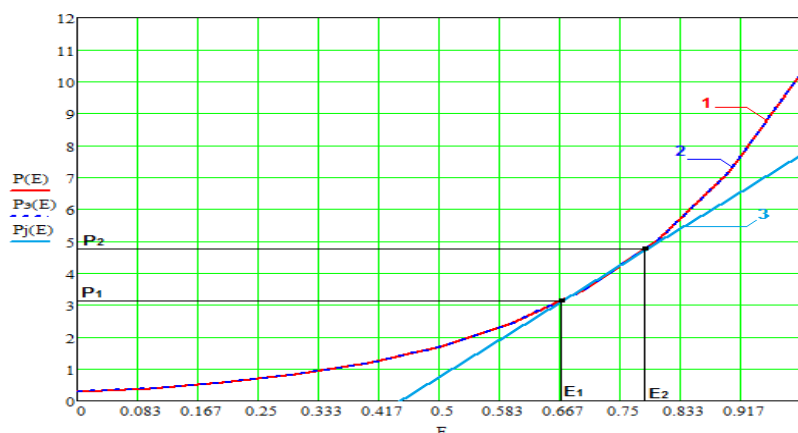


Fig.3. Comparison of received results with the sample graph

The glucose analyzer has been developed. The following goals were achieved as the results of the research:

- Information analysis of existing methods is made
- Metrological effectiveness has increased
- Increased efficiency not less than 3 times
- The use of the innovation along with the existing methods strongly complement clinical picture of the disease and improve the quality of monitoring concentration blood glucose

#### References

1. Jel'baev D.A., Akaeva S.A., Kurdanov H.A. Sposob opredelenija koncentracii gljukozy v krovi [The method for determining the concentration of glucose in blood]. Patent Russia, no.2198586.2003 (Rus)

## НОВЫЙ МЕТОД ИЗМЕРЕНИЯ КОНЦЕНТРАЦИИ ГЛЮКОЗЫ КРОВИ

О.К. Абуладзе, Ю.Б. Сергеева

Кафедра: Биомедицинская техника.

ТГТУ, Тамбов, Россия

e-mail: abuladze94@mail.ru, ulya\_sergeeve94@mail.ru

**Аннотация:** В данной статье рассмотрены методы неинвазивного измерения концентрации глюкозы в крови, основанные на различных физических явлениях, выявлены их недостатки и предложен новый метод мониторинга глюкозы в крови по температуре тела.

**Ключевые слова:** измерение глюкозы крови, контроль сахара крови, неинвазивное измерение, сахарный диабет, температура тела

## A NEW METHOD OF GLUCOSE ANALYSIS

**A. P. Babashkina, D.V. Akhtyamov**

Tambov State Technical University, Tambov, Russia  
e-mail: anuta.babashkina@yandex.ru, user\_spk@mail.ru

**Abstract:** *The present article focuses on non-invasive measurement of glucose concentration in blood. As the number of people suffering from diabetes grows steadily, it is necessary to measure glucose level in blood. Nowadays, invasive methods of finding glucose concentration concerning penetration in the organism are the most widespread.*

*We have investigated glucose concentration in blood and offered the non-invasive measurement of glucose concentration in blood. A device for the integrated analysis has been developed.*

**Keywords:** *diabetes, glucose control, glucose concentration, measurement, non-invasive measurement.*

Diabetes refers to the group of the diseases that are characterized by hyperglycemia; its symptoms are fatigue, a large amount of urine, leading to relative dehydration and problem with power exchange in the organism. The analysis of glucose concentration in blood is one of the most frequent biochemical analyses in laboratories. It is also the most important component of continuous «glucose control» in case of diabetes. The analysis is needed for monitoring diabetes and its treatment. It is a widespread chronic metabolic disease, which more than 1 million people from Great Britain and 100 million people in the world have. A great number of patients with diabetes need a daily analysis of glucose level in blood.

Modern progress of clinical diagnostics is characterized by the improvement of research methods which have been developed due to the practical implementation of essentially new ways of determining glucose concentration in blood.[1]

Patients with diabetes are forced to analyze glucose level in blood in domestic conditions. This information makes it easier to correct their diet, physical activities, the usage of insulin etc. Scientific research allowed creating various types of devices and methods of determining glucose concentration in blood.

The scientific study aims to make express analysis for analyzing glucose concentration in blood. The method of non-invasive analysis of glucose concentration in blood by the current-voltage characteristics is developed. It allows measuring glucose concentration in blood through optimization its maximum options of glucose and skin conductivity. Such a method allows increasing the accuracy and reliability of the analyzed blood to avoid systematic errors.

To achieve the goal of the research we used such methods as:

4. Methods of analysis and comparison of non-invasive glucose concentration in blood.
5. The creation of methods for prototypes by defining their inter dependence.
6. Metrological effectiveness improvement

The following device was used for glucose analysis in blood. It consists of separate components. The first one is voltmeter. It is used to measure current characteristics of the patient's skin. Another component is a microcontroller, it is used to connect the previous device with the computer which analyses the received data by comparing results of the suggested method with the existing method.

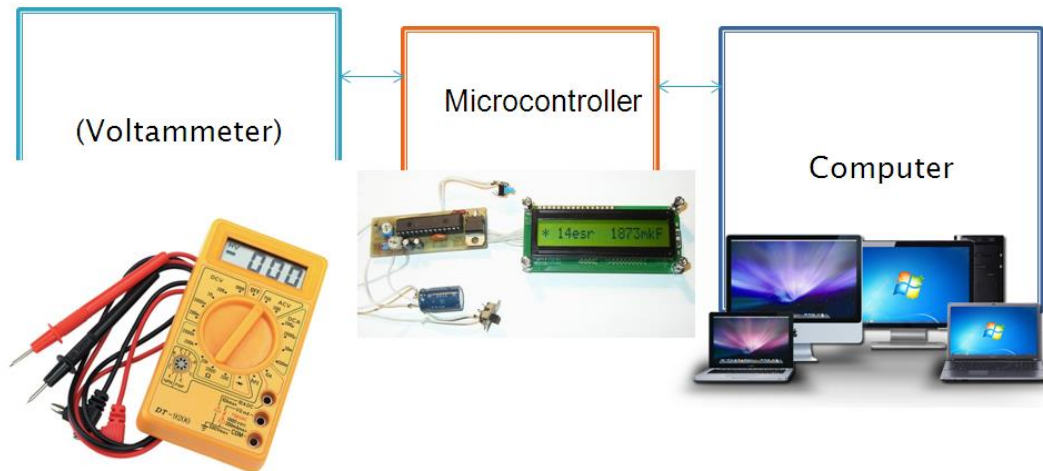


Fig.1.Components for the complex analysis

A 4-electrode receptor is connected with the patient's body, and the programme developed by the authors.

After getting the results, graphs were made (Fig. 2, 3).

Fig. 2 shows the graph of dependence of glucose concentration on the skin conductivity

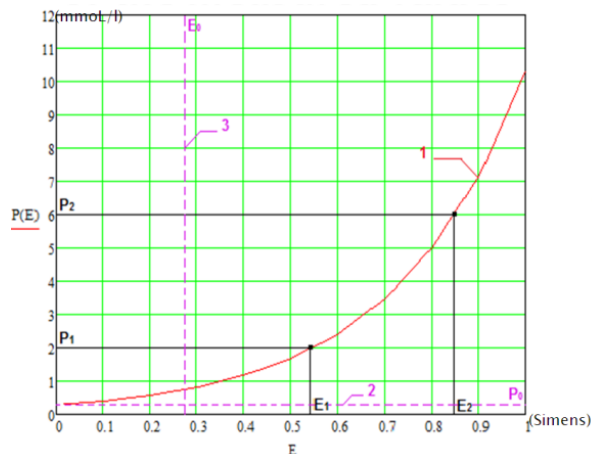


Fig.2. The graph of the measured values

The ordinate shows the glucose concentration, «P» in mmol per litre and the abscissa axis displays the skin conductivity, which is the represented by «y» and measured in Simens.

Fig 3 shows the comparison of the received results.



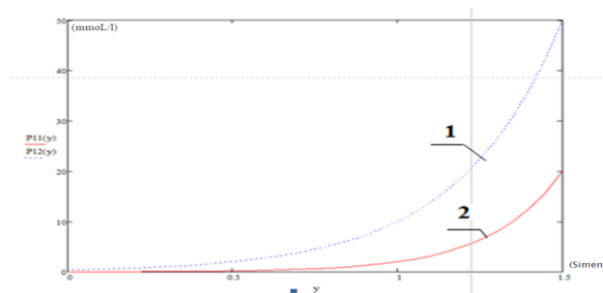


Fig.3. Comparison of the received results with the sample graph

This graph shows the curve «1» which is the measurement done with the suggested method and curve «2» is the measurement done with the help of a prototype. (Fig.3)

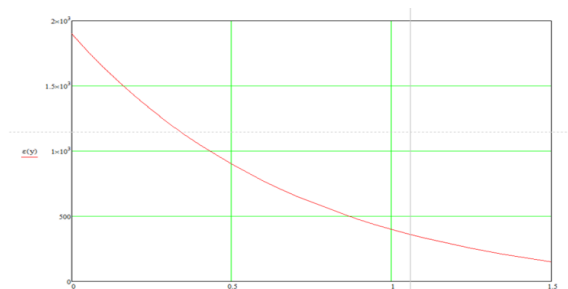


Fig.4. The error line

This graph shows an error line which is much lower than in the suggested method. (Fig.4)

The glucose analyzer was developed. The following goals were achieved as the results of the research:

- Information analysis of existing methods is made
- A principally new method of glucose concentration defining method has been developed
- Metrological effectiveness has increased

### References

1. Jel'baev D.A., Akaeva S.A., Kurdanov H.A. Sposob opredelenija koncentracii gljukozy v krvi [A method for determining glucose concentration in blood]. Patent Russia, no.2198586.2003

## НОВЫЙ МЕТОД ДЛЯ АНАЛИЗАТОРА ГЛЮКОЗЫ

**А. П. Бабашкина, Д. В. Ахтямов**

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: anuta.babashkina@yandex.ru, user\_spk@mail.ru*

**Аннотация:** Статья обращает внимание на неинвазивные измерения концентрации глюкозы в крови. По мере того как число людей, страдающих от диабета неуклонно растет, необходимо измерять уровень глюкозы в крови. В настоящее время известны инвазивные методы определения концентрации глюкозы с забором крови, как наиболее распространенные.

Мы исследовали концентрацию глюкозы в крови и предложили неинвазивное измерение концентрации глюкозы в крови. Устройство для комплексного анализа было разработано.

**Ключевые слова:** диабет, контроль глюкозы, концентрация глюкозы, измерения, неинвазивные измерения/

## A METHOD FOR DETECTING DISORDERS OF BLOOD CIRCULATION IN THE FINGERS

A. Y. Volkov, D. S. Kuzmin

Tambov State Technical University, 392000, Tambov, Russia

e-mail: a.89606699545@yandex.ru

**Abstract:** *In this article, we consider a method for determining circulatory disorders in the distal fingers. The effectiveness of the method was evaluated.*

**Keywords:** *blood, diseases, disorder, finger, criteria.*

Currently, diagnosis of vascular diseases is of paramount importance in today's world, as more and more people are susceptible to repetitive stresses, temperature fluctuations.

Blood vessels perform a variety of functions. Firstly, they provide differential distribution of blood in the tissues. Secondly, blood vessels actively synthesize and secrete vasoactive substances that regulate vascular tone, as well as antithrombogenic agents that maintain blood flow and vascular permeability. Thirdly, blood vessels provide delivery and distribution of cells of the immune system to infected tissue. Peripheral vascular disease entail violation of these important functions.

Peripheral vascular study can be conducted using conventional survey methods (manual, tool and hardware), as well as thermal imaging diagnostic method.

The purpose of this work - to improve the accuracy of the thermal imaging method diagnostics of the functional state of peripheral vessels.

The object of research is the functional state of peripheral vessels, the subject of research is thermal imaging method for the diagnosis of the functional state of peripheral vessels.

An analysis of the literature [4] made it possible to identify the main factors influencing the temperature of the distal phalanges of limbs, as well as to identify the relationship of the temperature of the distal phalanges of limbs and condition of the organism. Temperature model is the state of the human body.

The main factors affecting the temperature of the distal phalanges are state of the thyroid gland, blood pressure human, the condition of blood vessels and environmental parameters.

The research was conducted in a dark room at a temperature of 20 - 22° C with a prior adaptation of the test person for 15 - 20 minutes. In addition, we had to measure the human blood pressure. The research was conducted in the control group of 3 people. These people did not have inflammatory diseases which could raise the average level of body temperature.

The results obtained and analyzed for each of the seven patients are given in Table 1, which shows the parameters measured for each patient.

Table 1 - Temperature dependence of the parameters of the occlusion of the test of time.

	P <sub>1</sub> , mm. Hg. Art.	T <sub>1</sub> , °C	T <sub>min</sub> , °C	T <sub>max</sub> , °C	T <sub>f</sub> , °C	T <sub>dpt</sub> , °C	ΔT <sub>1</sub> , °C	ΔT <sub>2</sub> , °C	ΔT <sub>3</sub> , °C
Patient 1	154/94	33.675	32.1	34.4	36.3	33.4	1.575	2.9	0.725
Patient 2	89/61	32.2	32.3	34.4	34.9	32.2	-0.1	2.7	2.2
Patient 3	124/63	33.825	31.8	34.3	35.3	33.6	2.025	1.7	0.475

We developed criteria of evaluation of the functional state of peripheral vessels, taking into account the differing impact of the state of the thyroid gland (Table 2).

Table 2 - Criteria for evaluating the functional state of peripheral vessels

The result of the survey	Diagnosis
$T_{max} \geq T_1$	Compliance of the norm. Hallmark violations endothelium regulation of vascular tone is not observed.
$T_{max} < T_1$	There is a sign of disturbances of endothelium-regulation of vascular tone.
$\Delta T_3 < 0$	Hyperemic type of microcirculation.
$\Delta T_3 \leq 2 \text{ } ^\circ\text{C}$	Normotonic type of microcirculation.
$\Delta T_3 > 2 \text{ } ^\circ\text{C}$	Spastic type of microcirculation.

In this paper, we proposed a method for diagnosing the functional state of peripheral vessels given the influence of the state of the thyroid gland, made additional temperature measurements of the distal phalanges of the fingers and forearm temperature, calculated the difference of these temperatures.

#### References

1. Fedyukovich, N.I. *Anatomiya i fiziologiya*. [Anatomy and physiology]. - Rostov na Donu: Phoenix. 2003. p. 209 - 210.

## СПОСОБ ОБНАРУЖЕНИЯ НАРУШЕНИЯ КРОВООБРАЩЕНИЯ В ПАЛЬЦЕВ

А.Ю. Волков, Д.С. Кузьмин

Тамбовский государственный технический университет, Тамбов, Россия

e-mail: a.89606699545@yandex.ru

**Аннотация:** В этой статье рассматривается метод определения нарушений кровообращения в дистальных пальцах. Оценивается эффективность данного метода.

**Ключевые слова:** кровь, заболевания, расстройства, палец, критерии.

## A METHOD OF RADIATION DOSE REDUCING DURING FLUOROSCOPY

**Yu.V. Suslova, K. E. Shvyreva**

Tambov State Technical University, Tambov, Russia

*e-mail: popova21.04@mail.ru*

**Abstract:** *The paper presents a method to reduce radiation doses during fluoroscopy. The method consists of selecting parts of images of a person, overlapping the optical image of the patient's body and processing the resulting image. The proposed method reduces the radiation dose for patients, improves the efficiency and reliability of diagnosis in general.*

**Key words:** *combining images of medical diagnostics, fluoroscopy, radiography, research methods, thermography.*

Image processing is a fundamental task in various spheres of human activity. The processing of images obtained using a wide range of modern medical apparatus, instruments, systems and complexes for diagnosis of various diseases of particular interest. Currently, such tasks are most relevant, as medicine moves forward and provides the possibility of diagnosing patients very quickly. Modern equipment allows obtaining a large amount of diagnostic information. However, this information involves multiple hardware examinations, some of which (e.g., x-rays) caused significant harm to the patient. In this regard, there is a need to protect the patient from harmful effects of the equipment or reduce this impact to a minimum. Image processing is able to solve this problem [1].

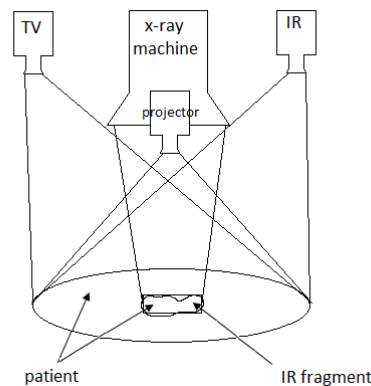
Fluoroscopy is an x-ray method, which is the formation of an image of the object on a fluorescent screen or a television screen by x-ray machines. Fluoroscopy is a very informative method, so the doctors examine patients in such a way very often. However, this method has its disadvantages: high dose and low spatial resolution. These disadvantages are essentially different, it is therefore necessary to divide the study into two stages: search of the way to reduce radiation doses received from fluoroscopy and an increase of the reliability of the resulting image.

The first stage of research aims to reduce a radiation dose. Frequent fluoroscopic procedures should not only reduce doses, but also the area of the irradiated surface of the patient's body. The information about a required area of exposure can provide a thermographic picture of a patient's body, as the temperature anomaly of the skin surface occurs in case of many internal pathologies. It is therefore necessary to obtain the thermal picture of the necessary area of exposure at the same time with x-ray studies [1].

When the location of temperature anomalies is analyzed, it becomes possible to narrow the area of x-ray irradiation. To eliminate unnecessary information of the thermal pattern it is necessary to select the portion of the corresponding zone of temperature anomalies related to the normal distribution of temperatures on the patient's body surface. During preparation for an x-ray examination a fragment of the temperature anomalies is optically superimposed on the corresponding part of the

patient's body. The structural scheme of the installation is shown in Fig. 1.

Thus, the apparatus combines three devices to generate images with different ranges. In this image, infrared and optical images are combined.



*Fig. 1 – Structural scheme of the complex x-ray, thermal imaging and video systems*

Ultimately, the use of thermography during x-ray examination will greatly reduce the radiation dose on the patient [2].

The second stage of the research is aimed at improving the information content of the resulting image because much attention is paid to the accuracy of medical diagnostic equipment. A reliable diagnosis can be obtained by using iconic instruments with different ranges. In this case, two objects are combined into one, increasing the informative content of the obtained graphic data.

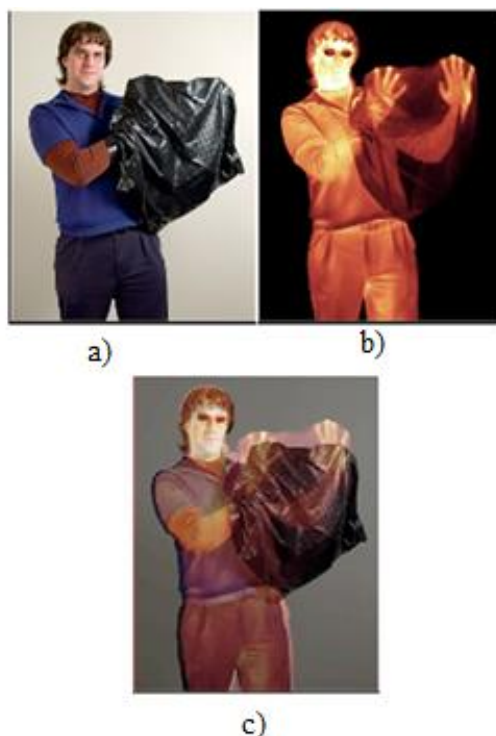
However, the usual combination of images may not solve this problem because in this case, the image may acquire a mosaic structure. To eliminate this disadvantage it is necessary to process combined images. The Interpolation of images is used for smoothing the mosaic structure [2].

Let us consider the results of images processing using cross-interpolation. Television images (video) almost entirely coincide with the picture of the observed object. The image details depend on the sensor resolution, the bandwidth of the communication line and the monitor resolution. However, a significant drawback of video is the lack of information on the thermal picture of the object.

Thermal imaging equipment (infrared camera) allows you to observe objects in the infrared frequency range [3]. Modern thermal imagers form an image in near, middle and far infrared ranges with a resolution of 0.1 degree Celsius. However, the thermal picture does not detail the object, so you must have a video image of a monitored object in the thermal range with an infrared image of the surface of the human body. Therefore, we have combined infrared and visible images. The combination must satisfy several requirements: the image must be formed at the same angles of view of the camera and thermal imager, the area of observation should be the same. Combining TV and infrared images will provide a more informative picture of the observed object [4,5].

The advantage of the combined images is demonstrated by the example (Fig.2). It shows the video image of the infrared image of a person and a combined image. The composite image clearly shows the temperature change; in this image, it is possible to

accurately identify the person.



*Fig. 2 – a) TV image; b) infrared image; c) combined image*

Many pathological processes alter the normal distribution of the temperature on the surface of the body. In many cases, temperature changes are ahead of other clinical manifestations. Therefore the results of thermography can be an additional informative parameter for assessing the status of the patient.

The paper presents a method of reducing the radiation dose during fluoroscopy-based selection of fragments of images of the person by overlapping the video image of the patient's body and processing the resulting image. The proposed method provides the possibility to reduce a radiation dose, improve the efficiency of diagnosis and patient safety.

### **References**

1. K. E. Shvyreva, Y. V. Suslova, A. N. Vetrov. Puti umen'sheniya dozy oblucheniya rentgenoskopii [Ways of reducing radiation dose fluoroscopy] // Virtual modeling, prototyping and industrial design: materials of II international scientific-practical conference 2015. – P. 244 – 245. (Rus)
2. A. L. Priori. Cifrovaya obrabotka izobrazhenij [Digital image processing] // YSU, 2007. – 235 p. (Rus)
3. Y. A. Tkachenko. Klinicheskaya termografiya [Clinical thermography] // CJSC Union of Eastern and Western Medicine, 2008. – 96 p. (Rus)
4. K. E. Shvyreva, Y. V. Suslova, A. N. Vetrov. Termografiya v komplekse s izobrazheniyami medicinskoj diagnostiki [Thermography in combination with image medical diagnostics] // Abstracts of the II International youth scientific conference: FTI-2015, 2016. – P. 78-79. (Rus)
5. K. E. Shvyreva, Y. V. Suslova, A. N. Vetrov. Snizhenie dozy oblucheniya pri rentgenoskopii [Reducing radiation dose in fluoroscopy] // XX open forum of researchers "facets of art": the short abstracts, 2016. – P. 19-20. (Rus)

## СПОСОБ УМЕНЬШЕНИЯ ДОЗЫ ОБЛУЧЕНИЯ ВО ВРЕМЯ РЕНТГЕНОСКОПИИ

Ю.В. Сулова, К.Е. Швырева

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: popova21.04@mail.ru*

**Аннотация:** Представлен метод уменьшения дозы облучения при рентгеноскопии. Идея заключается в выделении фрагментов термограммы человека, их наложении на оптическое изображение тела пациента и обработке результирующего изображения. Предложенный метод позволяет не только снизить дозу облучения пациентов, но и повысить эффективность и информативность диагностики в целом.

**Ключевые слова:** Методы исследования, рентгенография, рентгеноскопия, совмещение изображений медицинской диагностики, термография.

---

УДК 616. 853-039.13

ББК Р627.709.2-4

## HOME MONITORING OF EPILEPTIC ATTACKS

A.A. Trubienko, A.N. Vetrov

Tambov State Technical University, Tambov, Russia

*e-mail: sniper\_elite@mail.ru*

**Abstract:** Existing methods of monitoring epileptic attacks are considered in the article, disadvantages of these methods are described, the method of monitoring epileptic attacks is proposed and the evaluation of its effectiveness is made.

**Keywords:** cardiac activity, epilepsy, epilepsy monitoring, motion activity, respiratory activity.

### Introduction

According to the world health organization, there are about 50 million people diagnosed with epilepsy in the world. This disease can be treated, but we need information about the frequency of epileptic attacks to analyze the effectiveness of this treatment and the dosage of medicines.

There is a syndrome of sudden unexpected death of patients, who suffer from epilepsy, according to the American Professor of Neurology David Fiker, the prevalence of this syndrome is 2 per 1,000 patients aged 20-40 years. According to the American Professor of Neurology Paul Shraeder, the cause of this syndrome is the development of cardiac arrhythmia or respiratory arrest.

The method of electroencephalography (EEG) is highly prevalent in diagnosing

and monitoring of epilepsy. Electroencephalography is a method of brain research, which registers the difference of electrical potentials projected from the brain on the head skin. Accordingly, EEG by recording electrical potentials of the brain shows its functional activity. There are inpatient and outpatient methods of EEG.

In addition to the EEG recording, the following method of collecting information about patient can be used:

- The journal of the patient's self-report;
- The observer's report;
- Video camera.

In the journal of the patient's self-report, the latter notes down the number of epilepsy attacks and all changes in his organism. Self-report is the main form of monitoring the patient's behavior during the ambulatory EEG records.

The observer's report can be used by medical staff or relatives; this report is a supplement to the patient's report.

The video is the main and most effective way of monitoring the patient's behavior in stationary conditions. Simultaneously with the EEG the video of the patient's behavior (VEEG) is recorded. The observation on the part of the medical staff, the patient's self-report and computer analysis of the EEG in the automatic mode allow to select episodes, which can be epileptic attacks with high degree of probability.

The methods used for monitoring epileptic attacks cannot be used continuously, and they are not able to be used for the analysis of cardiac and respiratory activity. Their interruption can take place during an epileptic attack and cause the patient's death.

Consequently, there is a need to improve methods of monitoring epileptic attacks and cardiac and respiratory activity during epilepsy attacks.

### **Materials and methods**

To improve the efficiency of epilepsy monitoring a new method is proposed. The proposed method differs from existing methods in the way it is not based on the results of the EEG. The evaluation of the patient's motion activity is used for it. In addition, cardiac and respiratory activity is monitored during an attack of epilepsy. The methodology of the monitoring is organized in two phases that are performed cyclically.

The first phase is continuous monitoring of motion activity of a sleeping patient. During the sleep the patient may make a series of single movements that are not related to the attack of epilepsy, therefore it is important to assess motion activity for signs of seizures. If the motion activity takes a paroxysmal form, then this point is considered to be the beginning of an epileptic attack and the time, when it takes place, should be recorded. Further monitoring transfers into the second phase of the methodology.

During the second phase, the device records the seizure activity of the patient's hand, which is necessary for the further evaluation of the intensity of epilepsy. Given the strong frequency irregularity of motion paroxysms, it is required to register the average frequency of motion activity, over a time interval equal to five seconds. Furthermore, the heart pace (HP) is registered and cardiac activity for the presence of



arrhythmia is analyzed and types of arrhythmia are classified. Simultaneously, the respiratory system is examined by monitoring peripheral oxygen saturation. If irregularities in the cardiac or respiratory system are noted, they are registered immediately. Then, if the seizure activity continues the second phase is repeated again, and when there is no seizure, the end time of epilepsy attack is fixed, and the first phase of the methodology starts again.

At the end of monitoring, the accumulated data are analyzed, which allow to assess the adequacy of the treatment, to adjust the dose of medicines, taken by the patient, depending on the frequency of attacks and to timely detect the influence of epileptic attacks on cardiac and respiratory activity.

### **Conclusion**

The use of the proposed method will significantly improve the efficiency of epilepsy monitoring and as a result increase the quality of treating the patient with such a diagnosis.

The effectiveness of monitoring is enhanced by continuous monitoring of the patient's state of health at home. Thus, according to the proposed method, the total clinical picture of the disease will be supplemented with the information about the frequency of motion activity, the precise duration of epilepsy, the information about cardiac arrhythmia and its variations, as well as continuous monitoring of the patient's respiratory activity.

Thus, the application of the proposed method will allow to decrease reports about the patient's state as such reports are less informative than the studied method.

### **References**

1. Chang BS, Lowenstein DH. Epilepsy. N. Engl. J. Med., 2003, Vol. 349, Issue 13.- pp. 1257–1266.
2. Niedermeyer E., da Silva F.L. Electroencephalography: Basic Principles, Clinical Applications, and Related Fields. Lippincot Williams & Wilkins, 2004.- 1309 p.
3. Ficker D. M. Sudden unexplained death and injury in epilepsy. Epilepsia, 2000, Vol. 41.- pp. 7-12.
4. Rugg-Gunn F. Cardiac arrhythmias in focal epilepsy: a prospective long-term study. Lancet, 2004, Vol. 364.- pp. 2212–2219.

## **МОНИТОРИНГ ЭПИЛЕПТИЧЕСКИХ ПРИСТУПОВ В ДОМАШНИХ УСЛОВИЯХ.**

**А.А. Трубиенко, А.Н. Ветров**

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: sniper\_elite@mail.ru*

***Аннотация:** Рассмотрены существующие методики мониторинга приступов эпилепсии, выявлены недостатки данных методов, предложена методика мониторинга эпилептических приступов и произведена оценка ее эффективности.*

***Ключевые слова:** дыхательная деятельность, двигательная активность, мониторинг эпилепсии, сердечная деятельность, эпилепсия.*

## PREDICTION CONDITION OF THE CARDIOVASCULAR SYSTEM BASED OF HEMODYNAMIC FOUR-CHAMBER MODELS

S.V. Frolov, A.A. Korobov, N.E. Aliev

Tambov State Technical University, Tambov, Russia

e-mail: korobov1991@mail.ru

**Abstract:** *The paper presents a mathematical description of a four-chamber model of the cardiovascular system, consisting of four series-connected resilient chambers. The authors discuss the problem of modern diagnostic circulation and the need to use a mathematical model of the cardiovascular system to predict the state of the patient as a result the treatment modality. Modeled hemodynamic of the cardiovascular system is graphically presented. The necessary clinical and physiological parameters are described.*

**Keywords:** *clinical and physiological parameters, hemodynamic, mathematical model of the cardiovascular system.*

### Introduction

When assessing the medical condition of a patient in the intensive care ward, the picture received on the basis of only one characteristic (e.g., arterial pressure) is one-sided and does not reflect the real state of the patient. Even with multiple dependencies (e.g., pre and post strain, or spasm hypervolaemia and resistance vessels), a random choice dependency can also lead to disparate results, which can affect the value of a decision.

One of the problems of modern diagnostics is the absence of possibilities for deep algorithmic data analysis and the evaluation of acute blood circulation disorders.

Existing protocols, standards, algorithms, guidelines and recommendations on the diagnosis, classification and measurement of blood circulation disorders generalize a large clinical experience. However, most of these are verbal and do not have software implementation. At the same time, diagnosis and treatment processes in modern clinic are so complex and multifaceted nature that verbal description is not sufficient.

In the treatment of blood circulation disorders, especially acute ones, the doctor needs to make quick assessment of the medical condition of the patient and a make an informed decision based on it. In most cases, this procedure the doctor makes a decision using the rules, clinical guidelines, protocols and treatment recommendations. This process requires time and attention, which may prove to be the decisive factor in the outcome.

Consequently, creating a mathematical model of circulation is quite relevant. It will make it possible to predict the patient's condition as a result the treatment modality.

A study of the circulatory system was conducted in three main directions. The first direction covered the study of the structure, function, reactivity of single kardiomyocytes, individual arteries and arterioles. The second direction focused on the total response of organ blood flow, general and specific laws regulating the regional blood flow. The third direction studied the system vasomotor reactions,

blood flow redistribution mechanisms in active hyperemia and other operational loads. A large database on the structure and function of the cardiovascular system, a neurohumoral regulation of blood circulation, formulated the basic principles of organization and circulation control system is accumulated. However, many of the laws of the cardiovascular system are still far beyond one's comprehension. Comprehensive knowledge of the functions of individual vessels do not give a complete picture of the regulation of the entire vascular tree. For this, you must take into consideration the architecture of the bloodstream, wall stiffness, the caliber of vessels of different generations of branching and a number of other factors. The solution to such problems is impossible without the use of mathematical modeling. There are many mathematical models of the entire circulatory system and regulation of blood flow patterns in individual organs. In our case, a four-chamber mathematical model of circulation is acceptable.

### Model

The starting point of research is to create a model that includes the left and right ventricles, large and pulmonary circulation. It can be represented as four series-connected resilient chambers (Fig 1.)

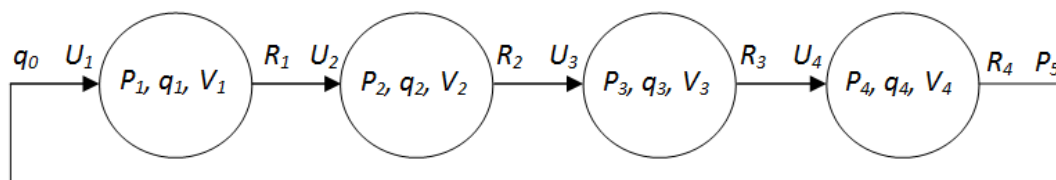


Fig. 1. The chamber structure of circulation models

At each time point of the  $i$ -th chamber the cardiovascular system is characterized by the blood volume  $V(t)$ , the pressure  $P(t)$  in the chamber wall, the input blood flow rate  $q_{input}(t)$  and the output blood flow  $q_{output}(t)$ , the absence of stress volume  $U(t)$ . The initial and final conditions of the model are adopted for blood flow  $q_0$  and pressure  $P_5$ , respectively.

Diagram resilient chamber is shown in Fig. 2.

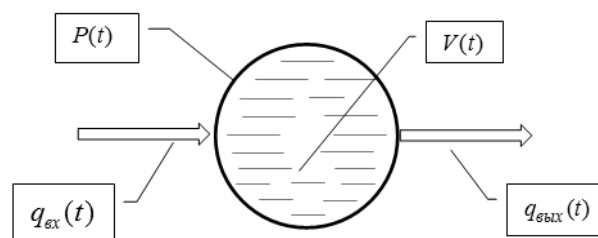


Fig. 2. Diagram of cardiovascular model chamber

In accordance with the law of mass conservation, the equation for the volume of the  $i$ -th chamber is written in the form:

$$\frac{dV_i(t)}{dt} = q_i^{input}(t) - q_i^{output}(t), \quad (1)$$

where  $q_i^{input}(t)$  is the vector of input blood flow ( $cm^3/s$ );  $q_i^{output}(t)$  is the vector

of output blood flow [2].

The total volume of blood, stretching the vascular bed ( $V$ ) is equal to the sum of the volumes, stretching every tank containing:

$$V_{LV} + V_{RV} + V_{SC} + V_{PC} = V$$

When finding the pressure  $P_i(t)$  in the wall of the  $i$ -th chamber, we assume that the more blood goes into the chamber, the more its walls are stretched, and the more pressure is created in the chamber wall. Then the pressure is calculated as:

$$P_i(t) = e_i (V_i(t) - U_i), \quad (2)$$

where  $e_i$  is the rigidity of the chamber wall ( $Torr/cm^3$ );  $U_i$  is the volume of blood, without stretching the chamber wall ( $cm^3$ ).

In accordance with Frank's concept of the elastic chamber, the vascular pressure in the systemic circulation is proportional to the generalized rigidity and the difference between the volume of blood in it and the volume of blood filling the vascular wall without stretching:

$$P_{SC} = e_{SC} \cdot V_{SC}$$

Likewise, we write the equation for the pulmonary circulation, left and right ventricle:

$$\begin{aligned} P_V &= e_V \cdot V_V \\ P_{RV} &= e_{RV} \cdot V_{RV} \\ P_{PC} &= e_{PC} \cdot V_{PC} \end{aligned}$$

Distending blood volume is the greatest part of the total volume of the chamber filling, which does not stretch the chamber wall. Filling the chamber, the blood spreads its, and only then, when the amount is sufficient, it stretches the wall [3].

Blood flow is found according to the Poiseuille law:

$$q_{input, output}(t) = \rho_{input, output} \left( P_{input}(t) - P_{output}(t) \right), \quad (3)$$

where  $\rho_{input, output}$  is communication conductivity ( $cm^3/(Torr \cdot s)$ ).

Blood flow  $q_{PC, LV}$  of the pulmonary circulation ( $PC$ ) into the left ventricle ( $LV$ ) and from the systemic circulation ( $SC$ ) in the right ventricle ( $RV$ ), respectively is proportional to the pressure in the pulmonary circulation and the systemic circulation:

$$\begin{aligned} q_{PC, LV} &= \rho_{PC, LV} \cdot P_{PC} \\ q_{SC, RV} &= \rho_{SC, RV} \cdot P_{SC} \end{aligned}$$

We assume that the blood flow  $f$  from the left ventricle into the systemic circulation, and from the right ventricle into the pulmonary circulation is proportional to the pressure difference between the chambers and the conduction between them:

$$\begin{aligned} q_{LV, SC} &= \rho_{LV, SC} \cdot (P_{LV} - P_{SC}) \\ q_{RV, PC} &= \rho_{RV, PC} \cdot (P_{RV} - P_{PC}) \end{aligned}$$

Limiting static mode allows to record the ratio:

$$q_{RV, PC} + q_{LV, SC} + q_{SC, RV} + q_{PC, LV} = q$$

Besides the description of a four-chamber model circulation it is necessary to be

aware of clinical and physiological parameters of the circulatory system that correspond to the current control of the monitor, reflecting systematically the related physiological processes that provide blood circulation, subsystems and communication, responsible for dysfunctions.

Table 1 shows the necessary parameters and the relationships between them:

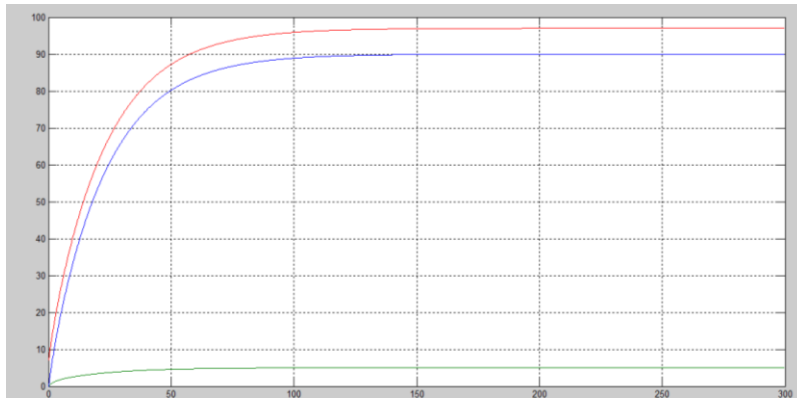
*Table 1. Parameters of circulation*

Symbol	Parameter	Formula
W	Weight	
G	Growth	
BSA	Body Surface Area	$W^{0.425} * G^{0.725} * 71.84 * 10^{-4}$
IV=SE=IE	Impact volume =Systolic ejection =Impact emissions	$10^3 * MVB / HR$
HR	Heart rate	
BP <sub>systolic</sub>	Blood pressure is the systolic	
BP <sub>diastolic</sub>	Blood pressure is the diastolic	
BP <sub>average</sub>	Blood pressure is the average	$BP_{diastolic} + (BP_{systolic} - BP_{diastolic}) / 3$
PPPA	Pressure plugging of the pulmonary artery	
CVP	Central venous pressure	
MVB	Minute volume of blood	$IV * HR / 10^3$
CI	Cardiac index = amount of blood ejected by the left ventricle for 1 minute at the rate of for each m <sup>2</sup> BSA	$MVB / BSA$ $SI * HR$
MWLV	Minute work is left ventricular	$0.0144 * MVB * (BP_{average} - PPPA)$
MIWLV	Minute index work is left ventricular	$MWLV / BSA$
PWLV	Pulse work is left ventricular	$0.0144 * IV * (BP_{average} - PPPA)$
PIWLV	Pulse index work is left ventricular	$PWLV / BSA$
CPVR	Common peripheral vascular resistance	$80 * (BP_{average} - CVP) / MVB$

These parameters are used to determine macrocausality which causes pathological changes in the cardiovascular status on clinical monitor control system [4].

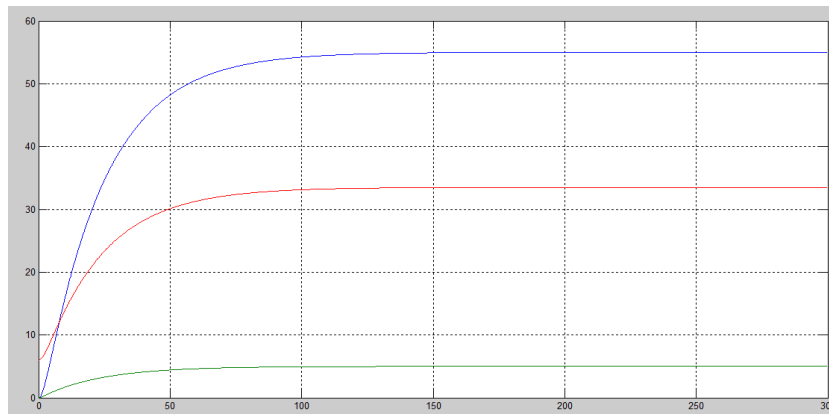
Simulation of hemodynamics of the cardiovascular system is produced in Matlab software environment.

The initial conditions are the volume and blood flow of the first chamber, the pressure of the fourth chamber. Fig. 3-5 show graphs of pressure values, blood flow and volume:



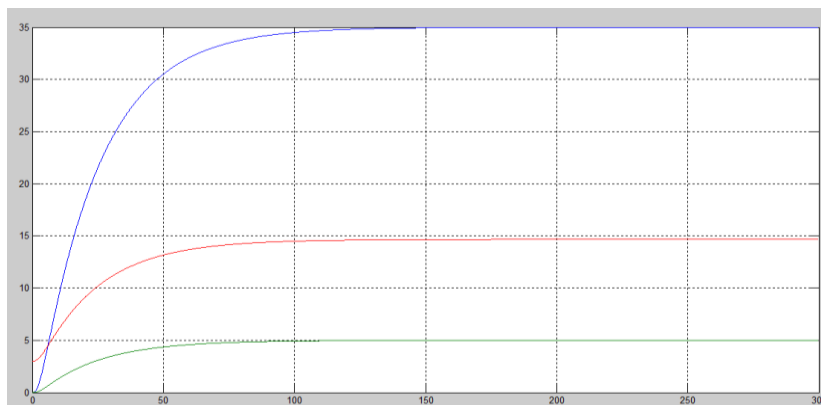
*Fig. 3. Calculated values of pressure in the chamber*

Fig. 3 shows the calculation of pressure values in the chamber at a predetermined pressure in the fourth chamber. The graphs show how the value of the pressure changes during the passage of the blood flow from one chamber to the other.



*Fig. 4. Calculated values of blood flow in the chambers*

Fig. 4 shows the calculation of blood flow values in chambers for a given initial value of the blood flow in the first chamber.



*Figure 5. Calculated values in the volume of the chamber*

Fig. 5 shows the calculation of volume values in chambers for a given initial value of the volume in the first chamber.

## **Conclusion**

As can be seen from Fig. 3-5, the pressure values, blood flow and blood volume passing through chamber are changing. The qualitative analysis of the charts to evaluate the dependence of hemodynamic parameters in the current chamber of the values in the previous one allows visually explore the simple laws of dynamics processes of the cardiovascular system. It is worth noting that this model of the cardiovascular system is the base one. Further development of the model is planned by increasing the number chambers, and a more detailed description of the model elements. For example, the pressure in the ventricles of the heart requires the introduction of additional coefficients, taking into account the compression and stretching of the myocardium of the elementary strips, and characterizing the elastic properties of the myocardium.

### References

1. Lishhuk V.A. Strategija informatizacii mediciny [The strategy of information medicine] / Lishhuk i dr. – Ejsk:JugPoligraf. – 2011. - 248 p. (Rus)
2. Frolov S.V., Matveev S.N., Kazakova D.Sh., Lishhuk V.A. Model' serdechno-sosudistoj sistemy, orientirovannaja na sovremennuju intensivnuju terapiju [The model of the cardiovascular system focused on modern intensive therapy] // Vestnik TGTU. 2008. Vol.14. (Rus)
3. Lishhuk V.A. Sistema zakonomernostej krovoobrashhenija [The system of laws circulation] // Klinicheskaja fiziologija krovoobrashhenija, 2005, Vyp.k 4, pp. 14-24. (Rus)
4. Lishhuk V.A., Gazizova D.Sh. Sistema fiziologicheskikh parametrov krovoobrashhenija [The system of physiological parameters of circulation].// Klinicheskaja fiziologija krovoobrashhenija, 2004, Vyp. 1, s. 28-38.. Clinical physiology of circulation, 2004, Issue 1, pp. 28-38. (Rus)

## ПРОГНОЗИРОВАНИЕ СОСТОЯНИЯ СЕРДЕЧНО-СОСУДИСТОЙ СИСТЕМЫ НА ОСНОВЕ ЧЕТЫРЁХКАМЕРНОЙ МОДЕЛИ ГЕМОДИНАМИКИ

**С.В. Фролов, А.А. Коробов, Н.Э. Алиев**

Тамбовский государственный технический университет, Тамбов, Россия  
*e-mail: korobov1991@mail.ru*

***Аннотация:** Представлено математическое описание четырехкамерной модели сердечно-сосудистой системы, состоящей из четырёх последовательно соединённых упругих камер. Рассматривается проблема современной диагностики кровообращения и необходимость применения математической модели сердечно-сосудистой системы с целью прогнозирования состояния пациента в результате лечебного воздействия. Графически представлена смоделированная гемодинамика сердечно-сосудистой системы. Описаны необходимые клиничко-физиологические показатели.*

***Ключевые слова:** гемодинамика, клиничко-физиологические показатели, математическая модель, сердечно-сосудистая система.*

УДК 664.144  
ББК 0145

## COMPOUNDING AND TECHNOLOGY OF FUNCTIONAL ASSORTED CHOCOLATES WITH LIQUID FILLINGS

**E.K. Bogatyreva**

Tambov State Technical University, Tambov, Russia

*e-mail: bek.tmb@bk.ru*

**Abstract:** *Assorted chocolates differ from sweets of other types in compounding, and in preparation. These chocolates are prepared with a liqueur filling, the alcoholized fruit and berries. Nowadays, almost total absence of vitamins, carotenoids, alimentary fibers, macro - and micronutrients in chocolates is the biggest disadvantage of confectionery. Therefore, the use of the new and nonconventional components containing biologically active agents, having functional properties and improving organoleptic indicators and structure of a product is topical. The purpose of our research is development of a compounding and technology assorted chocolates with liquid fillings enriched with vitamins, mineral substances and alimentary fibres.*

**Keywords:** *assorted chocolates, fillings, functional food, sweets.*

The level of consumption of confectionery products in Russia gradually approaches consumption level in the countries of the European Commonwealth and is at the fourth place in the world (after Great Britain, Germany and the USA). The chocolate industry is one of the most dynamically developing segments of a consumer sector of economy. The severe competition induces producers to expand the assortment and to create more and more new and interesting products.

According to specialists, almost total absence of vitamins, carotenoids, alimentary fibers, macro - and microelement in chocolates is the biggest disadvantage of confectionery. Therefore, the use of the new and unconventional components containing biologically active agents having functional properties and improving organoleptic indicators and structure of a product is topical [1].

The production of assorted chocolates with liquid fillings is topical today. The range of chocolates with liquid fillings is quite monotonous, therefore, creation of new flavoring combinations will allow to expand an assortment and to create essentially new product. Also, the use of liquid fillings will allow to create a product of functional purpose with high comprehensibility of nutrients as liquid fillings is an optimum form for enrichment of an organism biologically active agents. Because now technologies for such products are practically absent, there is a need for studying the problems which occur when receiving such types of confectionery products [2].

The main technological production stages of assorted chocolates are preparation of chocolate weight, preparation of fillings, formation of cases, selection of forms and packing. The chocolate cover for all types of chocolates is prepared from chocolate



weight with content of fat of 35%. Thickness of a cover depends on filling type, the viscosity of a filling is less, the cover is thicker. Chocolate covers fill with fillings, condense and cast a bottom. For casting of a bottom use chocolate weight with high content of cocoa butter (to 41%) [3].

In assorted chocolates the main role is played by fillings, therefore the following requirements are imposed:

- to be resistant in case of storage
- not to change the tastes and consistency
- not to contain perishable components.
- not to interact with the casing of sweets and to dissolve it
- to have a uniform consistency and to have sufficient viscosity.

In addition, concentration of sugar has to be close or equal in a filling to concentration of saturation at a formation temperature. Sucrose in a liquid filling has to form saturated or slightly supersaturated solution. If the solution is not saturated, then the dissolution of sugar occurs in the case of chocolate and on a surface of a product filling droplets are formed. At excessively supersaturated solution on the internal surface of the case at storage the large crystals of sugar worsening taste of a product are formed. Considering that density of a filling is less than density of the case, it is necessary to create a crust on a filling surface when cooling it, for the prevention of mixture of a filling and case.

Now the most popular liquid fillings are liqueur and honey. Liqueur fillings contain sugar, treacle, alcohol or wines. Alcohol in these fillings defines taste of a product. It is the best of all to apply the substances from 60 % concentration of alcohol which are not entering interaction with the candy case. Liqueur fillings must contain no more than 21 % of alcohol: at its bigger share there is a deformation of the chocolate case, and it sticks to chocolates. Honey fillings represent the boiled-down sugar molasses syrup with natural honey and various additives. Additives are different types of fruit puree which increase viscosity of filling [4].

There is method of production of chocolates on the basis of herbal mixes of several herbs containing mix extracts to receipt of the functional chocolates enriched with food fibers and vitamins, such as sage, peppermint, rebaudiana, plantain, etc. The method of production of functional fillings from fruit and berry raw materials, sugar, treacle and a product from a brown alga is also known. Application of such methods will allow to enrich a product with a complex of biologically active agents [5].

The method of production of confectionery with the filling located in the center is of special interest. This method assumes filling of a cover with the temperature of 71-105 °C with a filling with the temperature of 49 °C or is lower in a concentric nozzle for partial glazing of a stuffing, a jiggling of partially glazed filling in a form cavity, complete glazing in a cover, at the same time the filling cools a cover with hardening of a layer of a filling adjacent to a cover.

Today there are various types of hardware and machine registration of a stage of formation of chocolates, both simple, and irregular shape, and also the scheme of formation of candies according to the «One Shot» scheme [6, 7].

Considering all the above, it is obvious that the quality improvement of confectionery by developing their consumer properties is the urgent task which has scientific and practical value.

Thus, the purpose of our research is development of a compounding and technology of candies with liquid and semi-fluid fillings. For achievement of an effective objective it is necessary to perform the following tasks:

1. Development of a compounding of receiving functional candies with liquid fillings

2. Definition of the optimum modes of filling of cases of candies with a liquid fillings.

3. Research of rheological properties of cases and fillings.

4. Improvement of a stage of preparation of fillings and a stage of formation of technology of receiving functional candies with liquid fillings.

5. Definition indicators of the developed products.

Having achieved objectives, we will receive essentially new type of sweets having the increased nutrition and biological value, making favorable impact on an organism which will be interesting to adults and children.

#### References

1. Grigorieva, V.E. Analiz ryinka konditerskih izdeliy. [Analysis of the market of confectionery]. Available from: <http://novainfo.ru/article/3450>. (Accessed 1 November 2016). (Rus)
2. Fedynina, L.N. Nachinka dlya konditerskih i hlebobulochnyih izdeliy. [Filling for confectionery and bakery products]. Patent RF, no 2011125569/13, 2013 (Rus)
3. Bhattacharia, K. Konditerskie izdeliya s nachinkoy v tsentre i sposob ih polucheniya. [Confectionery with a filling in the center and a way]. Patent RF, no 2011124547/13, 2013 (Rus)
4. Dragilev, A.I. Oborudovanie dlya proizvodstva saharistyih konditerskih izdeliy. [Equipment for production of sugar confectionery] / A.I. Dragilev.- M.: Akademiya, 2004. - 272 p. (Rus)
5. Dragilev, A.I. Osnovyi konditerskogo proizvodstva. [Bases of confectionery production] / A.I. Dragilev.- M.: DeLi print, 2007. - 532 p. (Rus)
6. Kormakov, S.I. Proizvodstvo konfet. [Production of candy] / S.I. Kormakov. – M.: Legkaya i pischevaya promyshlennost`, 2012. - 176 p. (Rus)
7. Lurie, I.S. Tehnologiya konditerskogo proizvodstva. [Technology of confectionery production] / I.S. Lurie. M.: Agropromizdat, 2009. - 399 p. (Rus)

## РАЗРАБОТКА РЕЦЕПТУРЫ И ТЕХНОЛОГИИ ФУНКЦИОНАЛЬНЫХ КОНФЕТ «АССОРТИ» С ЖИДКИМИ НАЧИНКАМИ

**Е. К. Богатырёва**

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: bek.tmb@bk.ru*

***Аннотация:** Шоколадные конфеты «Ассорти» значительно отличаются от конфет других групп как по рецептуре, так и по способу приготовления. Такие конфеты готовят с ликерной начинкой, заспиртованными фруктами и ягодами. В настоящее время, существенным недостатком кондитерских изделий является практически полное отсутствие в них витаминов, каротиноидов, пищевых волокон, макро- и микроэлементов. Поэтому актуально использование новых и нетрадиционных компонентов, содержащих*

такие биологически активные вещества, которые обладают функциональными свойствами и способны улучшить как органолептические показатели, так и состав изделия. Исходя из вышесказанного, целью наших исследований является разработка рецептуры и технологии конфет «Ассорти» с жидкими начинками с увеличенным содержанием витаминов, минеральных элементов и пищевых волокон.

**Ключевые слова:** кондитерские изделия, конфеты «Ассорти», начинки, функциональные продукты.

---

УДК 574  
ББК 0145

## CONTROL OF TECHNOLOGICAL PARAMETERS OF PRODUCTION OF A CONTAINER FOR FOODSTUFF

V.V. Budantsev, E.E. Viskov

Tambov State Technical University, Tambov, Russia  
e-mail: gepard-xxx68@mail.ru

**Abstract:** The majority of containers for foodstuff are made by casting under pressure, in which the manufacturing process is important as industrial control, occurring at all stages of the process. Production control includes 3 types of control: input, output, and out functional. For the organization of the production control scheme developed technological control of production, which ensures the production of high-quality and safe products. There are 15 possible types of casting of defect, their solutions, as well as some of their methods of quality control.

**Keywords:** control, control methods, defect, package, production control, technological control.

The majority of a container is made for foodstuff by casting under pressure. In case of process of production such component as production supervision is important.

Production supervision is the production control of products at all stages of engineering procedure including technical and chemical, microbiological control, etc. depending on production type. Production control includes three types of control:

- is entrance a quality evaluation of raw materials, auxiliary, packaging materials and a container which are included into the technological scheme of production of a projectable type of finished goods;
- output is a quality evaluation of finished goods;
- out functional is a control of observance of technological parameters of production ( $\tau$ ,  $\rho$ ,  $c$ ,  $t$ ) and qualities of a semi-finished product on all technological transactions.

Schemes of technological production control, according to the chosen technological scheme, requirements of the technological instruction, standards on raw materials, auxiliary, packaging materials and a container, finished goods and control methods are developed for the organization of production supervision.

Production control of products according to the schemes developed taking into account requirements of technological instructions provides development of high-

quality and safe products.

Casting flaw. Types of flaws and ways of their elimination:

- 1) junctions
- 2) undulating surface
- 3) silvery strips
- 4) flash
- 5) scorch
- 6) the increased thickness of the products
- 7) overweight products
- 8) fluctuation of product's weight
- 9) bad removing of products
- 10) insufficient gloss
- 11) incomplete filling
- 12) buckling
- 13) shrinkage cavity
- 14) emptiness
- 15) holes

Control methods:

1. Monitoring of indexes of quality is carried out on the container exemplars beforehand sustained not less than 3 clocks at a temperature plus  $(20 \pm 2) \text{ }^{\circ}\text{C}$  after its manufacture.

2. Definition of appearance and color.

Appearance and color of a container check visually without use of magnifying devices, by their comparison with a control specimen and (or) an approved sample. The approved sample is approved at the enterprise in accordance with the established procedure for every color and coordinated with the customer.

3. Overall dimensions of a container check the range L-500 in accordance with GOST 427 and a caliper of «SHTS-P-200-0,1» in accordance with GOST 166-89 or other measuring tool with similar metrological characteristics.

4. Determination of durability of a container at compression in the axial direction is carried out according to 9.10 state standard specification GOST P 51760.

5. Definition of resistance of a container to hot water is carried out according to 9.12 state standard specification GOST P 51760.

6. Migration of dye is determined by wiping of a container a white cotton or the cotton plug beforehand moistened with water with the temperature of 30-40 C. Apply fabric of black color to monitoring of the container painted in white color.

At the end of termination of rubbing on fabric or a tampon there should not be dye traces.

7. Density of shutting of covers is controlled by shutting of products by them for which they are intended. The cover has to be put on a product densely.

8. Definition of a heat resistance of a container is carried out according to item 9.15 state standard specification GOST P 51760.

Exemplars of a container place in the climatic cell, establish temperature  $(+40 \pm 2)^{\circ}\text{C}$ . Exemplars maintain in the camera within 2 clocks. Then exemplars take

out from the camera, maintain at ambient temperature within 30 min. After endurance carry out an inspection of appearance, parameters and sizes. Exemplars consider passed tests if they conform to the established requirements.

9. Definition of frost resistance of a container is carried out according to item 9.16 state standard specification P 51760. Exemplars of a container place in the climatic cell, establish temperature (minus  $25 \pm 2$ ) °C. Exemplars maintain in the camera within 2 clocks. Then exemplars take out from the camera, maintain at ambient temperature within 30 min. After endurance carry out an inspection of appearance, parameters and sizes. Exemplars consider passed tests if they conform to the established requirements.

10. The mass of products is determined by weighing on an analytical balance by 3 or 4 classes of accuracy in accordance with GOST 24104-88 with the greatest limit of weighing of 1000 and accuracy of weighing of  $\pm 0,01$  g or others with similar metrological characteristics.

11. Determination of rated capacity of a container is carried out according to item 9.5 state standard specification P 51760.

Volumetric control method using volumetric glassware. Each sample was filled with water from the volumetric glassware temperature ( $20 \pm 5$ ) ° C. For capacity product samples the arithmetic mean value of the volume of water poured into the controlled sample containers. Capacity products must conform to the value specified in the working drawings for the product.

12. Monitoring of hygienic indexes.

When determining hygienic indexes the choice of model environments and preparation of extracts for a research are carried out on point 7. Organoleptic indexes also determine by point 7. The choice of controlled indexes is carried out on point 1. Indexes determine by the methods given in point 1, 8 or another, approved by bodies of «Rosпотребнадзор» in accordance with the established procedure.

## **КОНТРОЛЬ ТЕХНОЛОГИЧЕСКИХ ПАРАМЕТРОВ ПРОИЗВОДСТВА ТАРЫ ДЛЯ ПИЩЕВЫХ ПРОДУКТОВ**

**В.В. Буданцев, Е.Е. Висков**

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: gepard-xxx68@mail.ru*

***Аннотация:** Большинство контейнеров для пищевых продуктов изготовлены путем литья под давлением, в котором процесс производства имеет важное значение в качестве промышленного контроля, происходящие на всех этапах этого процесса. Производственный контроль включает в себя 3 вида контроля: вход, выход и выход функционал. Для организации схемы управления производством разработан технологический контроль производства, что обеспечивает производство высококачественных и безопасных продуктов. Есть 15 возможных типов литья дефектов, их решения, а также некоторые из их методов контроля качества.*

***Ключевые слова:** управление, методы контроля, дефект, упаковка, контроль производства,, технологический контроль.*

## PROCESSING OF MYCELIAL WASTAGE OF BIOTECHNOLOGICAL MANUFACTURING

**A.I. Bushkovskaya, I.A. Bogdanov, P.A. Moseev**  
Tambov State Technical University, Tambov, Russia  
*e-mail: moonblack@yandex.ru*

**Abstract:** This article is devoted to ways of utilization of mycelial biomass. Literature review of some ways of biomass processing is held. The possible way of processing of mycelial biomass is offered and flowchart of this technology is given.

**Keywords:** biomass, biotechnology, mycelium wastage, processing

Biotechnology is one of the key directions for innovative development of modern economy. It has a great importance for economic modernization and development of various industries. More than 80% of biotechnological products consumed in Russia are imported (for example, fodder proteins, enzyme preparation, antibiotics, organic acids and other food ingredients). At the same time volumes of consumption of biotechnological production remain very low in comparison with other countries [1]. According to the development strategy till 2020 the bioeconomy share in GDP (gross domestic product) has to make constitute approximately 1%, by 2030 – not less than 3%, which means increase in biotechnological productions in the nearest future.

Biotechnological productions are characterized by lower environmental impact in comparison with the chemical manufacturing. However, there are specific wastage in such as air-gas emissions with biological particles, or the significant amounts of biomass. So the biotechnological productions using microscopic fungi as producers interfere with a problem of utilization of mycelial biomass, e.g. in producing of antibiotics of tetracyclines with *Streptomyces aureofaciens*, in biosynthesis of a citric acid (with *Aspergillus niger*), cyanocobalamin (with *Nocardia rugosa*), in receiving technical and purified enzyme preparations.

There are three groups of processing types of mycelial biomass according to the literature review.

Coking, gasification and liquefaction fall into thermochemical technologies. Using those methods biomass is incinerated or turned into valuable energy. At the same time the profit depends on the cost of manufacturing equipment, transportation of biomass and energy sources. And costs of receiving biofuel from biomass depend on local conditions in foe agriculture it will be below average level.

Processing of biomass with physical and chemical technologies allows receiving substances using extraction and a chemical treatment or bioconversion to products, which are used as biodiesel.

Biochemical processing of mycelial biomass with fermentation allows receiving substances which can be used as liquid or gaseous fuel or fertilizers.

Works on a solution of the problems of utilization of mycelial wastage continues in several main directions, which are:

1. Using mycelial wastage for the technical purposes as additives in concrete grouts, gauge staffs or fired materials, for receiving fuels, sorbents.
2. Using nutritional chemicals of biomass in agriculture for biofertilizers.

Biochemical method of processing of biomass is based on bio-composting. Biomass is mixed with biologically active agent as a carrier of compost microorganisms and the organic material, which sorbs free water. It can be wood scraps, straw and some renewable natural material as peat. One of these methods based on application of vermiculturing. Mycelial biomass is mixed with organic materials and is processed with using a compost worm. The received mass provides further using as fertilizer [2].

The attractive option of processing biomass is using biomass as foam-forming addition in getting hollow compressions. Firstly biomass is hydrolyzed to foam-forming substance, which is implemented in the production of construction materials [3].

Micelial wastage are used as components of broths for microorganisms with a pretreatment by enzymatic hydrolysis. That allows to release larger amount of the used raw materials, to reduce costs of purchase of expensive and scarce components of mediums.

The problem of utilization of biomass is urgent for the biotechnological enterprises producing fodder ferment preparations. At the moment the domestic and foreign enterprises for production of biotechnological production send biomass (as by-product) for burial. Usually it is subjected beforehand to a thermal or chemical treatment for the purpose of an inactivation of viable cells. Processing biotechnological wastage into biohumus presents one of the most using methods of biotechnological ways of utilization, based on available materials.

There are two problems: ecological and economic. Ecological problem is elimination of pollution of the air environment from the territory of burial. Economic problem is receiving the product to be used it as organic fertilizer. The flowchart of biomass processing in agriculture by bioconversion is proposed.

The proposed flowchart is presented in the form of functional model (Fig. 1).

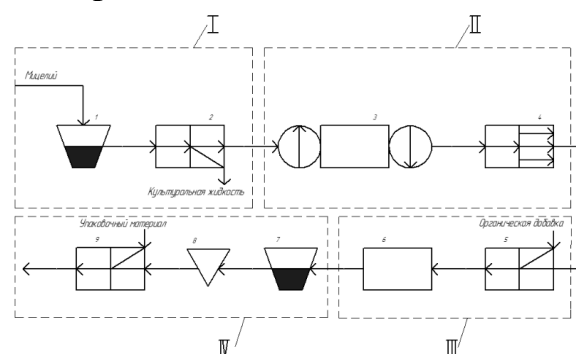


Fig. 1 – Functional model of technology of processing of mycelial biomass in industrial conditions.

*I – mycelium pre-treatment stage, II – inactivation stage, III – bioremediation stage, IV – receiving a commodity form;*

*1 – mycelium accumulation, 2 – filtration, 3 – heat treatment, 4 – desintegration, 5 – mixing with organic addition, 6 – biocomposting, 7 – accumulation of a bioproduct, 8 – dosing, 9 – packaging.*

Biomass is collected in the tank, and then is dehydrated on press filters. The dehydrated biomass is exposed to thermal treatment within an hour at a temperature of 135-140 °C in acidic environment. The neutralized biomass is exposed to disintegration then mixes up with the organic addition containing natural microorganisms. Then there is a biocomposting. The processed bioproduct is collected, then is packaged and stored.

There is an urgent need of the development in technology of biomass processing is making environment safe and cost efficient. This way allows to receive fertilizers for use both in agriculture, and at private owners of garden sites as the received weight will possess the useful nutrients for plants growth and the useful microflora due to mixture with organic material.

According to the current legislation in Russia the enterprises that violate sanitary and environmental standards have no right for operation and have to be reconstructed or closed. In this regard, development of technologies for processing of industrial biowaste is extremely topical.

### References

1. Ministerstvo Economicheskogo razvitiya Rossiyskoy Federatsii (2012) "Strategiya razvitiya biotekhnologii Rossiyskoy Federatsii do 2020 g." [Comprehensive program of development of biotechnology in the Russian Federation for the period till 2020], available at: [http://www.bio-economy.ru/upload/bio\\_2020\\_programme.pdf](http://www.bio-economy.ru/upload/bio_2020_programme.pdf) (Rus)
2. Patent RF № 2205164. Orlov, U.N., Poludov, S.A., Eliseeva, O.N., Lachno, T.I. Sposob utilizatsii mitselialnyh othodov [Way of utilization of mycelial wastage]. (Rus)
3. Vasilenko, M.I., Starostina I.V. Otchody microbiologicheskikh proizvodstv – potentsialnoe syrie dlya polucheniya penoobrazovateley, ispolzuytsihihsya v stroitelnoy industrii [Wastage of microbiological productions is potential raw materials for receiving the foamers which are used in the structural industry]//Fundamentalnye issledovaniya. – 2004. - Vol. 3. (Rus)
4. Dvoretzki D.S., Dolgunin V.N., Zuzina O.V., Muratova E.I., Nagornov S.A., Strashnov N.M., Habarova E.V. Resursoberegautskie tehnologii – osnova konkurentnosposobnosti sovremennoy pitshevoy i pererabatyvautshey promyshlennosti [Resource-saving technologies is a basis of competitiveness of the modern food and processing industry]. Voprosy sovremennoy nauki i praktiki. – 2013. - Vol. 3 (47). - 282-291. (Rus)

## ПЕРЕРАБОТКА МИЦЕЛИАЛЬНЫХ ОТХОДОВ БИОТЕХНОЛОГИЧЕСКИХ ПРЕДПРИЯТИЙ

**А. И. Бушковская, И.А. Богданов, П.А. Мосеев**

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: moonyblack@yandex.ru*

*Аннотация:* Данная статья посвящена различным способам утилизации мицелиальной биомассы. Был проведен литературно-патентный обзор по нескольким способам переработки мицелиальной биомассы. Была предложена возможная технология переработки и ее схема.

**Keywords:** биомасса, биотехнология, мицелиальные отходы, переработка



## INFLUENCE OF PROCESS CONDITIONS ON THE MANUFACTURE OF LOW-LACTOSE DAIRY DRINK

A. S. Velikanova

Tambov State Technical University, Tambov, Russia

e-mail: nastay1812@mail.ru

**Abstract:** The article studies the influence of process conditions on the manufacture of low-lactose fermented milk drink. The optimal dose of enzyme was applied and the type of dairy starter cultures was selected. The obtained fermented milk drink was evaluated for physico-chemical and organoleptic indicators.

**Keywords:** enzyme, fermented milk drink, low-lactose, sourdough, technological modes.

The implementation of priority directions of state policy in the field of healthy nutrition involves the development of new food products using biotechnology achievements. Currently fermenting microorganisms with new functional properties, and enzymes that generate high digestibility and biological value, the flavour and texture of fermented milk products are extensively used [1]. The use of both types of organic products sold in developing dairy products for people with lactase intolerantly. Fermented milk drinks partly in prove the physiology of nutrition in secondary lactose intolerance, but primary require special nutrition with the use of the products, partially or completely devoid of lactose. The lactase enzymatic hydrolysis is implemented to obtain such products.

A study to determine the dose of the enzyme to obtain low-lactose dairy substance [2] and selection of the type of starter culture was conducted for the manufacture of lactose-free dairy drink (Table 1).

Table 1 – Characteristics of starter cultures

The name of the starter	Composition and types of microorganisms ferment	The titer of microorganisms
"Vivo:Yogurt"	Str. thermophilus, Lac. delbrueckii ssp. bulgaricus, Lac. acidophilus, Bb. lactis, Lac. ssp. lactis, lactose.	ICD – $2 \times 10^9$ CFU/g; Bifidobacteria – $2 \times 10^9$ CFU/g.
"Bifivit"	Str. thermophilus, to Milk. delbrueckii marked ssp. Bulgaricus Milk. acidophilus, Bb. ctis, Milk. marked ssp. cremoris, Lac. marked ssp. milk, Milk. milk marked ssp. milk var. diacetylactis	Lactic acid bacteria $2 \times 10^9$ CFU/g; Bifidobacteria - $2 \times 10^9$ CFU/g.
"Kefir"	Kefir fungi, Str. thermophilus, Bb, Lac. delbrueckii ssp. bulgaricus	Lactic acid bacteria - $5 \times 10^8$ CFU/g; Yeast – 103 CFU/g.

Out of the manufactured experimental samples of fermented milk drink using three types of starter cultures, there was a preference for the product on the starter "Yogurt", which had a delicate sour taste, dense clot and was used in subsequent experiments.

In studying the effect of chemical composition on properties of milk in the fermented milk drink the samples were manufactured from normalized milk with fat content 2.5 %, 3.0 % and 3.9 % of the milk with the same fat content, but processed by  $\beta$ -galactosidase from the calculation of the 7000 activity units per 1 dm<sup>3</sup> of milk. The fermentation was carried out by incubation method in order to avoid infection at a temperature of 38 °C 8 hours and up to 24 hours the drinks were kept at 5 °C [3]. Physico-chemical parameters, the content of lactose, SNF were measured in the final samples was (Table. 2).

*Table 2 – Physico-chemical parameters of samples*

Sample	Dry nonfat milk rest, %	Lactose content, %	Acidity, °T	pH	The viscosity of the expiration, s
Whole milk	7.91	4.6	19	6.58	1.82
low-lactose milk treated with the enzyme					
Fat = 2.5 %	8.1	3.96	80	4.51	7.31
Fat = 3.0 %	9.3	3.44	83	4.57	8.56
Fat = 3.9 %	9.7	2.25	77	4.63	3.23
milk not treated with enzyme					
Fat = 2.5 %	8.0	4.4	80	4.61	3.15
Fat = 3.0 %	9.3	3.6	83	4.54	8.08
Fat = 3.9 %	9.5	4.2	82	4.58	4.75

Every two hours from the start of fermentation within 8 hours active and titratable acidity was measured, as the clot at the time of expiration of fermented mass. The diagram (Fig. 1) clearly shows that an active increase of acidity was observed in milk samples treated with enzyme, the product of 3% processed milk. For samples based on whole milk indications of defined targets were close to the drink from fermented milk with 2.5% fat content. A slow accumulation of lactic acid in full-fat milk after the processing of  $\beta$ -galactosidase was observed. During exposures up to 24 hours the in a refrigerated state fermented drinks continued to build-up acidity, this was especially manifested in samples treated with fermented milk.

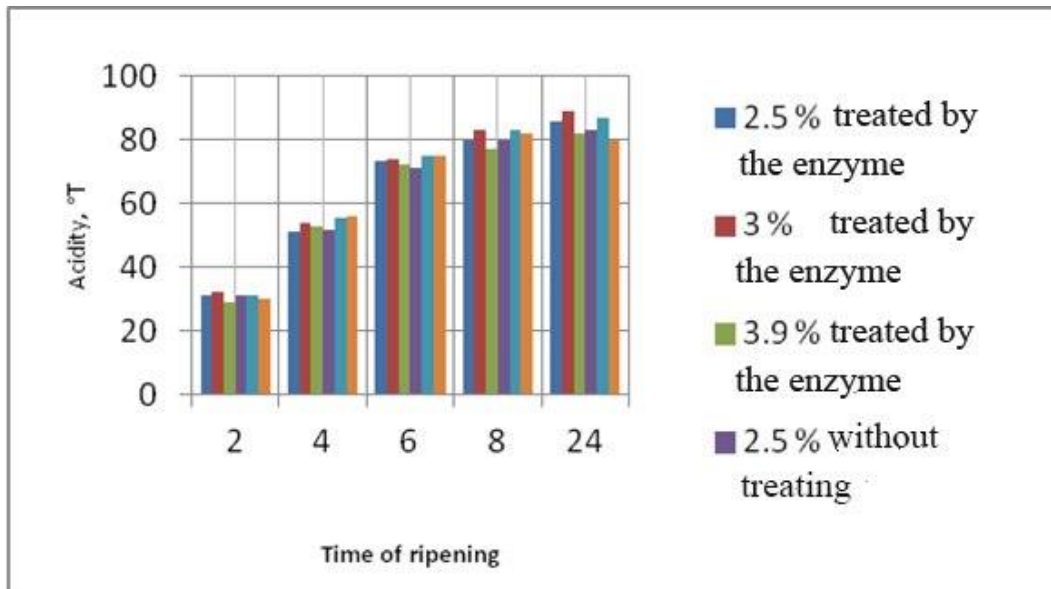


Figure 1 –Diagram of the changes of acidity of the samples

Changes of the viscosity of samples depending on the fat content of the mixture, the treatment with enzyme and time of ripening are presented in chart form in Figure 2.

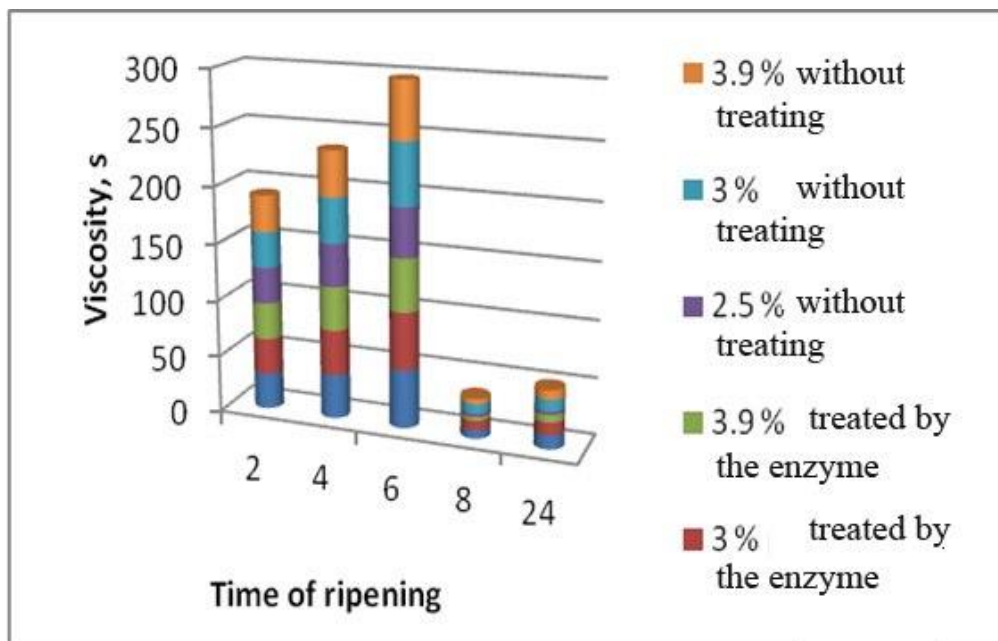


Fig. 2 – Diagram of change of the viscosity of samples

At the end of fermentation sensory characteristics from six samples of the finished product were also evaluated (Fig.3) on a ten point scale.

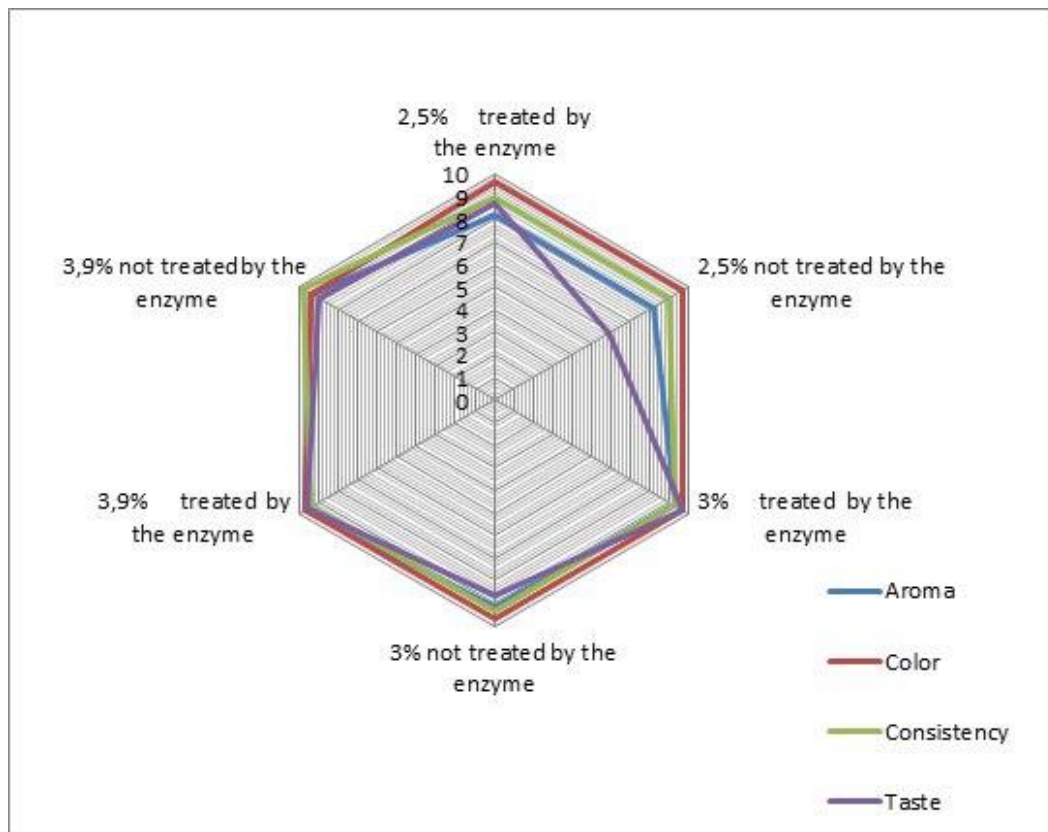


Fig. 3 – Diagram of organoleptic characteristics of drinks

Preference was given to products with fat content of 3.0 % and 3.9 %, treated with the enzyme. They had a sweet, dairy flavor, creamy flavor and delicate texture.

#### Acknowledgment

The work was performed in the laboratories of the chair "Technology and Equipment for Food and Chemical production" of Tambov State Technical University under the supervision of Candidate of Technical Sciences, Associate Professor O. V. Zyuzina.

#### References

1. Zyuzina, O. V. Tekhnologicheskiye aspekty snizheniya ekologicheskoy nagruzki v molochnom proizvodstve. [Technological aspects of reducing the environmental burden of milk production] / S. V. Zyuzina, A. S. Nadezhdina, N. M. Strashnov // international scientific-practical conference "V. I. Vernadsky: sustainable development of regions". – Tambov: Publishing house FGBOU VPO "TSTU", 2016. (Rus)
2. Nadezhdina, A. S. Izucheniye kineticheskikh zakonornostey fermentativnogo gidroliza laktozy molochnoy syvorotki. [Study of kinetic regularities of enzymatic hydrolysis of lactose of whey] / A. S. Nadezhdina, O. V. Zyuzina, O. B. Shunyaeva // Advanced enzyme preparations and biotechnological processes in the technologies of food and fodder. – M.: vniipbt, 2016. – 98 – 102 p. (Rus)
3. Lantsov, W. V. Razrabotka kislomolochnogo produkta dlya detskogo pitaniya na osnove kozyego moloka. [Development of fermented milk product for baby food based on goat's milk] / Modern preconditions of development innovative economy [Electronic resource]: proceedings of III-th Interuniversity scientific-practical conference / under the General editorship of M. A. Istomin. – Tambov: Publishing house FGBOU VPO "TSTU", 2015. – 32 – 33 p. (Rus)

# ВЛИЯНИЯ ТЕХНОЛОГИЧЕСКИХ УСЛОВИЙ ПРИ ИЗГОТОВЛЕНИИ НИЗКОЛАКТОЗНОГО КИСЛОМОЛОЧНОГО НАПИТКА

**А.С. Великанова**

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: nastay1812@mail.ru*

***Аннотация:** В статье изучено влияние технологических условий при изготовлении низколактозного кисломолочного напитка. Определена оптимальная доза вносимого фермента, подобран тип кисломолочной закваски. Полученный кисломолочный напиток оценен по физико-химическим и органолептическим показателям.*

***Ключевые слова:** закваска, кисломолочный напиток, низкое содержание лактозы, технологические режимы, фермент.*

---

УДК 631.331.8

ББК 40

## THE PROSPECT OF USING ADVANCED TECHNOLOGIES OF CULTIVATION OF SOYBEAN SEEDS IN TAMBOV REGION

**V.P. Kapustin, S.G. Hairullina**

Tambov State Technical University, Tambov, Russia

*e-mail: hsg1988@mail.ru*

***Abstract:** The description of the value of soy and its use in animal breeding, human nutrition, manufacturing, pharmaceuticals and construction is given. The types of planters used for planting soybeans are described and their shortcomings are listed.*

*We have proposed a sowing machine, including disks with cells forms and dimensions, which correspond to the seeds of soybean with the aim of improving the quality of sowing.*

***Keywords:** soybeans, machinery, cultivation technology, harvest.*

The country development strategy till 2020, is to increase the productivity of crop and livestock production 1.6-1.7 times and to achieve in this result, the world average [1].

For the implementation of this program a forage base is needed, which will allow us to organize the production of a full research-based recipe feed with the maximum use of high-protein legumes - peas, soybeans, beans, lupin, canola.

The most valuable culture of the bean is soy, which contains 36...48% biologically complete protein (all essential amino acids), which is an alternative to expensive animal protein. It contains 20...26% fat, a lot of different vitamins and other biologically active substances, which makes soy a valuable additive for animal feed.

In addition to high nutritional value, high quality soybeans are important in modern agriculture. This crop can improve water-physical properties of the soil.

Fixing nitrogen from the air and returning it to the soil through rhizobia bacteria. It can utilize nutrients inaccessible substances from the deep layers of the soil, which makes it a valuable precursor for many crops, especially under irrigation.

Soy, as a source of cheap protein food, is also used to make pharmaceuticals, cosmetics and food of the population.

Therefore, soybean is a strategic crop for increasing livestock production, especially pigs and poultry [2].

According to statistics, in 2007, the total sown area of soybean in the world has made 90,19 million hectares and total production was 220, 5 million tons [3].

According to the statistics of Tambov region in 2012-2015 years the acreage of soybeans increased from 7.81 to 44.05 thousand hectares i.e. 5-6 times, and the yield rose from 14.92 to 18.60 kg/ha and the gross harvest from 11.64 to 81.61 thousand tons.

Tambov region is an the area of intensive pig breeding and takes the third place in meat production in the country [4].

Cultivation of soybeans is a priority for the further development agriculture of the Russian Federation and the Republic of Kazakhstan. Quality sowing is one of the conditions for obtaining high yields of this crop, which is provided by the use of machines for precise seeding.

Attempts to design other crops have not been successful due to the mismatch of the technological process of their work, dimensional, physical, mechanical and technological characteristics of the zoned seeds of soybean.

Along with the increase in acreage one of the important conditions of soybean gross yield increase is its increase in yields mainly due to the correct introduction of intensive technology of cultivation, based on modern scientific and technical achievements and best practices.

The correct introduction of intensive technology of cultivation leads to an increase in gross harvest of soybeans.

The scientific validity of each operation, their focus on improving conditions for growth and development of plants; high quality and timely execution of all processes, the availability of the necessary funds in strict accordance with the modern agro-technical requirements are the main conditions of high efficiency of new technology of cultivation.

Integrated combination units for row crops American or European production ensure high productivity and quality of soybean cultivation.

However, the majority of rural households in Russia cannot buy expensive imported equipment due to financial and economic problems.

In addition, maintenance of imported equipment in Russia requires much time for its execution, which leads to the violation of agrotechnical terms of performance of technological processes and, consequently, a reduction in the yield of agricultural crops [5].

Nowadays in Russia and abroad many devices have been developed for seeding grain, small-seeded and little loose materials of various designs and styles: coil, straight, spiral, different-sized grooves with a herringbone arrangement of

grooves and screw, disc.

A reel-to-reel and disk sowing machines had the greatest distribution of available ones, which have drawbacks: the irregularity of seeding on the length of the row; intermittent seeding rate - deviation  $\pm 4\%$ ; increased consumption of seeds; the injuring of seeds more than 1%, which did not satisfy the agricultural requirements [6,7,8].

This is because of bobbin and the disk apparatus can sow the seeds of certain geometric sizes and shapes only at a given seeding rate (optimal), compliance with speed limits, uniformity of soil surface before sowing and appropriate, and customize the planter for optimal operation [9].

Advanced sowing machine for soybean is the disk with cells, the shape and dimensions of which correspond to the seeds of soybean. Therefore, the development, substantiation and research of the sowing apparatus for sowing of soybean seeds is an important task, which has important economic and commercial value.

Development of designs of sowing machines is aimed at the improvement of technological process of seeding. It provides for higher yields, improves their productivity, reduces metal consumption and labor costs for technical and technological services.

Also, great importance is attached to modernization of existing and creation of new planting machines for better performance of technological process of sowing.

#### **References:**

1. Fisinin, V.I. Strategiya mashinno-tehnologicheskoi modernizacii selskogo hozyaistva Rossii na period 2020 goda. [Strategy of machine-technological modernization of agriculture of Russia for the period up to 2020] / V. I. Fisinin and others - Moscow: FGNU "Rosinformagrotekh", 2009. - 80 p. (Rus)
2. Gomanyuk, S. N. Polnozhirnaya soya - vazhnii factor povisheniya konkurentosposobnosti. [Full fat soya is an important factor in competitiveness] / S. I., Gomanyuk // Industrial and tribal pig production, 2004, № 1. - 63 p. (Rus)
3. [Electronic resource] <http://www.agrodialog.com.ua/proisxozhdenie-i-istoriya-soi.html>
4. Shulaev, G. I. Tehnologiya prigotovleniya obogatitel'nykh dobavok dlya kombikormov iz belka. [The technology of preparation and processing additives for animal feed from plant protein] / GI Shulaev, V. F. Engovatov, R. K. Milush et al. // Science in the Central Russia No. 3. - 2016, p. 69-74. (Rus)
5. Golubev I. G., Korolkov N. In. Korolkova A. P. Servisnoe obsluzhivanie zarubezhnoi selskohozyaistvennoi tehniki. [Service foreign agricultural machinery] /I. G. Golubev, N. In. Korolkov, A. P., Korolkova // Increase resource efficiency in the production of agricultural products - new technologies and a new generation of technology for crops and livestock. Collection of scientific papers of the XVII International scientific-practical conference on 24-25 September 2013, Tambov. - p. 13-16. (Rus)
6. Aniskin, V. I. Ishodnie trebovaniya na bazovye mashinnie tehnologicheskie operacii v rastenievodstve. [Basic requirements at a basic machine technological operations in crop production] / V. I. Aniskin, A. A. Artushin. M: FGNU "Rosinformagrotekh", 2009. - 270 p. (Rus)
7. Ilyukhin, T. A., Dissertaciya na soiskanie uchenoi stepeni kandidata tehniceskikh nauk po specialnosti 05.20.01 - Tehnologii i sredstva mehanizacii selskogo hozyaistva. [Thesis on competition of a scientific degree of candidate of technical Sciences, specialty 05.20.01 - Technology and mechanization of agriculture. Thesis "Improvement of seeding soybeans coil sowing machine"] 2014. (Rus)

8. Bychkov, V. I. Povishenie kachestv poseva semyan melkosemennih kultur razrabotkoi i primeneniem visevaushego apparata seyalki. [Improving qualities of seeding small-seeded crops to the development and application of the sowing unit of the seeders] / I. V. Bychkov. The abstracts of dissertations on competition of a scientific degree of candidate of technical Sciences, specialty 05.20.01 - Technology and mechanization of agriculture. Penza: 2013. - 19 p. (Rus)
9. Капустин В. п. Glazkov Yu. e. Selskohozyaustvennie mashini: Uchebnoe posobie. [Agricultural machines: textbook] -М.: INFRA - М, 2015. - 280 p. (higher education: Bachelor's degree). (Rus)

## ПЕРСПЕКТИВА ИСПОЛЬЗОВАНИЯ УСОВЕРШЕНСТВОВАННЫХ ТЕХНОЛОГИЙ ВОЗДЕЛЫВАНИЯ СЕМЯН СОИ В ТАМБОВСКОЙ ОБЛАСТИ

**В.П. Капустин, С.Г. Хайруллина**

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: hsg1988@mail.ru*

**Аннотация:** Приведено описание ценности сои, а также ее использование в животноводстве, питании человека, производстве лекарственных препаратов и строительстве. Представлены типы высевальных аппаратов, используемых для посева сои, и указаны их недостатки.

Мы предложили перспективный высевальный аппарат, включающий диски с ячейками, формы и размеры которых соответствуют семенам сои, с целью повышения качества посева.

**Ключевые слова:** соя, техника, технология возделывания, урожай.

---

УДК 637.041.5

ББК 36.88

## A STUDY OF KINETIC REGULARITIES OF ENZYMATIC HYDROLYSIS OF WHEY LACTOSE

**A. S. Nadezhdina**

Tambov State Technical University, Tambov, Russia

*e-mail: a\_nadezhdina@list.ru*

**Abstract:** The article presents data from a study of enzymatic hydrolysis of lactose whey after thermoacid coagulation proteins with  $\beta$ -galactosidase fungal origin. The reaction rate and conditions of enzyme catalysis of whey lactose are determined.

**Keywords:** whey lactose, kinetics of enzymatic hydrolysis of lactose, conditions of hydrolysis of lactose.

Biochemical processes in the manufacture of products from recycled milk and raw milk are actively involved in the stages of formation of nutritional and organoleptic properties of the products, and provide security and stability during storage. It should be noted that biochemical processes involved in the processing of



secondary raw milk – whey, buttermilk – have less pronounced activity, except when the fermented drinks based on them are produced. This group occupies a special place in the production of food products for people suffering from lactose intolerance, the preparation of which involves the use of an enzyme preparation  $\beta$ -galactosidase for digestion of lactose.

In developing whey-based drinks it was decided to produce lactose-free whey drinks. The feedstock was secondary dairy raw material generated in the production of soft cheese by thermoacid coagulation.

### Features of raw materials

The advantages of whey produced in this way, compared to cottage cheese and cheese are as follows: a small amount of protein crisps, sweet-sour taste, fat concentration in the range of 0.3-0.8%, pH 5.5-6.1. Furthermore, whey is virtually sterile due to the high temperature of 92-94°C of the milk required for clot formation. We made a series of samples of whey beverages with herbal supplements in the form of syrups - cherry, rosehip, orange, - providing for the original organoleptic characteristics and changes in the physiological value by increasing the mineral content (Figure 1).

The produced drinks have a good taste and quench thirst well, but are characterized by the presence of easily digestible carbohydrates, including whey lactose. In order to reduce the proportion of sugar and milk in the beverage with low whey lactose was obtained by enzymatic hydrolysis of beta-galactosidase of microbial origin using *Aspergillus oryzae* fungus.

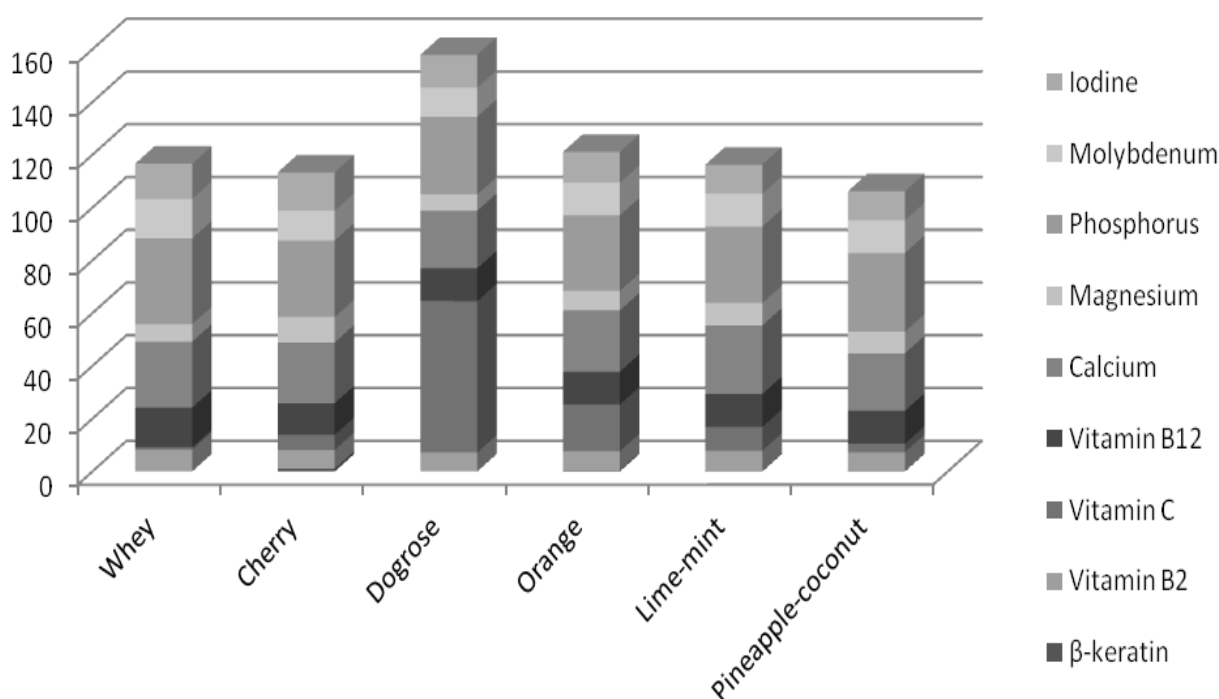


Fig. 1 – Mineral content in whey drinks

### Determination of the velocity of hydrolysis of lactose

To clarify the flow of the enzyme preparation and the conditions of its use in beverage production we carried out experimental studies of kinetic regularities of

catalysis of lactose in whey medium after thermoacid coagulation of milk proteins. This is important, as chemicals in whey lactose can affect the catalytic activity of the enzyme. To determine the Michaelis constant we used the Lineweaver-Burke graphical method of reciprocals. We found experimentally the lactose hydrolysis reaction rate and the amount of lactose that was not hydrolyzed (Fig. 2).

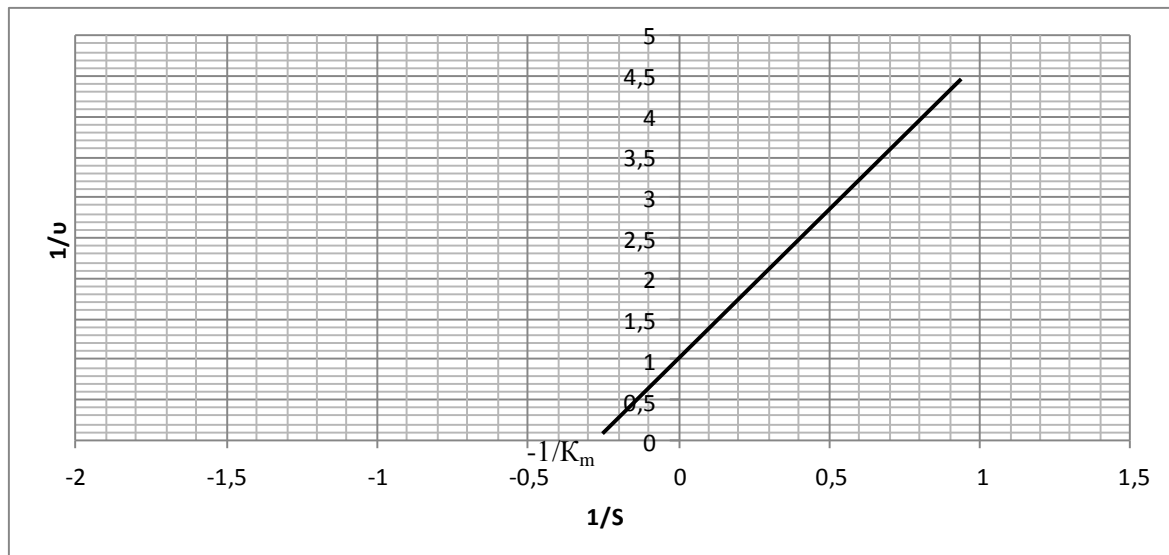


Fig. 2 – Graph of Lineweaver-Burke linear transformation of double return values

According to the obtained value of the direct Michaelis constant  $K_m$  for this case is 1.14 mM, in agreement with the order of magnitude of half the data for  $\beta$ -galactosidase, obtained from various biological materials (1 to 2.5 mmol). Using the Michaelis-Menten, the equation rate of lactose hydrolysis reaction in the presence of whey enzyme  $\beta$ -galactosidase preparation is obtained. As a result of the experiments the velocity of lactose enzyme catalysis reaction was  $v = 0.01 \text{ g / s}$ . The magnitude of the reaction rate can be used to calculate the time of the enzymatic hydrolysis of lactose.

To clarify the optimal conditions for catalysis of whey lactose in thermoacid we determined dependence of the rate of the hydrolysis reaction on the pH value. In the pH range of 5.5 - 6.0, the velocity of the hydrolysis reaction had a maximum value. It is known that the optimal temperature for lactose hydrolysis is in the range 32-45°C. To clarify the process conditions for processing whey as a substrate a complex chemical composition, and the individual components which may have an inhibitory effect on  $\beta$ -galactosidase, we studied the effect of temperature on the reaction mixture during the hydrolysis of lactose. It was found that the maximum rate of hydrolysis of lactose in whey was observed in the temperature range of 33-37°C.

The findings form the basis for the development of process instructions for making lactose-free whey drinks. The cost of such a drink would be 5% higher than the whey drink with lactose. According to preliminary calculations, processing of 1 ton of whey requires about 70 grams of enzyme with the activity of 700 units.

## References

1. Shidlovskaya V.P. Spravochnik tekhnologa proizvodstva moloka. Tom 10. Fermenty moloka. [Directory technologist milk production. Vol.10. Enzymes milk.] / V.P. Shidlovskaya. - St. Petersburg: GIORD, 2006. - 296 p. (Rus)
2. Nadezhdin A.S. Razrabotka napitkov na osnove molochnoi syvorotki. [Development of whey-based drinks] / A.S. Nadezhdin, M.I. Lopatin, N.V. Romanova // Problemy technosfernoi bezopasnosti i ustoichivogo razvitiya. TSTU. 2014. №5. Pp 162-166. (Rus)
3. Gamayurova V.S., Zinoviev M.E. – Fermenty. Laboratotny practicum. [Enzymes. Laboratory Practicum] / V.S. Gamayurova, M.E. Zinoviev // Kazan, KNRTU. - 2010. – 272 p.
4. Hramtsov A.G. Fenomen molochnoi syvorotki [The phenomenon of whey] / A.G. Hramtsov - SPb .: Professia, 2011. – 804 p.

## ИЗУЧЕНИЕ КИНЕТИЧЕСКИХ ЗАКОНОМЕРНОСТЕЙ ФЕРМЕНТАТИВНОГО ГИДРОЛИЗА ЛАКТОЗЫ МОЛОЧНОЙ СЫВОРОТКИ

**А. С. Надеждина**

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: a\_nadezhdina@list.ru*

***Аннотация:** В статье приведены данные исследования ферментализации лактозы молочной сыворотки после термокислотной коагуляции белков с использованием  $\beta$ -галактозидазы грибного происхождения. Определена скорость реакции и условия ферментативного катализа лактозы сыворотки.*

***Ключевые слова:** лактоза молочной сыворотки, кинетика ферментализации лактозы, условия гидролиза лактозы.*

---

УДК 62-112.5

ББК 35.11

## DESIGN OF THE REACTOR FOR THE PRODUCTION OF FORMALDEHYDE BY CATALYTIC OXIDATION OF METHANOL

**A. G. Annakurbanova, Y. A. Budantsev**

Tambov State Technical University, Tambov, Russia

*e-mail: annakurbanova94@mail.ru*

**Abstract:** *The article describes a method of improving the basic design of the reactor for the production of formaldehyde. The existing methods of production of this product are unprofitable in relation to the economic component and from the technological part of production. We propose a method of improving the design of the reactor by using a stainless steel grid made with the argentic catalyst placed on it.*

**Keywords:** *formaldehyde, technology, reactor, catalyst, chemical engineering, technology equipment.*

### Introduction

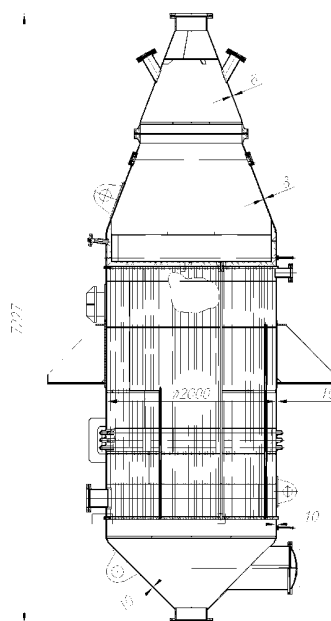
Formaldehyde is a very active chemical compound that easily reacts with other substances forming a big class of new connections. It was found out that a classical method of production of formaldehyde is very expensive; therefore, we propose to enhance a basic design of the reactor by using corrosion-resistant grid with the argentic catalyst.

The method of production of formaldehyde involves oxidizing of methanol by dehydrogenation of air oxygen under high temperature on the argentic catalyst. At the same time, the catalyst in the reactor is placed so that the distance from a pipe grid of the shell and tube heat exchanger to a surface of a layer of the catalyst makes 2 cm. The method allows to reduce the formation of by-products and to increase selectivity of process [1].

The reactor consists of a vertical cylindrical device in which the lower part is the shell and tube heat exchanger, where the interpipe space water condensate moves, and reactionary gases pass on the pipe space. The catalyst is located on two layers of a corrosion-resistant grid, with the electrofuse from above (Fig.1).

At start-up, the warming up of the contact weight up to the temperature of 300 °C was carried out by an electrofuse, and further rise in temperature occurred due to the heat of reactions.

The reactions of contact gases in the catalyst layer resulted in the formation of methanol-air mix: formaldehyde, hydrogen, carbon dioxide, carbon monoxide, nitrogen, water vapors, non-reacted methanol.



*Fig.1. The reactor*

For prevention of thermal decomposition of formaldehyde and termination of collateral reactions, the contact gases coming out the engagement zone were sharply cooled in the subcontact refrigerator up to the temperature of 200 °C by evaporation of the water condensate coming from a steam collector to interpipe space of the heat exchanger, a steam collector from heatpoint from a collector.

The device represents a vertical welded structure made from stainless steel. It is integrated in it so that it is possible to select the upper cylinder-conic chamber in which the lower part of the catalytic agent layer, the pipe bundle and the lower cylinder-conic chamber are located. A heat-exchanging part (a pipe bundle) consists of a cylindrical casing and two fixed pipe grids in which heat-exchanging pipes are fixed. To compensate non-uniformity of temperature deformations of the casing and heat-exchanging pipes on a cylindrical shell of a pipe bundle lens compensators are set.

The device is also supplied with necessary links for submission of the initial components and exit of a product, exit of cooling liquid and units for monitoring of process parameters. The parts of the device have flanges plane welded with a sealing surface like overhang trough.

In the course of work, we developed the route card of an operational production process of a pipe grid.

Pipes in the grid of the heat exchanger are the punched round parts with the openings located on them. They are used for placement of heat exchange tubular elements.

The pipe grid consists of a disk with a diameter of 2055 mm, with a large number of openings (3333 pieces) with a diameter of 25 mm ocated on tops of the correct hexagon. The height of a pipe grid was 30 mm, with two facets 2.5x45° and 1x45° in the openings. The method of fixing pipes in the pipe grid was flaring in two flutes (the length of flaring was 26 mm), the width of a flute was 3 mm, the distance

between the flutes was 7 mm.

Proceeding from the fact the pipe grid has a big diameter it is reasonable to use the sheet hire.

In the process of manufacture of the pipe grid we performed:

1. procurement, i.e. cutting procurement from a sheet;
2. Turning, i.e turning of four surfaces for 2 sets;
3. Marking, i.e. 3333 openings with a diameter of 25 mm were marked up, the opening with a diameter of 10 and an opening with a diameter of 12 mm for 3 sets were marked up;
4. Drilling operations included drilling, chamfering and core-drilling of 3333 openings with a diameter of 25 mm, chamfering of facets and boring of two flutes. Then the opening with a diameter of 10 mm and facets were drilled. In nother set an opening with a diameter of 12 mm was drilled, chamfering of a facet in this opening was carried out and the carving was cut with a radial-drilling machine 2A554.

5. Testing

The proposed design of the reactor allows:

- to reduce account coefficient on raw materials;
- to increase the selectivity of process;
- to increase the conversion of methanol.

#### References

1. Ogorodnikov, S.K. Formal'degid [Formaldehyde]/ S. K. Ogorodnikov. – L: Himija, 1984. – 280 s. (Rus)

## РАЗРАБОТКА КОНСТРУКЦИИ РЕАКТОРА ПОЛУЧЕНИЯ ФОРМАЛЬДЕГИДА КАТАЛИТИЧЕСКИМ ОКИСЛЕНИЕМ МЕТАНОЛА

**А. Г. Аннакурбанова, Ю. А. Буданцев**

Тамбовский государственный технический университет, Тамбов, Россия  
*e-mail: annakurbanova94@mail.ru*

***Аннотация:** Рассмотрен метод усовершенствования базовой конструкции реактора, предназначенного для получения формальдегида. Методы получения этого продукта, которые используются в настоящее время, являются невыгодными по отношению к экономической составляющей и технологической части производства. Предложена установка сетки, выполненной из нержавеющей стали, на которой будет располагаться серебросодержащий катализатор для усовершенствования конструкции реактора.*

***Ключевые слова:** формальдегид, технология, реактор, катализатор.*

## CARBON NANOSORBENT FOR CLEANING OF AQUEOUS MEDIA

**A.V. Babkin, E.A. Neskromnaya**

Tambov State Technical University, Russia, Tambov

*e-mail: Lenok.n1992@mail.ru*

**Abstract:** *In this article, we propose to use carbon nanotubes (CNT) and nanoporous carbon (NPC) as an adsorbent. We have carried out various experiments on water purification from organic molecules. The adsorption capacity was 380 mg/g and 780 mg/g for the CNT and NPC.*

**Keywords:** *adsorption, adsorption capacity, carbon nanotubes, mesoporous carbon, methyl orange.*

Currently, much attention is paid to the complex purification of fresh water and technical water treatment. The main problem is not only limited water resources, but also their disturbed elemental composition. This formulation contains many contaminants. All living organisms consist of water to 70-80%. This confirms the importance of water resources [1-3].

High rates of development of industry and urbanization and anthropogenic factors (people cut down forests, discarded household and industrial waste into the environment, etc.), are the main causes of the lack of quality water.

Scientific developments are aimed at solving global environmental problems. Scientists propose to modify the known sorbents, create new material. All these materials have improved sorption properties for water purification from organic materials.

Water purification processes are different, but the adsorption methods are the most widespread. These methods can remove up to 90% of the pollutants molecules. The volume of the pore space of the material and structural characteristics affect their adsorption properties [4-5].

The work is aimed at studying the properties of carbon nanostructured materials, such as CNT and NPC.

The authors studied the structural characteristics of sorbents using SEM with Raman spectroscopy (Raman, Raman). SEM images were obtained at the Interdisciplinary Center of "Analytical Microscopy" at Kazan (Volga) Federal University, using a field emission scanning electron microscope (CARL ZEISS, the accelerating voltage of 5kV, InLins SE detector) (Fig.1).

Also, the authors obtained Raman spectra (Center for collective use "Preparation and Use of multifunctional nanomaterials TSTU"). We used the Thermo SCIENTIFIC (USA).

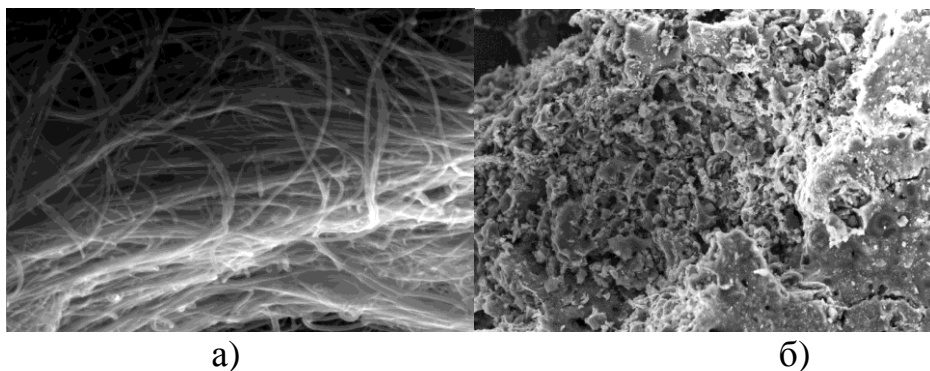


Fig.1. SEM image of the surface of carbon materials (a - CNT, b - NPC)

We obtained spectra of the carbon material. Lanes G and D lie in the range of  $1500-1600\text{ cm}^{-1}$  and  $1250 - 1450\text{ cm}^{-1}$  [6].

These data show a low content of single-wall carbon nanotubes, and amorphous carbons. The Raman spectrum of NPC shows the uniform and orderly structure of the sample.

The authors conducted experiments on the purification of aqueous solutions from pollutant molecules. Methylene orange dye was used in the experiments as a pollutant. The researchers used a technique of carrying out the experiment with GOST 4453-74. We poured into 25 ml of solution volume in the flask was added the mass of 0.03 g sorbent in the rotator flasks were shaken at 120 rev / min. The experiment lasted exactly 45 minutes. These tubes were centrifuged at 10 000 rev / min. To determine the concentration of the solution in a test tube we used a spectrophotometer PE-5400. Experimental data were counted and plotted (Fig. 2) [7-8].

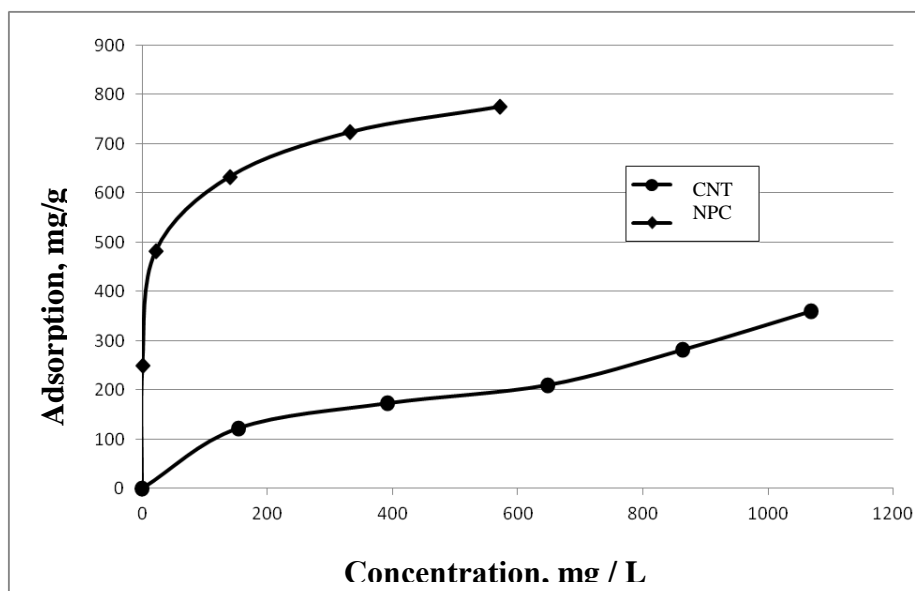


Fig. 3 Sorption isotherms of organic dye on the carbon nanotubes and mesoporous carbon

Adsorption is 50 mg / g for a standard activated carbon, adsorption on CNTs and NPC was 380 mg / g and 780 mg / g, respectively. These results confirm the



promising applications of nanomaterials as adsorbents.

Thus, the authors have shown improved properties of nanoporous materials in comparison with conventional adsorbents.

### References

1. Donglin Zhao, Weimeng Zhang, Changlun Chen, Xiangke Wang. Adsorption of methyl orange dye onto multiwalled carbon nanotubes. International Symposium on Environmental Science and Technology. doi:10.1016/j.proenv.2013.04.120, 2013, Vol. 18, P. 890–895.
2. Zhilyaeva, A.V., Myasoedova, T.N., Yalovega, G.E. Razrabotka jekologicheskij neopasnyh sorbentov dlja ochistki vody ot nefteproduktov i izuchenie ego svojstv. [The development of environmentally nonhazardous sorbent for water purification from oil products and study its properties]. / A.V. Zhilyaeva, T.N. Myasoedova, G.E. Yalovega. Technical science, 2014, No 9 (158), PP. 217-225. (Rus)
3. <http://vestnik.pstu.ru/>
4. Mishchenko, S.V., Tkachev A.G. Uglerodnye nanomaterialy. Proizvodstvo, svojstva, primenenie. [Carbon nanomaterials. Production, properties, applications] / S.V. Mishchenko, A.G. Tkachev M.: Mashinostroenie, 2008. - 320 p. (Rus)
5. Patent of the Russian Federation No 2531172. Metod proizvodstva dispersii uglerodnyh nanotrybok [A method producing the carbon nanotubes dispersions] / A.G. Tkachev, A.V. Melezhyk A.V., V.G. Odnolko. Publ.: 20/10/2014. (Rus)
6. Melezhyk, A.V., Tkachev, A.G. Sintez grafenovyh nanoplastinok iz perokso-sul'fat interkalirovannyh soedinenij grafita [Synthesis of graphene nanoplatelets from peroxosulfate graphite intercalation compounds] / A.V. Melezhyk, A.G. Tkachev. Vol. 5, M.: Himija 2014, P. 294-306. (Rus)
7. Burakov, A.E. Zhidkofaznoj adsorbicii organicheskogo krasitelja na nemodificirovannyh i Nanomodificirovannyj aktivirovannyimi ugljami: Ravnovesie i kineticheskij analiz [Liquid-Phase Adsorption of an Organic Dye on Non-Modified and Nanomodified Activated Carbons: Equilibrium and Kinetic Analysis] / A.E. Burakov. Issue 1 - M.: Sovremennye materialy i tehnologii 2016, - PP. 42-48. (Rus)
8. Neskormnaya, E.A. Sozdanie gibridnyh nanosorbentov ugleroda dlja kompleksnoj ochistki vodnoj sredy [Creating a hybrid carbon nanosorbents for the aqueous media complex purification] / E.A. Neskormnaya. Vol. 3 - T.: TGTU, 2015. – P. 83-87. (Rus)

## УГЛЕРОДНЫЕ НАНОСОРБЕНТЫ ДЛЯ ОЧИСТКИ ВОДНЫХ СРЕД

**Бабкин А.В., Нескоромная Е.А.**

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: Lenok.n1992@mail.ru*

**Аннотация:** Мы предложили в этой статье использовать углеродные нанотрубки (CNT) и нанопористый углерод (NPS) в качестве адсорбента. Мы проводим различные эксперименты по очистке воды от органических молекул. Сорбционная ёмкость для CNT и NPS составила 380 мг/г и 780 мг/г соответственно.

**Ключевые слова:** адсорбция, адсорбционная ёмкость, мезопористый углерод, метиленовый оранжевый, углеродные нанотрубки.

## PROSPECTS OF DEVELOPMENT OF DOMESTIC NANOPRODUCTS

**A.B. Edapina**

Tambov State Technical University, Tambov, Russia

*e-mail: edapinaal@gmail.com*

**Abstract:** *Economic growth is characterized by the value of scientific and technological progress and by the intellectualization of the basic factors of production. Nanoproducts help to improve the properties of products and contribute to the economic growth in general. The paper studies the state of the nanotechnology market in Russia and assesses the prospects of the domestic production of nanoproducts.*

**Keywords:** *nanoproducts, domestic production, global market, economic level, increase in effectiveness.*

The leading role in the intensive development of the economy belongs to qualitatively new industrial technologies, which provide an increase in equipment productivity and the emergence of materials with new properties and possibilities of their application. The production of nanomaterials and adding them into the products contributes to such development. Currently, the majority of nanomaterials are different kinds of coatings, membranes and powders, which can be used in the production of materials for the improvement of consumer characteristics.

For several years, there have been debates and discussions about the prospects of development of nanotechnologies. Carbon nanomaterials are not unique in foreign manufacturing. The market of domestic production of nanoproducts is in its infancy now. But at the same time, the leading Russian research organizations obtain significant results in the field of synthesis of carbon nanostructures.

Therefore, the results of scientific research and industrial production of carbon multi-wall nanotubes conducted by Tambov State Technical University are extremely interesting. The process of creation of technology and equipment for industrial production of carbon multi-wall nanotubes is done in cooperation with «Tambov Plant «Komsomolets» named after N.S. Artyomov» and Tambov Innovative–Technological Center of Mechanical Engineering. The result of this work is the reactor for the synthesis of CNT "Taunit", the chemical and technological scheme of production of CNT "Taunit" and distribution of these products abroad. Such results of small-scale industries give us hope that the development of nanotechnologies in Russia may increase the economic level of the country.

However, nanotechnologies in Russia constitute a very small part of all used materials. The expected return in the nearest years remains low and a growth of investments has not changed over the past few years. However, further development of this sphere can lead to a significant increase in the effectiveness of the industry, as well as the final transition of the country from the natural-resource economy to the knowledge-based economy. It means the significant reduction in the influence of natural resources and the increase in the influence of human capital on the national

economy. Small companies, which produce CNT, need more financing and support of the government to enter the global market. Increase in the volume of nanoproducts and entering the global market cannot only promote the economic growth of the country, but in general can allow changing the direction of economic development of the Russian Federation.

Also, there are some advantages of such support for the government. Investments in nanotechnologies and creation of strategy can really bring huge economic benefits, the basis of which is the increase in the effectiveness of the economy as a whole, rather than a large-scale production of nanotechnologies. Meanwhile, the emergence of innovative products and new industries can create an opportunity for significant change in the regulation of power in the world. Eventually it is impossible to win the race of technologies by investing more and more resources in it, but it is possible by evaluating the impact of the nanotechnology market on the economy and by using the effective strategy.

### References

1. Tkachev, A.G., Shubin, I.N. Promyshlennye tehnologii i innovatsii. Oborudovanie dlya nanoindustrii i tehnologiya ego izgotovleniya [Industrial technologies and innovations. Equipment for the nanotechnology industry and the technology of its production]. - Tambov: Publishing house of the SEI HPE TSTU. 2010. 312 p. (Rus)
2. Metodologiya otsenki rynka nanotekhnologiy [The methodology of evaluation of the nanotechnology market]. // O2Consulting [Electronic resource] – 2014. (Rus) – Access mode: <http://o2consulting.ru/articles/metodologiya-ocenki-rynka-nanotekhnologij/>

## ПЕРСПЕКТИВЫ РАЗВИТИЯ ОТЕЧЕСТВЕННОЙ НАНОПРОДУКЦИИ

**А.Б. Едапина**

Тамбовский государственный технический университет, Тамбов, Россия  
e-mail: [edapinaal@gmail.com](mailto:edapinaal@gmail.com)

***Аннотация:** Экономический рост характеризуется ведущим значением научно-технического прогресса и интеллектуализацией основных факторов производства. Нанопродукция помогает улучшить свойства производимых продуктов и способствуют экономическому росту в целом. В статье исследуется состояние рынка нанотехнологий в России и оцениваются перспективы развития отечественного производства нанопродуктов.*

***Ключевые слова:** нанопродукция, отечественное производство, мировой рынок, уровень экономики, повышение эффективности.*

## ENVIRONMENTAL RISKS OF INNOVATIVE PROJECTS

**A.A. Popova, A. A. Glushkova, A.B. Edapina**  
Tambov State Technical University, Tambov, Russia  
*e-mail: barbie1512@mail.ru*

**Abstract:** The paper studies the basic environmental risks and the causes of their occurrence. The projects of young scientists of Tambov State Technical University are the example of effective work to identify and eliminate potential environmental risks.

**Keywords:** environmental risks, innovative project, environmental safety.

In the XXI century competitiveness of the company is becoming increasingly important. Competitiveness implies a detailed analysis of the company activity through market research, which consists of demand for products, the wishes of consumers, the development of innovative products and promotion of them on the market and as a result, the profit. It's important to make this process constant because nowadays it is the main factor of success [3].

But working on an innovative project at any stage of its realization may be accompanied by different risks. Along with the external political and economic risk there is environmental one, because the elimination of its damage requires a significant investment.

Environmental risk can be defined as the one which entails environmental degradation manifested in the deterioration of the environment and human health [1]. The main causes of environmental risks are frequent changes in legislation, especially in the sphere of environmental requirements; industrial accidents; changes in attitudes to government project [2].

There is a great problem that risk factors, and especially environmental, are not taken into account during the creation of inter-sectoral criteria for the evaluation of the effectiveness of the innovation project. But the ratings of investment attractiveness of the industry are created on the basis of these evaluations.

The task of reducing environmental risks becomes relevant during the work on large innovative projects, which are characterized by rapid development of production and accompanied by conflict of interests of economic growth and the environment protection. Generally, business owners and various types of institutions: the social, administrative and political one spread such interests. However, their interests often have a dual character.

Unfortunately, most consumers do not care about the product's safety, but about its low cost. That is why society is not the main element, which influences the decision of environmental safety management.

Today, the government increases the restrictions in the area of air protection, water use, waste management and soil pollution, what should positively affect the environmental safety of the country in their opinion [3].

But how effective this policy is? After all, for its productive realization which

involves the creation of the necessary enabling mechanisms, we need to compensate the appearing environmental risks which get a lot of attention nowadays.

In economic terms, the cost of environmental elaboration of projects, including the environmental risk evaluation, should be made at the early stages of projects realization, because the return in this case comes from the environmental payments by creating effective management of reduction of risks in the innovative project. But the practice shows that at the initial stage of the project environmental safety does not get enough of attention [2,5].

But it should be noted that evaluation of the environmental risks of innovative projects has serious methodological and practical importance that has been confirmed many times in the process of realization of innovative projects.

Environmental risks management or their elimination at the preliminary stage is a challenging task for project managers. That is why one of the most effective ways of risk prevention is the analysis of possible environmental risks and their classification at the early stages. It can help to control them during the further work.

While working on the projects, young researchers of Tambov State Technical University consider potential environmental risks. For them the environmental safety and protection is becoming one of the most important tasks, as an opportunity for financial gain and economic growth as whole. At the preliminary stage scientists analyze the main components of innovative products, one of the main criteria for which is environmental safety.

For example, in the project "The long-term heat storage based on sodium acetate modified by graphene", environmentally friendly products were initially taken and the causes of environmental risks were fully worked out from the stage of inception of the idea to the stage of product utilization [7].

A primary goal of the project "Investigation of lubricants modified with CNM" is the removal of the treatment of the most dangerous materials concerning human health and environment [6].

The project "Development of the program for promotion and improvement of international competitiveness of domestic innovative products using the example of carbon nanotubes series "Taunit " and equipment for its synthesis" aims not only to explain the effectiveness of using carbon nanotubes (increase of material strength, its main characteristics and the optimization of weight and size parameters) but also to prove its environmental safety [4,5].

Thus, we can conclude that the using of elaborate mechanisms which can compensate the environmental risks leads to the successful implementation of innovative projects.

### References

1. Bogatin, Yu.V. Otsenka effektivnosti biznesa i investitsiy. [Evaluation of effectiveness of business and investment] / Ju.V. Bogatin, V.A Shvandar // Uchebnoe posobie dlya vuzov. - M.: Finansy, UNITI-DANA, 2006.(Rus)
2. Popov, A.I. Upravlenie innovacionnoj aktivnost'ju predpriyatija: metod. ukazaniya. [Management of innovative activity of the company: methodical instructions] / A.I. Popov // Tambov. Izdatel'stvo TGTU, 2008. 24 p. (Rus)

3. Tkachev, A.G. Promyshlennye tehnologii i innovacii. Oborudovanie dlya nanoindustrii i tehnologiya ego izgotovleniya. [Industrial technology and innovation. Equipment for the nanoindustry and the technology of its production] Uchebnoe posobie /A.G. Tkachev, I.N. Shubin, A.I. Popov // Tambov. Izdatel'stvo TGTU, 2010. 132 p. (Rus)
4. Shhegol'kov, A. V. Teploakkumuliruyushhiy material na osnove acetata natriya, modifitsirovannogo grafenom. [Heat storage material based on sodium acetate, modified by the graphene] / A.V. Shhegol'kov, A.A. Popova // Nauchno-metodicheskiy elektronnyy zhurnal «Koncept» – 2016. – Tom 11. – P. 3666–3670. (Rus)
5. Tarov, D.V. Modifitsirovanie uglerodnyh nanomaterialov napravlennoy himicheskoy funkcionalizatsiey. [The modification of carbon nanomaterials by the direct chemical functionalization] / D.V. Tarov, A.A. Glushkova, A.V. Emel'janov, I.N. Shubin // «Sovremennye tverdogaznye tehnologii: teoriya, praktika i innovatsionnyy menedzhment»: materialy VIII Mezhdunarodnoy nauchno-innovatsionnoy molodezhnoy konferencii: 27 - 28 oktyabrya 2016. – Tambov: Izdatel'stvo IP Chesnokova A.V., 2016. – 404 p. (Rus)

## ЭКОЛОГИЧЕСКИЕ РИСКИ ИННОВАЦИОННЫХ ПРОЕКТОВ

**А.А. Попова, А.А. Глушкова, А.Б. Едапина**

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: barbie1512@mail.ru*

**Аннотация:** В статье представлена основная информация, относящаяся к экологическим рискам, приведены причины их возникновения. В качестве примера эффективной работы по выявлению и устранению возможных экологических рисков, представлена успешная работа учёных технического вуза.

**Ключевые слова:** экологические риски, инновационный проект, экологическая безопасность

---

УДК 661.61

ББК 24.6

## EVALUATION OF CARBON NANOTUBES STRUCTURE AFTER FUNCTIONALIZATION WITH RAMAN SPECTROSCOPY

**Yu. A. Khan**

Tambov State Technical University, Tambov, Russia

*e-mail: Khantermail@gmail.com*

**Abstract:** Raman spectroscopy is one of the methods of studying the grapheme layers structure of carbon nanotubes (CNTs). In this work were studied Raman specters of CVD-processed CNTs. Changes of characteristic peaks and defectiveness parameters after liquid-phase functionalization at 65% nitric acid and gaseous-phase processing by fluorine steams were investigated. Decreasing of defectiveness parameters, what may be due to removing amorphous phase of carbon, with short processing time was noticed. Oxidizer's aggressive effect provokes a growth of defectiveness with increasing of processing time. Possibility of studying optimal modes of functionalization with minimal destruction of CNTs was shown.

**Keywords:** carbon nanotubes, functionalization, oxidation, fluorination, raman spectroscopy

Carbon nanotubes can be used as filler of composite materials with improved mechanical and electric properties. For getting this result necessary to solve problem of uniform allocation CNTs in different types of material. It can be reached with chemical processing in solutions of acid and other compounds and their steams. In processing of this different functional groups are created on surface of graphene layers, which improves interaction between them and composite matrix.

The most popular methods of functionalization is oxidation and fluorination. It is known that some defects are created in locations of functional groups formation. Character and placement of this depends of chemical processing conditions. This properties can affect to mechanical and electric characteristics of CNTs and composites based on it. Destructive changes of CNTs after functionalization can be very essential [1]. Raman spectroscopy can be used for qualitative assessment of graphene layers of CNTs. Raman spectra of CNTs includes some typical peaks [2]: D ( $\sim 1250 \text{ cm}^{-1}$ , presence of carbon in  $\text{sp}^3$ -hybridization state, defective surface area), G ( $\sim 1550 \text{ cm}^{-1}$ , presence of carbon in  $\text{sp}^2$ - state, non-defective surface area), 2D, D+G and 2G ( $\sim 2650 \text{ cm}^{-1}$ ,  $\sim 2950 \text{ cm}^{-1}$  and  $\sim 3210 \text{ cm}^{-1}$ , combined overtones of D and G peaks, changing of graphene layers structure). Analysis of their intensity and areas and calculating of ratios can give information about power of surface defectiveness.

The purpose of the study was discovering influence of functionalization methods (oxidation and fluorination of CNTs) to continuity of graphene layers by Raman spectroscopy based on inelastic scattering of visible and near infrared radiation.

As samples were used multiwalled carbon nanotubes "Taunit-M" ("NanoTechCenter", Tambov), which was processed by: a) oxidation in  $\text{H}_2\text{O}_2$  steams with  $140^\circ\text{C}$  during 2-30 hours; b) oxidation in 65% nitric acid with  $100^\circ\text{C}$  during 0.5-6.5 hours; c) gaseous fluorine with  $150\text{-}250^\circ\text{C}$  and pressure 0.8-1.0 atm. up to 2 hours.

Fig.1 shows Raman spectres of initial and processed CNTs by hardest conditions (temperature or duration). Processing by nitric acid provokes growth of areas of D and G peaks. But their relative growth is different. This leads to high increasing of D/G ratio, which is defectiveness parameter, and illustrate partial destruction of surface layers of CNTs. Oxidation by  $\text{H}_2\text{O}_2$  steams characterized by decreasing of D/G ratio. It illustrates regenerative effect to CNTs surface, but relative growth of the peaks is small, which indicates low power of functionalization. It confirms by [3]. Fluoridation is not affecting to value of D/G ratio. Growth of areas of the peaks is small, which says about low power of functionalization.

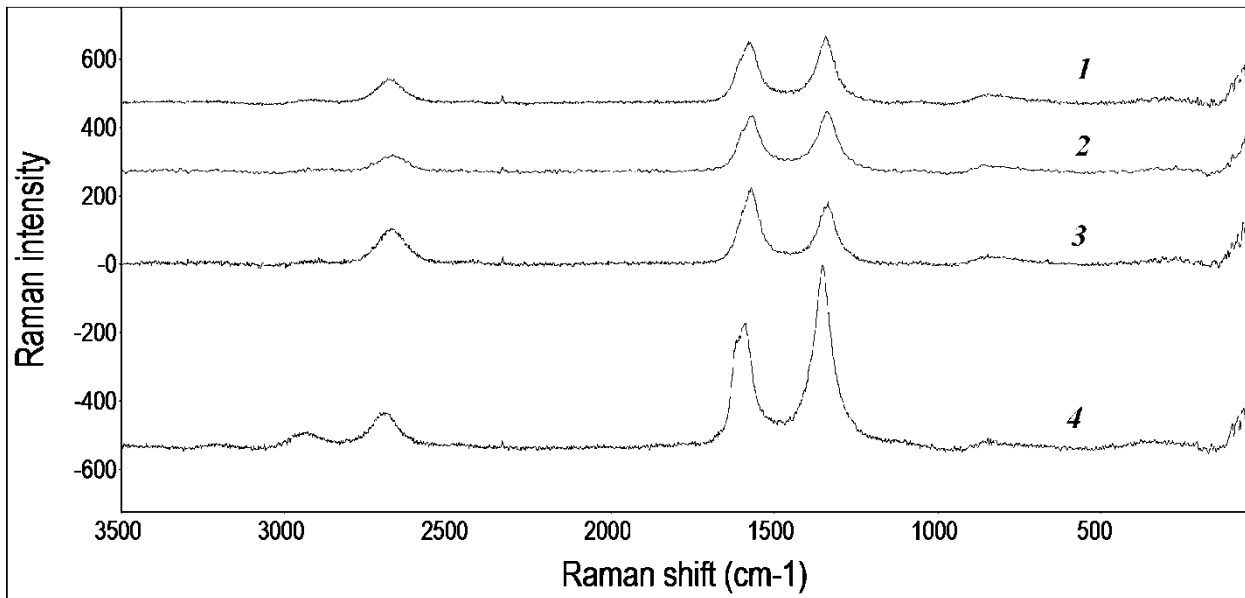


Fig. 1. Raman spectra of CNTs: 1) initial; 2) fluorinated at 250°C during 2 h; 3) oxidized at H<sub>2</sub>O<sub>2</sub> steams at 140°C during 30 h; 4) processed by 65% nitric acid at 100°C during 6.5 h

Fluorinated and oxidized CNTs is effectively using as composite modifiers with increased mechanical properties. Therefore influence of chemical processing modes to power of functionalization is interesting for studying. Analysis of Raman spectra presented in tab.1.

Table 1. Data of Raman specters analysis of fluorinated and oxidized CNTs “Taunit-M”

Type of processing	Conditions of process	D/G	Average peaks area		
			2D	D+G	2G
initial CNTs	-	1.011	7184	1098	491
Oxidation by HNO <sub>3</sub>	100 <sup>0</sup> C, 0.5 hrs.	0.941	7695	1089	380
	100 <sup>0</sup> C, 2.5 hrs.	1.340	7782	2274	591
	100 <sup>0</sup> C, 3.5 hrs.	1.350	10702	2479	321,4
	100 <sup>0</sup> C, 6.5 hrs.	1.577	12659	5687	797
Fluorination	150 <sup>0</sup> C, 0.9-1.0 atm., 2 hrs.	1.166	4856	1084	752
	250 <sup>0</sup> C, 0.9-1.0 atm., 2 hrs.	1.114	4564	1082	609
	150 <sup>0</sup> C, 0.8-0.9 atm., 2 hrs.	1.063	5739	1003	679
	150 <sup>0</sup> C, 0.8-0.9 atm., 10 min	0.895	7253	692	776
	100 <sup>0</sup> C, 0.8-0.9 atm., 9 min	0.953	5424	845	648

Processing with nitric acid dirung 0.5 h reduces defectiveness parameters of



CNTs. This is due to removing amorphous phase of carbon on first stages of oxidation. Further growth of D, G, 2D and D+G occurs because of new defects creates. Intensity of 2D peak decreases up to 3.5 h and later starts to grow up.

Functionalization with gaseous fluorine characterized by slight increasing of D/G parameter in the long processing and decreasing in the processing less than 10 minutes. Totally, short processing time characterized by decreasing of 2D and D+G peaks. Also it can be explained as removing of amorphous phase. Long time processing with increasing temperature and decreasing pressure reduce growth speed of defectiveness parameters of CNTs.

In this work was presented possibility of researching of functionalization modes, which minimizes destruction of grapheme layers of CNTs to exclusion negative effects of processing.

#### References:

1. Zaharychev E.A. Issledovanie vlijaniya stepeni funkcionalizacii na nekotorye svojstva mnogoslojnyh uglerodnyh nanotrubok [Research of influence of the degree of functionalization on some properties of multiwalled carbon nanotubes] / E.A. Zaharychev, S.A. Rjabov, Yu.D. Semchikov // Vestnik Nizhegorodskogo universiteta im. N.I. Lobachevskogo. – 2013. - #1 (1). – P.100-104.
2. Synthesis, characterization, and electrochemical testing of carbon nanotubes derivatized with azobenzene and anthraquinone / K. Sadowska, K.P. Roberts, R. Wiser et al. // Carbon. – 2009. – V.47. – P.1501-1510.
3. Okislenie mnogoslojnyh uglerodnyh nanotrubok v parah perekisi vodoroda: zakonomernosti i jeffekty [The oxidation of multilayer carbon nanotubes in the vapor of hydrogen peroxide: patterns and effects] / T.P. D'yachkova, Yu.A. Han, N.V. Orlova. // Vestnik TGTU. – 2016. – Tom 22 (#2). – P.

## ОЦЕНКА СТРУКТУРЫ УГЛЕРОДНЫХ НАНОТРУБОК В РЕЗУЛЬТАТЕ КОМБИНАЦИОННОЙ СПЕКТРОСКОПИИ

Ю.А. Хан

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: Khantermail@gmail.com*

**Аннотация:** *Спектроскопия комбинационного рассеяния (КР) является одним из инструментов исследования структуры графеновых слоев углеродных нанотрубок (УНТ). В работе изучены КР-спектры УНТ, синтезированных методом газофазного химического осаждения. Исследованы изменения характерных пиков и показателей дефектности УНТ в ходе жидкофазной функционализации в 65%-ой азотной кислоте и газофазной функционализации в парах фтора. Замечено уменьшение показателей дефектности при малом времени функционализации, связанное с удалением аморфной фазы. В связи с агрессивным воздействием среды наблюдается рост дефектности при увеличении длительности химической обработки. Показана возможность нахождения оптимальных режимов функционализации, при которых разрушение УНТ минимально.*

**Ключевые слова:** *углеродные нанотрубки, функционализация, окисление, фторирование, спектроскопия комбинационного рассеяния*

УДК 574  
ББК 0145

## IMPROVING THE EXTRACTING TECHNOLOGY OF SULPHAMIC ACID

**A.S. Goncharov, Y.V. Zhdanova, V.V. Kireev, D.Y. Pshichkina**

Tambov State Technical University, Tambov, Russia

e-mail: psh1009@yandex.ru

**Abstract:** *The importance of crystallization is emphasized by the fact that the problems at this stage not only have effect on the quality of the finished product, but also create additional energy in the final stages of production.*

**Keywords:** *sulphamation, crystallization, recrystallization, sulphamic acid.*

Production of sulphamic acid (SA) is one of the strategic directions of the Pigment Chemical Company. In recent years, a significant reconstruction of the technological schemes of sulphamic acid production was carried out, as well as the technology changed the parameters, resulting in improved product competitiveness in the Russian Federation.

However, the level of competitive prices on SA of similar quality produced in China and India is no more than 18.5 rubles / kg in the world market, while the level of the cost of manufactured SA - 39.2 rubles / kg. In this context, the issue of reducing non-productive and direct costs is quite sharp and is a high priority [1].

The crystallization step (recrystallization) and isolation determines not only the desired product particle size distribution, but also indicators such as the share of main substance and impurities, and the product yield. The importance of crystallization is emphasized by the fact that the problems at this stage not only have effect on the quality of the finished product, but also create additional energy in the final stages of production.

In view of the fact that the sulphamation step is carried out with 15 - 20% excess of oleum, with a mass fraction of 24% sulfuric anhydride in the crystallization process, 1) the solubility of SAH in the presence of sulfuric acid is reduced and, consequently, a coarse phase cannot be obtained; 2) the presence of acidic medium significantly increases the hydrolysis rate (2-2.5), and decreases the hydrolysis initiation temperature.

To neutralize the high acidity during the sulphomass crystallization step water is added to bring the total mass concentration based on the sulfuric acid to the range 270 - 300 g / dm<sup>3</sup>, with the formation of side reaction with sulfuric acid.

Upon completion of centrifugation, the filtrate obtained as sulfuric acid with an impurity content of about 4-6%. The resulting filtrate containing 80 to 90% H<sub>2</sub>SO<sub>4</sub> is not used. It is stored in the storage pond and is securely isolated prior to injection into

deep aquifers.

For the purposes of resource and energy-saving the possibility of re-use of sulfuric acid in related industries is considered. The main difficulty for this decision are the content of impurities in the acid, about 3-4% ammonium bisulfate and the presence of fine crystalline phase of sulphamic acid, which cannot be completely filtered on a centrifuge, due to too small crystal size (from 15 to 25 microns).

The main process parameters that affect the shape and size of the crystals are the rate of cooling and hydrodynamic conditions in the machine. Complete extraction of the target substance and the formation of the crystal structure also depends on the initial and final temperatures of the crystallization process [2].

The expected results of the study: preparation of sulphamic acid with a mass fraction of the basic substance to 99% and reduction of impurities to 0.5%; obtaining crystals with a size of 40-45 microns, which would reduce the SA content in the filtrate to 0.8 - 1.0% and make valid use of the spent sulfuric acid in related industries.

#### References

1. Hamsky E.V. Kristallizatsiya v himicheskoy promyshlennosti. [Crystallization in chemical industry]. / E.V. Hamsky - M.: Chemistry, 1986. – 343p.(Rus)
2. Matusevich L.N. Kristallizatsiya iz rastvorov v himicheskoy promyshlennosti. [Crystallization of solutions in chemical industry] / L.N. Matusevich. - M.: Chemistry, 1968. – 301p. (Rus)

## СОВЕРШЕНСТВОВАНИЕ ТЕХНОЛОГИИ ПОЛУЧЕНИЯ СУЛЬФАМИНОВОЙ КИСЛОТЫ

**А.С. Гончаров, Ю.В. Жданова, В.В. Киреев, Д.Ю. Пшичкина**

Тамбовский государственный технический университет, Тамбов, Россия

e-mail: psh1009@yandex.ru

*Аннотация:* Важность кристаллизации подчеркивает, что проблемы на данном этапе отражаются не только на качестве готового продукта, но и создают дополнительную энергию на заключительных этапах производства.

*Ключевые слова:* сульфирование, кристаллизация, перекристаллизация, сульфаминовая кислота.

## THE USE OF SOLVENTS RESTRUCTURED TO REMOVE IMPURITIES FROM THE PASTE OF AZO PIGMENTS

**M.Yu. Subocheva, E.A. Balashova**

Tambov State Technical University, Tambov, Russia

*e-mail: dzhimbo1@mail.ru*

**Abstract:** *The main qualitative characteristics of the pigments, the main methods of removing impurities from the pigment paste are described. The types of washer fluid are analysed.*

**Keywords:** *coloristic concentration, water-soluble impurities, nanostructured materials, flushing pigment pastes.*

The main indicator of the quality of the final form of pigments and dyes is a concentration of the color palette (I,%), i.e. the ability of the pigment to influence the color of the final product. The concentration of the color depends on many factors: the shape of the crystal structure of the chemical elements included in the structural formula, the spatial structure of the molecule, composition and concentration of impurities.

Impurities have a great influence on the properties of the pigments. During synthesis salts are formed in pigment pastes. This results in reduced product quality indicators. We need to find solutions to improve the process of removing the water-soluble salts from azopigments pastes.

The main industrial cleaning method is to wash the residue on the filter septum. The first is the formation of a precipitate, washing it and then this sequence leads to an increase in energy costs and high costs of the wash water.

We need to separate the step of removing soluble impurities from the filtering stage. We conduct decantation in azo coupling device. This method is suitable for the laboratory and for small flexible multi-type production. The method that allows to remove the mother liquor is more complete than when the precipitate is washed on the filter septum. The essence of the method is the overflow from the settled sludge. The method is one of the most simple and thorough to maintain the structure of azo crystals.

The main disadvantage of this method is the long time of division phase azo pigment / water. When nanometals are added to water flushing, they:

- 1) increase the rate of phase separation;
- 2) increase the solubility of the salts.

Improvement of these parameters was observed when using water in the melt, or by passing the water through a layer of carbon sorbent of high reactivity (USVR).

Inserts of thin metal powders have a particle size of 50-100 nm. Micellar solutions are used in an organic solvent, with a particle size of 3-5 nm. Positive washing effect was achieved with the introduction of wash 0.0005% (wt.) nanomaterials. This result is explained by the change due to its restructuring solvent properties. To control changes in the structure of the process water its electrical

conductivity, density, and surface tension were measured.

It has been demonstrated that the results affect the water structure and nanometals as shown in the example of F Orange pigment paste having been washed with six times the volume of water. Decantate was analyzed for the presence of soluble impurities by determining the conductivity of PP-50 solution to the liquid analyzer Sartorius AG, since this value indicates the number of dissolved salts, and the dynamics of the process shows the efficiency of various cleaning pastes with water cluster structure.

To assess the relative ability of the dye (concentration), hue and color purity, the color difference in the total binder offset F Orange pigment is dried at a temperature of 70-80 ° C and then assayed by the standard method and visual colorimeter complex "Macbeth" to calculate the concentration of the pigment to the color type, color characteristics and tolerances in the shade lightness net difference in total color in CIE LAV system [3].

Different types of water were used:

- 1) artesian;
- 2) artesian melt;
- 3) the well water is passed through CMHC layer.
- 4) artesian water, passed through CMHC.

Coloristic concentration increased by 3% when nanostructured metals (Au, Ag, Cu, Ni, Fe, Ni-Cr) were added to wash water. It was also found to increase the color concentration of 5.6%. Data on the impact of the integrated use of structured water and nanomaterials are presented in Table 1.

*Table 1. Orange color pigment G indicators*

Cleaning technology		Instrumental evaluation				
		$\Delta E$	$\Delta L$	$\Delta C$	$\Delta H$	I, %
Traditional technology		0.33	-0.24	-0.23	0.04	101.4
6-fold washing of artesian water		1.00	0.60	-0.75	0.25	103.4
6-fold washing of artesian water, passed through CMHC		0.87	-0.4	0.69	0.35	105.8
6-fold washing with well water that has passed through CMHC containing nanostructured material	Au	2.386	0.184	2.29	0.642	109.3
	Ag	4.402	0.778	4.218	0.989	121.4
	Cu	3.691	0.453	3.585	0.752	115.9
	Ni	10.09	-1.77	9.6	2.36	157
	Fe	10.12	1.95	9.64	2.38	159
	Ni.Cr	3.79	1.076	3.469	1.115	121.9

Using the purified water makes final product cleaner. This increases the concentration of the color (I = 105,8%).

The use of nanomaterials increases the concentration. Ni and Fe demonstrated the highest efficiency.

Experimental results showed that the structure of water and nanostructured

materials:

- 1) improve the qualitative properties of organic pigments;
- 2) influence the solubility of the salts in the pastes of organic pigments.

The total decrease in the amount of water used to flush the pigment and the amount of waste water is reduced four times in comparison with washing on the filter.

### References

1. Zenin, S.V. Struktyrirovannoe sostoyanie vody kak osnova upravleniya povedeniem I bezopasnostju zhivyh sistem [Structured condition of water as the basis of the behavior of the control and safety of living systems [Text]: dis. Dr. biol. Sciences: 05.26.02 / Stanislav V. Zenin. - M., 1999.- 207 p. Bibliography: pp 189-207 ;
2. Mosin, O.V. Strukturirovannaya voda I sposoby ee polucheniya [Structured water and methods for its preparation];
3. Ochnev, E.N. K voprosu organizacii mnogofactorного eksperimenta [On the question of the organization of multi-factor experiment ] Vestnik Tambovskogo universiteta. Seriya: Estestvennue I tehnicheckie nauki. -Tambov. 2004. № 2. pp. 292-293.

## ПРИМЕНЕНИЕ РАСТВОРИТЕЛЯ С ИЗМЕНЕННОЙ СТРУКТУРОЙ ДЛЯ УДАЛЕНИЯ ПРИМЕСЕЙ ИЗ ПАСТ АЗОПИГМЕНТОВ

**М.Ю. Субочева, Е.А. Балашова**

Тамбовский государственный технический университет, Тамбов, Россия  
*e-mail: dzhimbo1@mail.ru*

**Аннотация:** Описание основных качественных характеристик пигментов, основные методы удаления примесей из паст пигментов. Анализирование типов промывной жидкости.

**Ключевые слова:** колористическая концентрация, водорастворимые примеси, наноструктурированные материалы, промывка паст пигментов.

---

УДК 574  
ББК 0145

## WASTEWATER TREATMENT IN GALVANIC LINES

**D.A. Kharin**

Tambov State Technical University, Russia, Tambov  
*e-mail: dima68rus@mail.ru*

**Abstract:** The paper presents methods of wastewater treatment in the electroplating galvanic lines.

**Keywords:** Galvanic lines, patterns, automated attendant, simulation.

Electroplating is one of the most dangerous sources of pollution, mainly surface and underground waters, due to the formation of a large amount of

wastewater, as well as a large amount of solid waste.

Electroplating wastewater outlets are characterized by the fact that they contain dirt which cannot be removed by filtration or other methods commonly used for the treatment of municipal sewage.

Such pollutions are strong poisons, capable of destroying, in certain circumstances, all life in natural waters or installations of biological treatment of municipal wastewater. Currently, environmental problems caused by electroplating have attracted widespread attention largely because of the continuing pollution of the environment with heavy metal ions. [4].

A diverse range of coatings applied by electroplating methods causes the variety of contaminants that are in the waste water. Based on the phase state of the substance in solution, all impurities may be divided into four groups:

1. Suspensions as fine suspensions and emulsions.
2. The colloids and macromolecular compounds.
3. Organic substances dissolved in water.
4. Salts, acids, bases, dissolved in water.

Each group has its own pollution cleaning methods. So, for the purification of water from the first group of substances the most effective methods are based on the use of gravity, flotation, and adhesion. For the second group, it is the coagulation method. Contaminants of the third group are more efficiently extracted from the water during the adsorption treatment, and the fourth group of contaminants which are electrolytes, the ions are removed from water soluble compounds in the transfer, using the method of reagent or desalting methods.

Cleaning methods can be divided into seven groups:

1. Mechanical
2. Chemicals
3. Coagulation-flotation
4. Electrochemical
5. Sorption
6. Membrane
7. Biological

However, none of the methods alone ensure the full implementation of modern requirements:

Cleaning up the ceiling standards, especially for heavy metal ions; a return of 90-95% of the water circulating in the cycle; low cost of treatment; small-sized installations, recycling of valuable components such as acids, alkalis and metals. Achieving environmental regulations often worsens the already bad financial situation of many companies. One way out of this situation is to improve means of wastewater treatment methods and optimize the organization of treatment systems [7].

In high-volume production on local treatment systems it is appropriate to use electrochemical methods and membrane, and the general treatment system based on a combination of several methods:

1. Reagent and ion exchange

2. Reagent and electroflotation
3. Reagent and electro dialysis.

With a small amount of production membrane and electrochemical methods should be preferred [3].

Electrochemical cleaning methods have several advantages over chemical methods:

1. A simplified flow diagram of the operation of production facilities.
2. Easy to automate their work.
3. Smaller production facilities necessary to accommodate the sewage treatment plants
4. The possibility of treating wastewater without prior dilution
5. Permanence effluent salinity and reduced rainfall after treatment of wastewater. [5].

Electroplating cannot function without treatment plant, as it is one of the most dangerous sources of environmental pollution. Therefore, the cost of production of galvanic products must include the costs of diversion of liquid waste disposal and solid waste disposal, of which the largest are the costs of waste disposal and in particular the treatment of wastewater. These costs are determined by the cost of pollution control equipment and its maintenance, as well as the cost of consumables. That is, a process wastewater treatment, and the type of purifying equipment to a large extent affect the cost of production [6].

Organization of electroplating, meeting environmental safety requirements, and modern treatment facilities to the mandatory use of automation and computerization of the main production processes will help to solve environmental problems cost-effectively [8].

An important factor in solving this problem is that technologists of the production plant and environmentalists work together since the initial stage of the selection of technological solutions. It is necessary that the main principle of the organization of production was the maximum prevention of contamination, i.e. it was economically advantageous for the treatment plant to prevent water pollution than to clean the contaminated water [1].

### References

1. Avramenko YG Decision Support System for the design of chemical-engineering processes (for example, drawing up schemes for sewage treatment, industrial enterprises): Dis. cand. tehn. Sciences: 05.13.01: RSL OD, 61: 04-5 / 798-5 / Avramenko Youri. - M., 2003. - 183 p. (Rus)
2. Anosov, OI Information technology in solving problems of designing plating lines /O.I. Anosov, MP Reshetnikov, KV Nemtinov, VA Nemtinov // [In: virtual simulation, prototyping and industrial design materials of the international scientific-practical conference. Edited by VA Nemtinova]. 2015. pp. 33-38. (Rus)
3. The hardware-technological decor of process of ion exchange wastewater electroplating / SI Pestretzoff, AA Homeland // [Magazine "Questions of modern science and practice. University. VI Vernadsky. »]№2 (40) 2012 – pp/327-332. (Rus)
4. Buchilo E. Wastewater etching and electroplating otdeleniy. M.: Metallurgy, 1974. – 200 p. (Rus)
5. Vinogradov, SS Environmentally sound electroplating production. / edited by prof. VN Kudryavtseva. - Ed. 2nd Revised. and add. M.: Globe, 2002. - 352 p. (Rus)
6. Vinogradov, SS Organization of electroplating / SS Vinogradov. - M.: Globe, 2002. - 191 p.



(Rus)

7. Nemtinov, VA On approach, the integrated use of information technology for the study of chemical-technological objects / VA Nemtinov, Y. Nemtinova, AA Pchelintseva, AM Manaenkov // [Herald of computer and information technologies]. 2013. № 5 (107). pp. 28-33. (Rus)

8. Reshetnikov, MP The virtual model of the complex waste water treatment galvanic lines / MP Reshetnikov, OI Anosov, KV Nemtinov, VA Nemtinov // [In: virtual simulation, prototyping and industrial design materials of the international scientific-practical conference. Edited by VA Nemtinova]. 2015. pp. 38-43. (Rus)

## **СИСТЕМА ОЧИСТКИ ВОДЫ НА ГАЛЬВАНИЧЕСКОЙ ЛИНИИ**

**Д.А. Харин**

Тамбовский государственный технический университет, Россия, Тамбов

*e-mail: dima68rus@mail.ru*

*Аннотация:* В статье приводятся методы очистки сточных вод на гальванических линиях.

*Ключевые слова:* Гальваническая линия, очистка, сточные воды, методы очистки.

---

### THE USE OF ULTRASONIC METHOD FOR NON-DESTRUCTIVE TESTING

V. Yu. Dmitriev

Tambov State Technical University, Tambov Russia

*e-mail: vladhanter@gmail.com*

**Abstract:** *The paper considers the ultrasonic method for non-destructive testing. The article describes the differences between ultrasonic method and other methods.*

**Keywords:** *ultrasonic method, non-destructive testing.*

The structural components used in modern automobiles and aircraft manufacturing are subject to stringent requirements, such as having a lightweight, yet mechanically robust design. Among other things, this ensures structures with improved crash behavior and excellent vibration and sound damping properties. Adhering to such demanding specifications requires the use of innovative materials like carbon or glass fiber reinforced polymer, high-strength steel and lightweight metals, which are often combined into hybrid components. As these type of materials can quickly cause end products to fail, material flaws need to be uncovered at an early stage - and this is where nondestructive testing (NDT) plays a key role. To be effective, NDT processes must have sufficient flaw detection limits and be easy to automate without impacting the material under inspection.

NDT methods are based on similar physical principles, conventionally grouped into types within and classified by three criteria:

- nature of the controlled object interaction with the physical field or substance;
- primary informative parameters (characteristics permeate or physical field, which is registered after its interaction with the object of control);
- in a manner that receives the initial information (primary information - set of characteristics permeate or physical field recorded after interaction with the controlled object).

Magnetic method based on the analysis of interaction between controlled object and the magnetic field. They are usually used for the detection of internal and surface defects of objects made of ferromagnetic materials.

The magnetic NDT methods include magnetic particle, flux-gate, and magnetographic induction methods. The most common and reliable among NDT its kind is magnetic particle - based on the occurrence of non-uniformity of the magnetic field over the defect site.

The most common and reliable among NDT methods is magnetic particle method based on the occurrence of inhomogeneities of magnetic field over the defect site. The main magnetic NDT methods include magnetic particle, flux-gate, and magnetographic induction method. The most common and reliable among NDT its

kind is magnetic particle - based on the occurrence of non-uniformity of the magnetic field over the defect site.

Eddy methods are based on a study of the interaction of electromagnetic fields with eddy current transducer induced in the test object electromagnetic field eddy current having a frequency of up to 1 million Hz.

In practice, this method is used to control the objects that are made of conductive materials. This method is used for obtain information about the chemical composition and the geometrical dimensions of the product, the structure of the material from which the object is made and detecting defects occurring on the surface and in the subsurface (at depths of 2-3 mm).

Ultrasonic methods based on registration and analysis of the parameters of elastic waves, which are excited and / or occur in the control object.

Elastic waves, or rather, their parameters are closely related to some of the properties of the material (anisotropy, density, elasticity, etc.). If we take into account the fact that the acoustic properties of solid objects and the air vary greatly, it becomes clear why using acoustic method can identify the presence of the smallest defects

Ultrasonic testing is one of the major NDT methods for inspecting multilayer materials because it overcomes the disadvantages of coupling materials like (water, gel, oil etc.).

Ultrasonic method for non-destructive inspection of multilayer materials are becoming more and more popular as a way of provide product integrity and quality. With the improvement of this method, it can be used for a number of solutions to complex problems.

#### **References**

1. Klyuev, V. Enciklopediya. Izmerenie, kontrol', diagnostika, testirovanie [Encyclopedia. Measurement, control, testing and diagnostics]. / V. V. Klyuyev. 3-7 T.– М.: Mashinostroenie, 2001. – 160 p.
2. Ermolov E.N. Ul'trazvukovoy nerazrushajuschiy kontrol' [Ultrasonic nondestructive testing]. / E.N. Ermolov. High school,1991. – 283 p.

## **ИСПОЛЬЗОВАНИЕ УЛЬТРАЗВУКОВОЙ МЕТОД НЕРАЗРУШАЮЩЕГО КОНТРОЛЯ**

**В.Ю. Дмитриев**

Тамбовский государственный технический университет, Тамбов Россия

*e-mail: vladhanter@gmail.com*

***Аннотация:** В статье рассматривается акустический метод неразрушающего контроля качества. В статье описаны другие методы неразрушающего контроля, акустический метод и его достоинства.*

***Ключевые слова:** акустический метод, метод неразрушающего контроля, МНК.*

## PROSPECTS OF POLYMER COMPOSITE MATERIALS WITH ELECTRICAL INSULATING REPAIR OF MOTOR VEHICLES

**A.I. Mishachenko, A.B. Efremov, D.E. Kobzev**  
Tambov State Technical University, Tambov, Russia  
*e-mail: Rus.andy95@gmail.com*

**Abstract:** *The world's first cars were almost entirely composed of metal. Now, the situation is different. Many parts of modern cars are made from plastic. Plastic products in any device are subject to breakage, cracks, bending, melting and deformation. In connection with this a new technology was created to repair car plastic parts.*

**Keywords:** *road transport, repair and service of cars, polymeric materials, costs, improved technology.*

Road transport is developing qualitatively and quantitatively at a rapid pace. Currently the global car fleet increases annually by 10-12 million units. Every four out of five of the total world fleet of vehicles are cars and they account for over 60% of passengers carried by all modes of transport. However, motorization process is not limited to the growth of the car park. The rapid pace of vehicle development has caused certain problems whose solution requires a scientific approach and the significant costs are associated with the repair and maintenance of vehicles.

Plastics are used in the car bodywork and cab design as well as in large and small-size parts for construction and decorative purposes, heat-insulating and soundproof parts, etc. The use of polymers (plastics) in the automotive industry:

- improves the appearance of the car;
- decreases its mass;
- reduces noise while driving;
- improves structural design details;
- increases the service life of components;
- reduces the labor intensity of production;
- reduces costs of production of parts.

Replacing metals with plastics in the manufacture of parts of complex configuration provides significant technical and economic effect, since many plastics parts can be produced on automated systems with a minimum waste of material.

The use of plastics for the manufacture of cabs, bodies and large parts is especially promising; it accounts for about half of the vehicle mass and ~ 40% of the cost. Bodies of corrosion-resistant plastic materials are more reliable and durable in operation, than those made of metal (70% of the vehicles with a metal body cannot withstand the 10-year service life due to corrosion of the metal), and their repair is cheaper and easier.

Polyester and fiberglass laminates based on phenolic resin and fabric made of plant fibers are most widely used in the manufacture of cabins and car bodywork. For example, hot pressing of fiberglass is used in the car bodywork of «Corvette» (USA)

and the bonnet and tail of the truck «Ford» L. Glass was also used for the manufacture of the cockpit "Fawn" truck (Germany) and car bodywork of "Navy" sports car model 1100 (United Kingdom) by contact molding. In the GDR the passenger car "Trabant" was produced with the fiberglass bodywork assembled of panels made by compression. Typically, the individual body parts are mounted on a metal frame.

### **Plastic insulating materials**

Currently, there is a very large number of industrial polymer insulation materials that differ in their characteristics and origin. These types of materials have a considerable strength, heat resistance, shock resistance, moisture resistance, and some of them have even dielectric, electrical and chemical-resistant properties that can find application in various industries and extend the life of structures and mechanisms. There is quite a lot of experience of using polymer materials as insulators and various types of protective coatings. The choice of polymer material, modifying agent and designing its geometrical dimensions is based on the studies of prototypes using different methods.

Production of insulators is possible by both classical methods of processing of polymer materials and methods of solid-state technology. The products obtained by these methods have improved performance.

However, a large amount of research is conducted on the use of polymer composite materials, which do not exceed the properties of modified polymers. The use of such materials is possible when applying protective insulating coatings for the repair of car parts. Improvement of technologies of repair and maintenance of vehicles is an urgent task, as it can bring significant economic effect.

In conclusion, it should be noted that research into improved technology of car repair of plastic parts and the application of insulating coatings of composite materials is a very important and promising direction, achievement of which will improve the reliability and service life of different types of equipment.

### **References**

1. Linejnye polimernye izoljatory: problemy i perspektivy [Linear polymer insulators: problems and prospects] / N.A. Vaga // Jenergetik. – 2010. - № 5. S. 39-42. (Rus)
2. Ob jekspluacionnyh harakteristikah linejnyh sterzhnevnyh polimernyh izoljatorov [On the operational characteristics of linear rod polymer insulators] / R.S. Gubaev, V.A. Kravchenko, A.K. Juldashev, K.A. Juldashev, Sh.M. Kamalov // Jelektrichestvo. - 2006. - № 2. S. 13-21. (Rus)
3. Distancionnaja diagnostika vysokovol'tnyh polimernyh izoljatorov [Remote diagnostics of high-voltage composite insulators] / A.V. Golenishhev-kutuzov, V.A. Golenishhev-kutuzov, I.E. Sinjugin, R.A. Husnutdinov, Mardanov G.D. // Izvestija vysshih uchebnyh zavedenij. Problemy jenergetiki. - 2014. - № 7-8. S. 77-82. (Rus)
4. Metod nerazrushajushhego kontrolja polimernyh kompozicionnyh izoljatorov naprjazheniem 35 KV [The method of non-destructive testing of polymeric composite insulators with 35 kV] / Gataullin A.M., Matuhin V.L., Nizamov I.I. // Nauchno-tehnicheskie vedomosti SPbGPU. - 2015. - № 2 (219). S. 119-125. (Rus)
5. Osobennosti jekspluacii polimernyh izoljacionnyh konstrukcij [Features of operation of polymer insulation constructions] / Jarmarkin M.K., Kircideli I.Ju. // Izvestija vysshih uchebnyh zavedenij. Jeletromehnika. - 2011. - № 3. S. 94-96. (Rus)

# ПЕРСПЕКТИВЫ ПРИМЕНЕНИЯ ПОЛИМЕРНЫХ КОМПОЗИЦИОННЫХ ЭЛЕКТРОИЗОЛЯЦИОННЫХ МАТЕРИАЛОВ ПРИ РЕМОНТЕ АВТОМОБИЛЕЙ

**А.И. Мишаченко, А.Б. Ефремов, Д.Е. Кобзев**

Тамбовский государственный технический университет, Тамбов, Россия  
e-mail: Rus.andy95@gmail.com

***Аннотация:** Первые в мире автомобили почти полностью состояли из металла. Теперь же, ситуация обстоит иначе. Очень много деталей современного автомобиля из пластмасс. Пластмассовые изделия, будь то в машине или в любом другом устройстве имеют свойство ломаться, трескаться, выгибаться, плавиться, деформироваться. В связи с этим создаются новые технологии по ремонту пластмассовых деталей автомобиля.*

***Ключевые слова:** Автомобильный транспорт, ремонт и обслуживание автомобилей, полимерные материалы, затраты, совершенствование технологий.*

---

УДК 67.02  
ББК 39.3

## APPLICATION OF POLYMER SOLUTIONS FOR REPAIR OF VEHICLES' COOLING SYSTEM RADIATORS AND COATINGS

**B.S. Moiseev, D.A. Kravchuk, D. E. Kobzev**

Tambov State Technical University, Tambov, Russia  
e-mail: borian.liventzev@yandex.ru

***Abstract:** The repair of radiators leakage is a very time-consuming process. In this article, we consider the repair process, develop a formula and improve the technology of repair coating application. Benefits and implications of the proposed technology are examined. We also note that this formula has a wide range of properties, including dielectric ones that extend the application range.*

***Keywords:** polymer, cooling system radiator, composite materials.*

In the transport (repair) production, various kinds of synthetic materials (plastics) become popular by component parts reconditioning. They are used by clearing of mechanical damages on details (cracks, breaches, spallings, etc.), by wear compensation of parts' working surface, and by part joining with the help of bonding. It is due to simplicity of the technical process and the used equipment, low process complexity, quite high physical and mechanical characteristics of plastics and their low cost.

Today to restore serviceability of vehicles that have a leak of coolant in radiator it is necessary to replace a radiator or to solder tubes in a leak spot, or to plug defected tubes.

The main disadvantage of radiator repair with solder application is that it can be used only when a leak spot is determined precisely and it is accessible for solder. It is possible to plug tubes of demountable radiators only. Plugging of leak in tubes by special products, which are poured into cooling system, helps restore serviceability of vehicles for a while.

To implement the technical process of coating and to repair vehicles' radiators with the help of polymer compound solution it is necessary to choose material and to make a composite formula on its base. It is suggested to use ABS plastic, aluminum powder, "Acetone" solvent (Fig. 1).



*Fig.1 – materials for radiators' repair: 1 – Acetone, 2 – ABS plastic, 3 – Solution of ABS plastic, 4 – Aluminum powder, 5 – Solution of ABS plastic with aluminum powder.*

The main tasks are to make a composite material formula on the base of ABS plastic, that meets the requirements of the vehicle repair industry, and to enhance repair coatings technologies with the help of polymer compound melt.



*Fig. 2 – Repaired vehicle cooling system radiator*

This paper introduces a devised cooling system radiators' repair technology with the help of polymer composite material solution. This technology consists in the filling of a local defect area with polymer composite material solution. Fig. 2 illustrates a vehicle cooling system radiator with a punched tube. Half of thin aluminum partitions were removed from this radiator to prepare a cavity that is filled with polymer composite solution.

Radiators with such defects have been rejected until the present. The introduced repair technology of vehicle cooling system radiator is unique and helps repair radiators with almost all types of defects.

A cleared area is degreased; a radiator is put on a flat surface. Under the cleared area, aluminum foil is put. Aluminum foil prevents leakage of solution from the repair area, as it is a repair cavity bottom. Then the repair cavity is filled with polymer solution to the level of upper radiator surface. It is necessary that air does not remain in the repair cavity. It can be done with the help of slight stirring by any tool, for example by screwdriver, awl, etc. Solution should dry out naturally more than 12 hours after the repair cavity was filled. After that the radiator is ready to use.

Aluminum powder was used as a bulking agent of polymer solution based on ABS plastic, because this type of radiator is made of aluminum. With the help of the introduced technology not only vehicles' cooling system radiators can be repaired but also protective coatings including insulating ones can be applied, and use for it solutions of unmodified polymer materials.

#### **References:**

1. Kobzev D.E., Osnovyi remonta i vosstanovleniya detaley mashin i mehanizmov. Tverdogaznyie metodyi polucheniya detaley iz polimernyih materialov [Basics of repair and restoration of details machines and mechanisms] / D.E. Kobzev, G.S. Baronin, P.V. Kombarova, Yu.E. Glazkov, A.V. Prohorov // Uchebnoe posobie. Tambov. Izd - vo Pershina R.V., 2015. - 100 s. (Rus)
2. Panimatchenko A.D. Pererabotka plastmass, [Plastic processing], izd. Professiya, Spb 2005 (Rus)
3. Karyakina M.I., Poptsov V.E. Tehnologiya polimernyih pokrytiy: Uchebnoe posobie dlya tehnikumov. [Technology of polymer coatings] – M.: Himiya, 1983 – 336s., il (Rus)
4. Yakovlev A.D., Zdor V.F., Kaplan V.I. Poroshkovyie polimernyie materialyi i pokrytiya na ih osnove. [Powdered polymer materials and coatings] L., Himiya, 1979. 254 s (Rus)

## **ПРИМЕНЕНИЕ ПОЛИМЕРНЫХ РАСТВОРОВ ПРИ РЕМОНТЕ РАДИАТОРОВ СИСТЕМЫ ОХЛАЖДЕНИЯ АВТОМОБИЛЕЙ И ЗАЩИТНЫХ ПОКРЫТИЙ**

**Б.С. Моисеев, Д.А. Кравчук, Д.Е. Кобзев**

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: borian.liventzev@yandex.ru*

***Аннотация:** Восстановление радиаторов, имеющих течь, крайне трудоемкий процесс. В данной статье мы рассмотрим технологический процесс ремонта, разработаем рецептуру и усовершенствуем технологию нанесения ремонтного покрытия. Будут рассмотрены плюсы и минусы предлагаемой технологии. Так же отметим, что данная рецептура имеет широкий круг свойств, в том числе является диэлектриком, что расширяет область применения.*

***Ключевые слова:** полимер, радиатор системы охлаждения, композитные материалы.*



## RESEARCH TOOL MATERIALS USING SOLID MODELING SOFTWARE

**E.O. Naumov**

Tambov State Technical University, Tambov, Russia  
*e-mail*:. Neuh94@yandex.ru

**Abstract:** *the article presents a study on optimal selection of tool material for machining of steel 20X13 on the stress strain state of the material and thermal analysis of the material using solid modelling software.*

**Keywords:** *tool material, stress strain state, thermal analysis, solid modeling program. solid alloy.*

The history of metal processing development shows that one of the effective ways to increase productivity in engineering is the use of new tool materials. For example, the use of high-speed tool steel instead of carbon has increased the cutting speed by 2-3 times. This required substantial improvements in the design of machine tools, primarily to increase their rapidity and power. A similar phenomenon was also observed when carbide was used as a tool material.

The tool material should have a high hardness to be able to cut chips for a long time. A significant excess of the tool material hardness as compared with hardness of the workpiece must be maintained during heating. The ability of tool material to maintain its hardness at a high temperature of heating determines its red hardness (heat resistance). The cutting part of the tool must have high wear resistance under high pressures and temperatures.

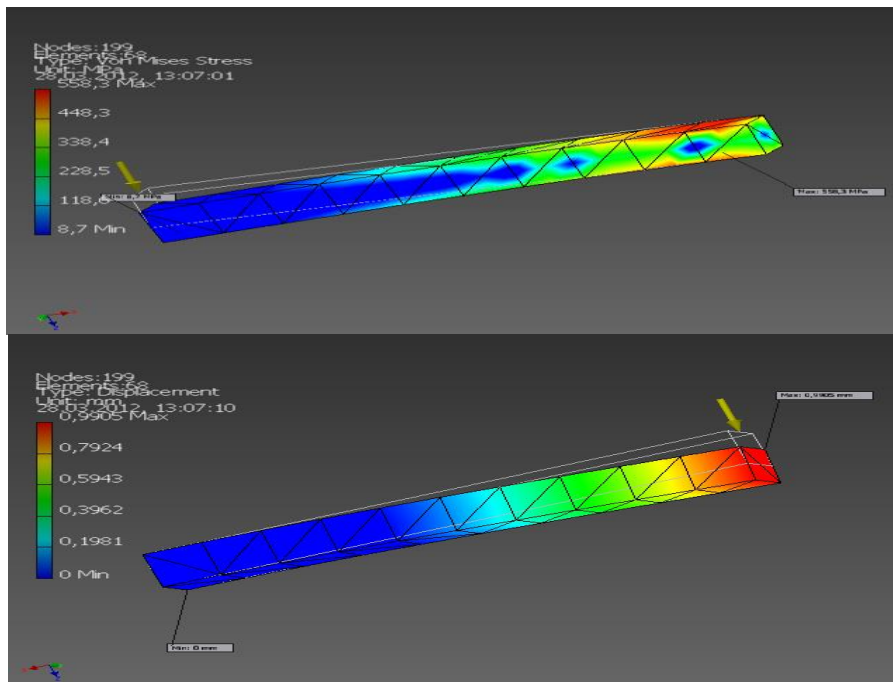
An important requirement is a sufficiently high strength of the tool material, as insufficient strength of cutting edges causes tool breakage when mowing.

Tool materials must have good processing properties, i.e. they must be easily handled during manufacture and regrinding tools as well as be relatively inexpensive.

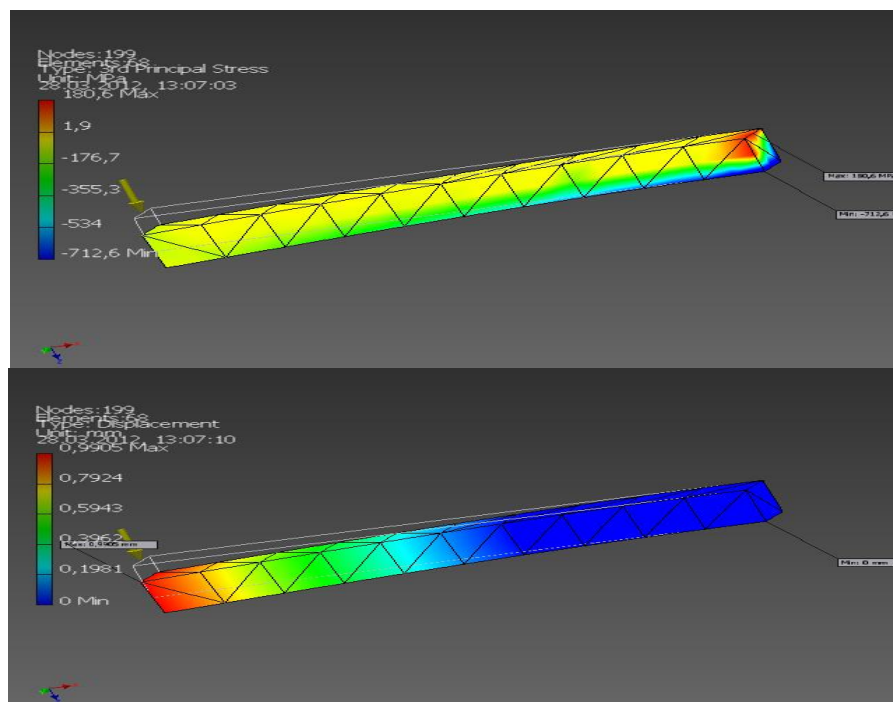
Currently, for the manufacture of cutting tools, steel elements are used (carbon, alloyed and high-speed), carbides, mineral ceramic materials, diamonds and other superhard and abrasive materials.

The study was conducted with the purpose of selecting the optimal tool material for machining steel 20X13. The two options of tool materials have been proposed: single-carbide hard alloy VK8 and three-carbide hard alloy TT8K6. To refine the selection, I analyzed the stress-strain state of the material and conducted the thermal material analysis. The results of the study are described below.

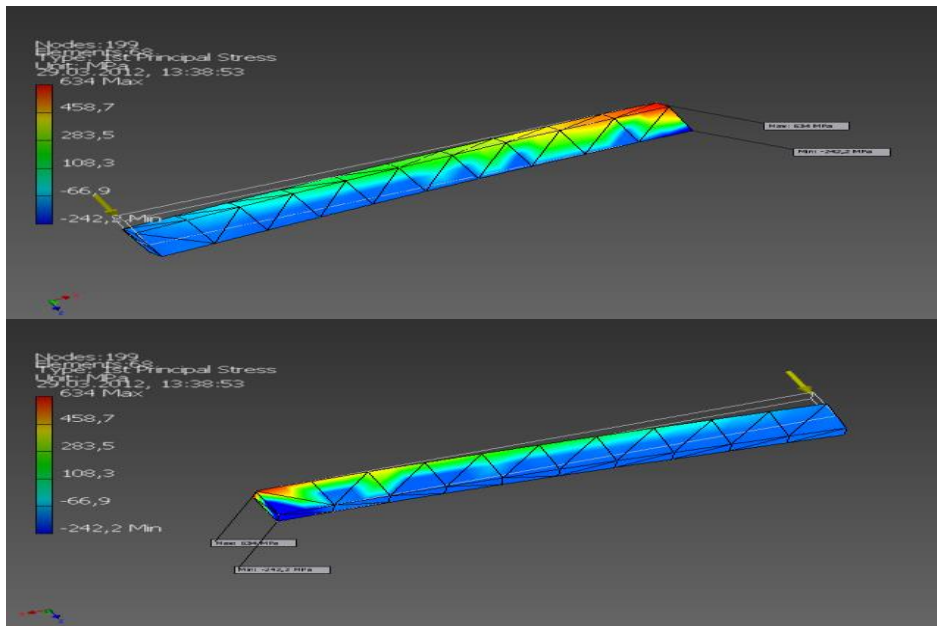
*The results of the stress strain analysis of the material condition.*



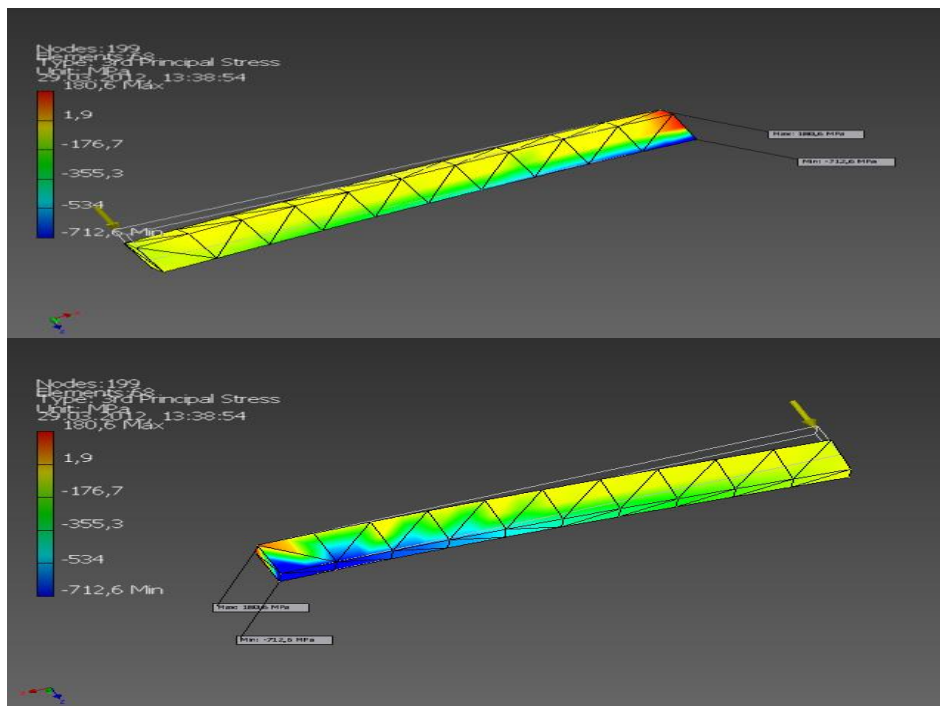
*Fig. 1 – The first basic voltage BK8*



*Fig. 2 – The second main voltage BK8*



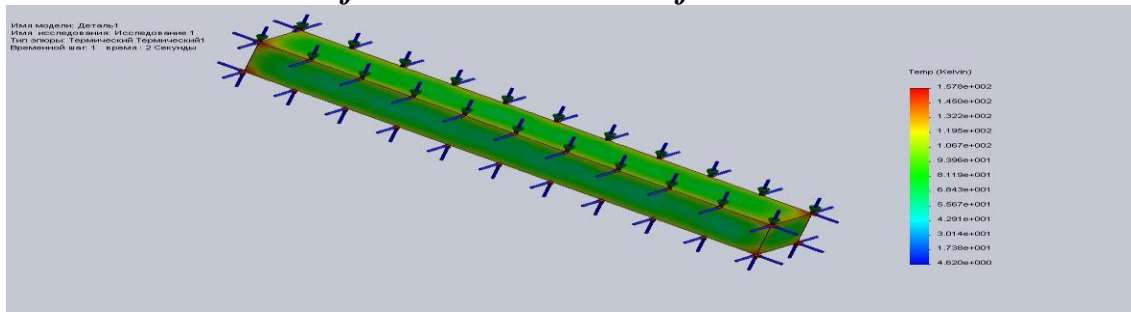
*Fig. 3 – The first basic voltage TT8K6*



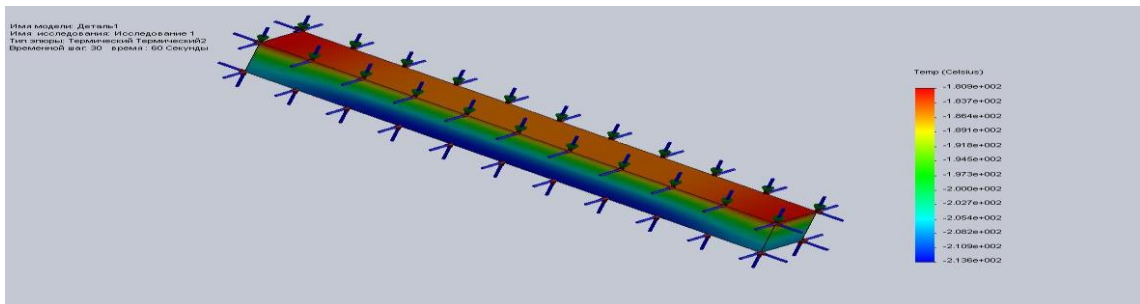
*Fig. 4 – The second main voltage TT8K6*

From the analysis of the voltage of the two materials BK8 and TT8K6 it is clear that the processing of the application of the best TT8K6 material. Because TT8K6 safety factor =  $3.05 > 2.52$  BK8.

## *The results of the thermal analysis of material status* *Calculation of the heat resistance of a tool material BK8*

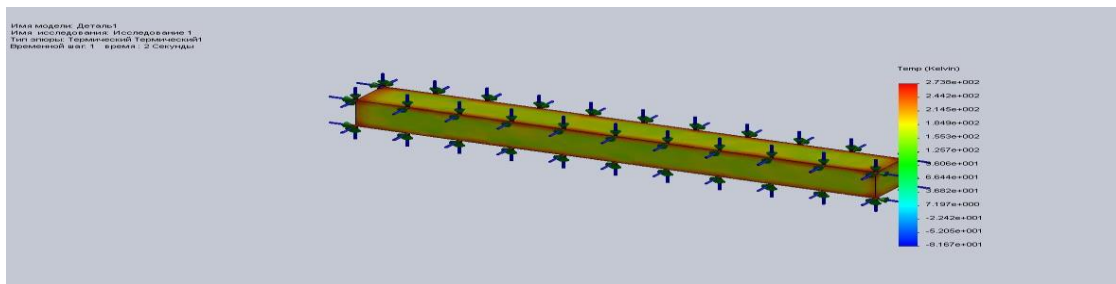


*Fig. 5 - Detail - Study 1 – Thermal*

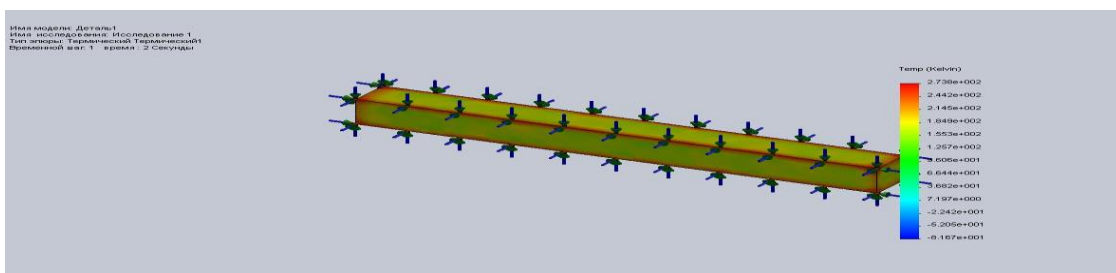


*Fig. 6 - Detail - Study 2 - Thermal*

## **Calculation of the heat resistance of a tool material TT8K6**



*Fig. 7 - Detail - Study 1 – Thermal*



*Fig. 8 - Detail - Study 2 - Thermal*

From the analysis of the heat resistance can be seen that the tool with the material handling TT8K6 harvesting less stable heat resistance than tool BK8 material.

The studies showed that for 20X13 working steel is preferred from the tool three-carbide TT8K6 carbide due to better heat resistance and high strength.

### **References**

1. Khvatov V. N., Zubkov D. V., Rodina A.A. Исследование производительности шлифования абразивными лентами с самозатачивающимся зерном. [Research performance grinding with

- abrasive belts self-sharpening grain.] / Bulletin of Tambov state technical University. 2012. T. 18. No. 4. P. 1031-1037. (in Russian)
2. Pestretsov S. I., Rodina A.A. Математическое моделирование процесса зенкерования и оптимизация геометрических параметров режущего инструмента в среде solidworks premium 2012. [Mathematical modeling of reaming process and optimization of geometrical parameters of cutting tools in SolidWorks premium 2012.] /Pestretsov S. I., Rodina A.A. Problems of contemporary science and practice. University. V. I. Vernadsky. 2012. No. 3. P. 37-41. (in Russian)
3. Khvatov, B. N. Технологическое обеспечение качества поверхности при механической обработке. Учебное пособие. [Technological provision of the quality of the surface when machined. Training manual.] [Electronic resource] / B. N. Khvatov, A. A. Rodina. Tambov: Publishing house of TSTU, 2012. - 80. (in Russian)
4. Vanin V.A., Kolodin A.N., Rodina A.A. Кинематическая структура металлорежущих станков с гидравлическими муфтами [Kinematic structure of metal-cutting machines with hydraulic couplings]/ Russian Engineering Research 34 (12). 2015, pp 763-768. (in Russian)

## ИССЛЕДОВАНИЕ ИНСТРУМЕНТАЛЬНЫХ МАТЕРИАЛОВ С ПРИМЕНЕНИЕМ ПРОГРАММ ТВЕРДОТЕЛЬНОГО МОДЕЛИРОВАНИЯ

**Э.О.Наумов**

Тамбовский государственный технический университет, Россия, Тамбов

*e-mail:neuh94@yandex.ru*

***Аннотация:** в статье приводится исследование оптимального выбора инструментального материала для обработки стали 20Х13 на напряженно-деформированное состояние материала и тепловой анализ материала, используя программы твердотельного моделирования.*

***Ключевые слова:** инструментальный материал, напряженно деформированное состояние, тепловой анализ, программа твердотельного моделирования. твердый сплав.*

---

УДК 620.1  
ББК 32.88-5

## DEVELOPMENT OF ENERGY-SAVING TECHNOLOGY OF MULTILAYER ELECTRICALLY-CONDUCTIVE MATERIALS UNDER CONTINUOUS QUALITY CONTROL

**A.A. Suleev**

Tambov State Technical University, Tambov, Russia

*e-mail: Artem-suleev@yandex.ru*

***Abstract:** This paper proposes the ways to modernize the existing methods of layered metallic materials production that reduce energy consumption by eliminating the intermediate annealing operations, shortening the production time and improving the quality of the finished material due to the introduction of information and measuring system of quality characteristics control.*

***Keywords:** bimetal products, cold controlling of bimetallic materials, composite materials, energy-saving, non-destructive methods.*

Layered composite materials, including bimetal products, are increasingly coming into use in modern technical equipment because composite materials allow obtaining products with high corrosion resistance, electrical conductivity, wear resistance, etc. At the same time, the problem of development and application of energy-saving technologies of such materials production is becoming more urgent.

This paper proposes the ways to modernize the existing methods of layered metallic materials production that reduce energy consumption by eliminating the intermediate annealing operations, shortening the production time and improving the quality of the finished material due to the introduction of information and measuring system of quality characteristics control.

The solution to this problem lies in the modernization of conventional methods of cold controlling of bimetallic materials with simultaneous impact of high density pulse current and subsequent control of the quality characteristics of finished bimetal. The quality control is carried out directly in the production process by non-destructive methods.

The structure of information and measuring system consists of the separate channels for the control of geometrical parameters of initial half-finished products after their preparation for cladding, the control of the bonding strength of layers and the ratio of their thickness after cold rolling, as well as the determination of the material rate before and after the rolling mill [1-2].

The peculiarity of the proposed method is that the conventional co-rolling of sheet material is effected by high density pulse current, which leads to the appearance of so-called electroplastic effect. This effect was discovered in 1970 and is used mainly for the plastic deformation of single materials (wire drawing, rolling of steel sheet, etc.). This paper suggests the use of this effect for the rolling of bimetal, as it will increase the bonding strength of layers due to the temporary loss of strength of materials and the increase of their plasticity under the influence of this effect.

It is known that the temperature of the substance increases under current exposure, while its power increases in accordance with the following law

$$Q = c \cdot m \cdot \Delta T = P_{im} \cdot t_{im} = U \cdot I \cdot t_{im} = U \cdot I \cdot S \cdot t_{im}, \quad (1)$$

where  $P_{im}$  is pulse power;  $U$  is pulse current voltage;  $I$  is current;  $J$  is current density;  $S$  is area through which the current flows;  $t$  is impulse time.

The dependence of the temperature alteration on the parameters of root-mean-square current is determined from this equation

$$\Delta T = \frac{U \cdot I \cdot t_{im}}{c_{ar} \cdot d_c \cdot S \cdot g_{ar}}. \quad (2)$$

Then we will assess the thickness of the diffusion layer for one-dimensional case by the following formula

$$x = \sqrt{-4 \cdot D_0 \cdot e^{-\frac{E_0}{R \cdot T}} \cdot t_{im} \cdot \ln \frac{c}{1}}, \quad (3)$$

$$\sqrt{4 \cdot \pi \cdot D_0 \cdot e^{-\frac{E_0}{R \cdot T}} \cdot t}$$

where  $D$  is diffusion coefficient;  $E_a$  is activation energy;  $R$  is gas constant;  $t$  is

interaction time;  $T$  is absolute temperature;  $D_0$  is pre-exponential factor;  $x$  is depth of diffusing material penetration;  $c$  is density of probability of atom location at distance  $x$  at time  $t$ .

The calculations have shown that the temperature in the contact zone between layers under the influence of pulse current reaches about 1400°K, this leads to the formation of solid solution of two materials, and the thickness of one layer material penetration into another is approximately  $d_{cl} = 2,5 \cdot 10^{-5} \text{ м}$  for the whole area in the zone of plastic deformation. It suggests that this production technology provides the reliable bonding of layers with guaranteed diffusion of one layer into another, which in turn helps to reduce the pressure on the rolls and contributes to the subsequent elimination of energy-intensive annealing operation for structure normalization.

*\*The work is performed under the supervision of Ph. D. in Engineering Sciences, Associate Professor of the department "Radio Engineering" S.P. Moskvitin*

### References

1. Moskvitin S. P. Razrabotka kompleksnogo metoda kontrolja harakteristik kachestva bimetalla v processe proizvodstva: Dis. k-ta. teh. nauk. [Development of Complex Method of Bimetal Quality Characteristics Control during Production: Ph.D. Thesis in Engineering Sciences.] Tambov, 2009. (Rus)
2. Patent 2356711 Russian Federation, B 23 K 20/4, B 32 B37/10, 21 B 38/00. Sposob izgotovlenija bimetalla [A Method of Bimetal Manufacturing] / S. P. Moskvitin, A. P. Pudovkin, E. E. Chvanov; the applicant and the patentee Tambov State Technical University. № 2007122210/02; stated 13.06.07; published 27.05.09, Bulletin number 15. 11 p. (Rus)

## РАЗРАБОТКА ЭНЕРГОСБЕРЕГАЮЩЕЙ ТЕХНОЛОГИИ ПРОИЗВОДСТВА МНОГОСЛОЙНЫХ ЭЛЕКТРОПРОВОДЯЩИХ МАТЕРИАЛОВ С НЕПРЕРЫВНЫМ КОНТРОЛЕМ КАЧЕСТВА

**А.А. Сулеев**

Тамбовский государственный технический университет, Тамбов, Россия  
*e-mail: Artem-suleev@yandex.ru*

**Аннотация:** Предлагаются пути модернизации существующих методов производства слоистых металлических материалов, позволяющих снизить энергозатраты за счет исключения операций промежуточного отжига, сократить сроки производства и повысить качество готового материала за счет введения информационно-измерительной системы контроля характеристик качества.

**Ключевые слова:** биметаллы, холодный контроль биметаллического производства, композитные материалы, энергосбережение, неразрушающий контроль.

## PROCESS ENGINEERING OF APPLYING POLYMERIC-SOLUTION-BASED SOUNDPROOFING AND PROTECTIVE MATERIALS ON THE PARTS OF VEHICLE

I.K. Furletov, I.A. Parshin

Tambov State Technical University, 392000, Tambov, Russia

e-mail: phurletov1994@yandex.ru

**Abstract:** *Improvement of acoustic comfort of a vehicle is one of the important problems for car drivers. In this article, we will consider the process engineering of applying polymeric-solution-based soundproofing materials on the parts of a vehicle. Safety precautions during the performance of work are considered as well.*

**Keywords:** *acoustic comfort, polymeric solutions, soundproofing materials, vehicle.*

The high level of acoustic comfort in the driver's cabin is one of the most important tasks in the production and tuning of vehicles. Car assembly lines, specialized centers and tuning shops use different technologies. The demand for services on soundproofing of vehicles creates supply and, consequently, stimulates producers of equipment and materials to improve their products and develop new ones.

Taping of internal and some external surfaces with soundproofing or damping materials has been considered a traditional method of aftermarket sound insulation of a vehicle until recently. This paper proposes to use solutions, which are based on polymers for enhancing the acoustic comfort.

Polymeric materials are increasingly used in the production of vehicles, especially the application of polymers on different surfaces. This paper proposes to use soundproofing compositions based on polymer solutions for enhancing the acoustic comfort of a vehicle.

The polymer solutions are of great practical importance. The use of polymers in the manufacture of plastics, varnishes, adhesives, films, artificial fibers is associated with the processes of dissolution of polymers.

The literature survey [1 - 6] clarifies that one of progressive methods of using of polymeric materials is sound insulation of the vehicle and the application of protective coatings, including insulating. This paper proposes to improve the ergonomics of a vehicle by enhancing its acoustic comfort. The choice of avenues of research is relevant because all auto enthusiasts today are concerned about the level of comfort of their vehicles.

In the process of noise insulation of a vehicle, the preparation of the treated surface is an important step. It comprises the removal of all impurities from the surface before applying the material; removal of the plugs covering the technological holes, drilling of additional holes using special drills if necessary; removal of all detached old coatings and pockets of rust using a metal brush or another tool;



washing and drying of the car bodywork; blowing with dry compressed air of hidden cavities and seams to remove moisture; removal of the remains of rust, using a convertor; protecting the parts that are not subject to treatment with tape or paper from the insertion of the applied materials. Special attention should be given to electrical connectors and sensors. The bare metal surfaces are recommended to prime before applying soundproofing composition. It is advisable to use an effective anticorrosive primer to create an additional layer of protection and enhance the adhesion of the treated surface.

The next step is treatment of hidden cavities. It is advisable to use tools and extensions for better access to hard-to-reach areas. Special nozzles are inserted into the part and soundproofing composition is applied under high pressure. The composition can be applied on the open surfaces, using anticorrosive mastic or brush. Coating should be dried for at least 8 hours after applying the composition. At the end of work, the tape is removed and the removed plugs are reinstalled. The car bodywork is wiped with special compositions to remove dirt.

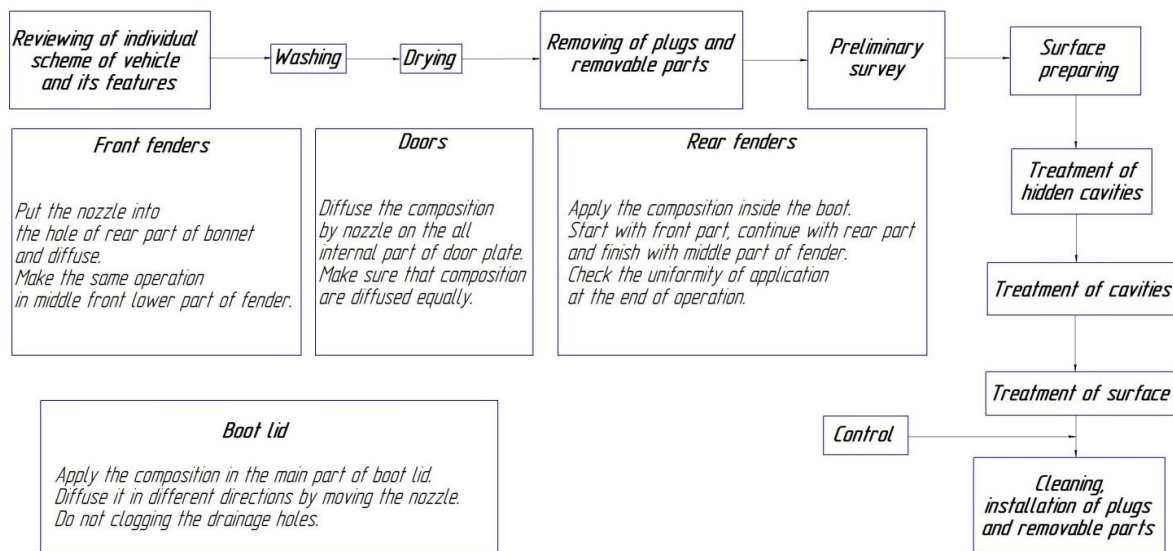


Fig.1 – Process engineering of applying of polymeric-based soundproofing materials

The process of applying soundproofing coating is shown in Fig. 1.

Soundproofing materials must comply with the following safety precautions:

3. Keep the materials in tightly closed package away from sources of heat and electrical devices;
4. Keep the materials out of reach of children and pets;
5. Do not spray solvent-borne materials near an open flame;
6. Work in a well ventilated area or outdoors;
7. Use individual protective gear, namely, goggles or mask, respirator, gloves and overall;

Thoroughly wash hands and face with soap and water after completing work;  
In case of contact with skin or eyes, rinse it with plenty of water.

### References:

1. Kobzev D.E., Osnovy remonta i vosstanovlenija detalej mashin i mehanizmov. Tverdogaznye metody poluchenija detalej iz polimernyh materialov [The basics of repair and restoration of details of machines and mechanisms. Solidphase methods of manufacturing parts from polymeric materials]/ D.E. Kobzev, G.S. Baronin, P.V. Kombarova, Ju.E. Glazkov, A.V. Prohorov // Uchebnoe posobie. Tambov. Izdvo Pershina R.V., 2015. - 100 s. (Rus)
2. Panimatchenko A.D. Pererabotka plastmass [Plastics Recycling], izd. Professija, Spb 2005. . (Rus)
3. Karjakina M.I., Popcov V.E. Tehnologija polimernyh pokrytij: Uchebnoe posobie dlja Tehnikumov [Polymer coating technology: testbook]. – M.: Himija, 1983 – 336s., il. . (Rus)
4. Jakovlev A.D., Zdor V.F., Kaplan V.I. Poroshkovye polimernye materialy i pokrytija na ih osnove [Powdered polymer materials and coatings based on them]. L., Himija, 1979. 254 s. . (Rus)
5. Rojh I.L., Kaltunova L. N. Zashhitnye vakuumnoe pokrytija na stali [Protective coatings on steel]. M.: Mashinostroenie, 1971. – 280 s. . (Rus)
6. Krasovskij A.M., Tolstopjatov E.M. Poluchenie tonkih plenok raspyleniem polimerov v vakuume [Manufacturing of thin tapes by diffusing of polymers in the vacuum]. / Pod red. Belogo V.A. - Mn.: Nauka i tehnika, 1989. – 181 s. . (Rus)

## РАЗРАБОТКА ТЕХНОЛОГИЧЕСКОГО ПРОЦЕССА НАНЕСЕНИЯ ШУМОИЗОЛЯЦИОННЫХ И ЗАЩИТНЫХ ПОКРЫТИЙ НА ОСНОВЕ РАСТВОРОВ ПОЛИМЕРОВ НА ДЕТАЛИ АВТОМОБИЛЯ

**И.К. Фурлетов, И.А. Паршин**

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: phurletov1994@yandex.ru*

***Аннотация:** Повышение акустического комфорта автомобиля является актуальным вопросом для современных автолюбителей. В данной статье мы рассмотрим технологический процесс нанесения шумоизоляционных покрытий на детали автомобиля. Также будут рассмотрены необходимые меры безопасности при выполнении данного типа работ.*

***Ключевые слова:** автомобиль, акустический комфорт, полимерные растворы, шумоизоляционные материалы,*

УДК 656.051

ББК 39.311

### IMPROVEMENT OF ROAD TRAFFIC ORGANIZATION ON KARL MARX STREET IN TAMBOV

**K. V. Istomina, N. A. Minkin**

Tambov State Technical University, Tambov, Russia

*e-mail: www.314515@mail.ru*

**Abstract:** *The article discusses the problems of traffic safety in the city of Tambov, Russia. The ways of improving the organization of traffic in Karl Marx Street are proposed.*

**Keywords:** *congestion, contra-flow traffic, road capacity, traffic delays, traffic flow, traffic intensity, traffic jams.*

#### **Introduction**

In the Russian Federation, over the past decade there has been high growth rate of motorization. During this period the number of vehicles has increased by more than 2 times. Currently, 1000 Russians have 284 units of all types of vehicles. The total number of motor vehicles is more than 48 million units. [1]

Recently, transport sector is increasingly becoming a bottleneck for economic growth, despite its dynamic development.

#### **Methods and Materials**

Traffic conditions in urban areas are increasingly complex. The annual growth of traffic is 10-20%, however the capacity traffic of the road network does not exceed 5%. The road network in many large and medium cities has already exhausted its traffic capacity, road accidents, congestions and traffic jams are typical for many road networks in cities. The average speed of traffic has decreased in many parts of the road network over the past 5 years by almost 40% and in metropolitan areas it reaches 15-30 km/h, in the big cities it is 20-40 km/h, and in the "rush hour" it falls to 5 -10 km /h. [1]

In the city of Tambov, the problem of insufficient development of the road network is primarily due to the historical buildings, and narrow streets. Therefore, the city of Tambov has limited opportunities to expand the roadway.

The high rates of motorization create additional preconditions for the deterioration of the situation with the accident rate on the roads. The annual fleet growth in the city has been from 5 to 15 thousand units over the last three years. Currently, 1,000 residents own for more than 250 cars, and, as shown by the analytical data in a few years, the number of cars per thousand people will be 300 - 350. [2]

The aim of the study is development of measures aimed at increasing the capacity of the road network in the city of Tambov.

After analyzing the traffic situation in the city, the site on which the unevenness is observed daily and constant congestion is Karl Marx street.

The object of research is Karl Marx street. This street is one of two in the city, which connects the northern and central part of the city. It plays an important role in solving transport problems of farm located in the area of economic development.

The uneven traffic flow on Karl Marx street during the day is observed at the intersection area from the street. Proletarskaya street to the Magistralnaya street. The busiest sections are of K. Marx street intersection with streets Ryazanskaya street, Pushkarskaya street, Boulevard Enthusiastov street, Schlichtera street.

*Table 1 - Indicators of intersections congestion in K. Marx street*

The name of the intersection	Number direction	$N_{ji}$ , units/h.	Number of bands	$\Pi_{cji}$ , units./h.	$K_{zji}$
1. Karl Marx street – Ryazanskaya street	1	1568	1	1800	0.87
	2	1422	1	1960	0.73
2. Karl Marx street– Pushkarskaya street	1	1704	1	1980	0.86
	2	1496	1	1880	0.8
3. Karl Marx street– Boulevard Enthusiastov street	1	1244	1	1860	0.67
	2	900	1	1820	0.5

The congestion factors at intersections are almost 1. This indicates congestion at intersections in the "rush hour".

One of the method of the organization of traffic, appropriate for busy roads, which can increase the road capacity is contra-flow traffic.

The main criteria for the feasibility of the introduction of contra-flow traffic are regular "pendulum flows" when a traffic flow has a ratio of 1: 3 and the presence of 3 or more lines [3].

The analysis of the intensity of vehicle traffic showed non-uniformity of traffic in the morning (from 8-00 to 9-00 hours) and evening (from 18-00 to 19-00 hours) "rush hour". Figure 1 shows the traffic flow in Karl Marx street during "rush hour".

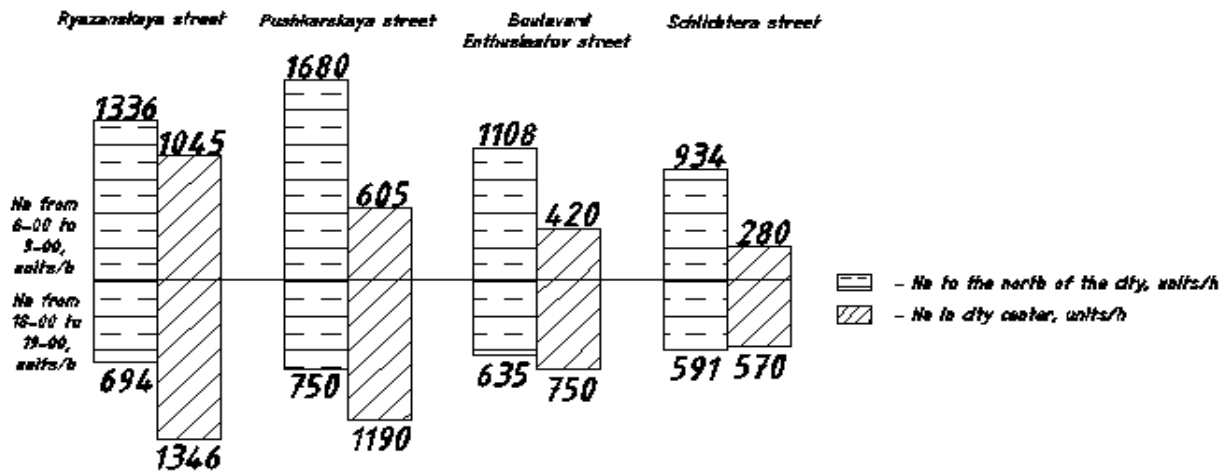


Fig. 1 - The intensity of the traffic flow in Karl Marx street in "rush hours"

Analysis of the intensity of traffic flow on Karl Marx street satisfies introduction of contra-flow traffic is regular "pendulum flows" in the ratio of 1: 3.

The presence on this stretch of road 3 lanes satisfies the second condition for the introduction of this method of organization traffic.

### Results and Discussion

Based on the above it can be concluded that the introduction of contra-flow traffic on Karl Marx street (in the intersection area from Proletarskaya street to Magistralnaya street) road capacity increases by 2 times, congestions factors are in the normal range, indicating free movement of vehicles on the lanes (Table 2).

Table 2 - Indicators of congestion at intersections of Karl Marx street in the projected conditions

The name of the intersection	Number direction	$N_{ji}$ , units./h	Number of bands	$\Pi_{cji}$ , units./h.	$K_{zji}$
1. Karl Marx street – Ryazanskaya street	1	1388	2	3960	0.35
	2	1390	2	3970	0.35
2. Karl Marx street – Pushkarskaya street	1	1692	2	3993	0.42
	2	1452	2	3860	0.38
3. Karl Marx street –Boulevard Entusiastov street	1	1136	2	3976	0.29
	2	800	2	3940	0.2

The contra-flow traffic lane is usually the middle lane which allows the direct movement. The far right lane allows the movement to the right.

The work of contra-flow traffic lights is developed in accordance with the traffic intensity.

The calculation results showed a significant increase in road capacity, as well as reduction in the negative impact of vehicles on the environment and reduction in the

delays of vehicles at intersections.

### References

1. Pugachev I. N. Organizacija i bezopasnost' dvizhenija. [Organization and traffic safety] / I. N. Pugachev. - Habarovsk: Izdatel'stvo HGTU, 2004. – 231s. (Rus)
2. Municipal'naja programma goroda Tambova "Povyshenie bezopasnosti dorozhnogo dvizhenija v gorode Tambove" na 2014 - 2020 gody". [The municipal program of Tambov "Improving road safety in the city of Tambov" on 2014 - 2020 years.]. (Rus)
3. Metodicheskie rekomendacii po proektirovaniju avtomobil'nyh dorog na podhodah k krupnym gorodam. [Guidelines for the design of roads on the approaches to major cities] - Moscow, 2010. – 186s. (Rus)

## СОВЕРШЕНСТВОВАНИЕ ОРГАНИЗАЦИИ ДОРОЖНОГО ДВИЖЕНИЯ НА УЛИЦЕ КАРЛА МАРКСА В ГОРОДЕ ТАМБОВЕ

**К.В. Истомина, Н. А. Минкин**

Тамбовский Государственный Технический Университет, Тамбов, Россия  
*e-mail: www.314515@mail.ru*

*Аннотация:* в статье исследуется проблематика дорожного движения в городе Тамбове, а так же предлагается совершенствование организации дорожного движения на ул. Карла Маркса.

*Ключевые слова:* дорожная “пробка”, реверсивное движение, пропускная способность дороги, задержки движения, транспортный поток, интенсивность движения, затор.

---

УДК 625.7 = 111

ББК 0311-044

К - 83

## ANALYSIS OF PAVEMENT REPAIR USING ASPHALT MIXTURES IN URBAN ENVIROMENT

**V.S. Krivopalov, A.A. Gavrikov, A.D. Poplevin**

Tambov State Technical University, Tambov, Russia  
*e-mail: Krivopalov.1993@mail.ru*

*Abstract:* The analysis of the current state of urban roads and streets is given. The typical pavement defects are described and analyzed. The methods and equipment used to perform the work connected with the road surface repairs in urban environments are considered. Advantages and disadvantages of the methods are exemplified. The recommendations that improve the quality of pavement repair using modern equipment and technology are given.

*Keywords:* asphalt, mixture, network, pavement, repair, road.

The length of the road network is about 331.9 km in Tambov. The total area is more than 3310 thousand m<sup>2</sup>. Currently, 70% road of urban roads and streets is in an

unacceptable condition. Some streets have not been repaired for more than 20-25 years. We conduct an analysis of the most common defects on the city roads according to the standards 218.1.052-2002 "Evaluation of the strength of non-rigid road pavements"

At present, the streets of the road network of the city are not in the best condition. Maintenance periods of capital repairs are not observed. Currently, the frequency of repairs of city roads is every six 6 years. As for capital repairs, the period is 13 years. The length of the service life of the pavement depends on current repairs and maintenance of roads.

The maintenance and repair of the road surface is carried out all year round, including spring and autumn, summer and winter periods. Depending on the time of the year (ambient air temperature, precipitation, etc.) repair and restoration of the road surface are done by various methods, which are discussed below.

1. Fig. 1 shows repairing of asphalt pavement using hot bituminous material. This method is appropriate in case of positive ambient temperatures and low humidity.



*Fig. 1. Repairing of asphalt pavement using hot bituminous material.*

2. Fig. 2 shows pavement repairing with cast asphalt by "recycling" road equipment. This method allows us to produce patching at considerably lower ambient temperatures and high humidity (temperature of the mixture is 190 °C).



*Fig. 2. Pavement repairing with cast asphalt by "recycling" road equipment.*

3. Fig.3 shows repairs of pavement with injection method. The method of pneumatic spraying of a mixture of emulsion and stone powder is used. The work is done by road repairer "Madpatcher". In this method, the ambient temperature must be above zero.



Fig. 3. Repair of pavement with injection method.

The selection of technological process with patching must meet the following requirements and criteria:

- the quality of potholes must comply with the main part of the road surface (parameters of durability, density, smoothness and roughness);
- the durability of the repair area;
- the availability of the required materials and mechanisms to carry out repairs with a particular method;
- the ability to use the repair method for a variety of weather conditions;
- the economic feasibility of the applied technology of repair in the field.

Much attention should be paid to the preparation of the repaired section of the road, which should include the following steps:

- surface treatment of potholes;
- marking of the boundaries of intact coating layer (in the case of a few potholes, close at a distance of 3-5 cm, they are noted in one circuit);
- cutting the material on the marked loop on a pothole depth, but not less than the thickness of the coating layer, the side contour of the wall should be cut vertically;
- treatment of the walls and bottom potholes with liquid or liquefied bitumen, bitumen emulsion.

The temperature mismatch is the main disadvantage of asphalt patching. As a result, we get lack of its seal. It is manifested especially clearly in the joints between the edges of the main pavement. There is an initial destruction at the site of the joint.

### **Conclusion**

As the research of current patching shows, the most problematic periods of the year are autumn and spring, associated with high humidity (large amounts of precipitation and sharp temperature fluctuations), as well as the winter, which is characterized by a low negative ambient temperature, so and sudden changes in temperature at 0 °C. This fact leads to the rapid destruction of the road surface, and



the execution of works related to patching is not to observe the temperature seal of asphalt mix.

Organizations that work on the repair and maintenance of urban roads and streets should provide year-round, continuous and safe movement of vehicles with preset speeds and loads, the safety of roads and road facilities.

The technology of work by using infrared heaters, or by the "adhesions". The name of a method refers that potholes joint place will be unnoticeable, and it will indicate the quality of the repair.

#### References

1. Vasiliev A. P. Ekspluatatsiya avtomobil'nykh dorog: uchebnyk dlya vuzov [Maintenance of roads: the textbook for high schools]. — M.: Academy, 2010. — 320 p. (Rus)
2. Zubkov A. F., Tekhnologiya ustroystva dorozhnykh pokrytiy s uchetom temperaturnykh rezhimov asfal'tobetonnykh smesey [The technology of road surfaces taking into account temperature of asphalt mixtures]. — Tambov: Publishing house Pershin R. V., 2006.-151с. (Rus)
3. SP 34.13330.2012. Avtomobil'nye dorogi. Aktualizirovannaya redaktsiya SNIp 2.05.02–85 [Road. The updated edition of SNIp 2.05.02–85\*]. (Rus)

## АНАЛИЗ МЕТОДОВ РЕМОНТА ДОРОЖНЫХ ПОКРЫТИЙ С ИСПОЛЬЗОВАНИЕМ АСФАЛЬТОБЕТОННЫХ СМЕСЕЙ В ГОРОДСКИХ УСЛОВИЯХ

**В.С. Кривопапов, А.А. Гавриков, А.Д. Поплевин,**

Тамбовский государственный технический университет, Тамбов, Россия

*E-mail: Krivopalov.1993@mail.ru*

***Аннотация.** Выполнен анализ текущего состояния покрытия городских дорог и улиц г.Тамбова. Приведены и описаны характерные дефекты дорожного покрытия. Указаны причины, вызывающие появление данных дефектов. Описаны методы и оборудование, применяемое для выполнения работ, связанных с ремонтом покрытий дорог в городских условиях. Приведены достоинства и недостатки, рассмотренных методов. Даны рекомендации, позволяющие повысить качество ремонта дорожного покрытия при имеющимся оборудовании и техники у специализированных организаций, занимающихся ремонтом и содержанием городских дорог и улиц.*

***Ключевые слова.** Асфальтобетонные смеси, дорожное покрытие, ремонт, улично-дорожная сеть.*

## IMPROVEMENT OF ROAD TRAFFIC ORGANIZATION AT INTERCHANGES IN TAMBOV

A. M. Strizhevsky

Tambov State Technical University, Tambov, Russia

e-mail: strizhstrizh72@yandex.ru

**Abstract:** *The article discusses the problems of traffic safety in the city of Tambov, Russia. Ways of improving the organization of traffic in one of the interchanges in Tambov are proposed.*

**Keywords:** *congestion, road capacity, traffic delays, traffic flow, traffic intensity, traffic jams.*

A large number of cars leads to an increase in traffic delays and accidents at interchangeы. In 2015 in Russia, over 1000 people had 284 units of vehicles. The total number of motor vehicles was more than 40 million units.

Roundabouts help to reduce the level of accidents. The advantages of roundabouts include:

- high traffic safety, which is achieved by reduction in conflict points (8 instead of 32) and the speed when approaching the interchange;
- increased road capacity, which is above normal compared to interchanges with traffic light control;
- improved environmental situation (less noise and exhaust from cars).

The disadvantages of roundabouts are as follows:

- they need a large area. The “island” in the middle cannot be used for traffic;
- organization of the flow of pedestrians and cyclists is complicated, as there is no traffic signalization. The length of pedestrian crossing is increased;
- congestion at the entrances when the traffic is heavy as cars can not enter the roundabout. But this disadvantage can be seen at conventional interchanges as well.

In the city of Tambov, the problem of insufficient development of the road network is primarily due to the historical buildings, and narrow streets. Therefore, the city of Tambov has limited opportunities to expand the roadway.

The high rates of motorization create additional preconditions for the deterioration of the situation with the accident rate on the roads. The number of cars has grown from 5 to 15 thousand units over the last three years. Currently, 1,000 residents own more than 250 cars, and, as shown by the analytical data in a few years, the number of cars will be 300 – 350 per thousand people.

The aim of the study is to develop the measures aimed at increasing the capacity of the road network in Tambov.

Having analyzed the traffic situation in the city, we propose to use roundabouts at the interchange of 40-let Oktybry and Kikvidze streets.

The object of research is the crossroad of 40-let Oktybry and Kikvidze streets. This crossroad is one of the two in the city, which distributes the flow of incoming cars from other cities and connects the western, northern and central parts of the city.

The uneven traffic at the crossroad is observed in the morning and evening.

Table 1 - Indicators of the crossroad of 40-let Oktybry and Kikvidze streets.

№	Type of vehicle	Direction 1			Direction 2			Direction 3			Direction 4		
		←	↑	→	←	↑	→	←	↑	→	←	↑	→
1	car (1)	516	348	130	17	93	51	10	84	28	64	92	26
				7	8	3	1	4	7	2	2	7	4
2	bus (2,5)	0	0	6	0	5	2	0	2	0	12	5	0
3	freight car (2)	12	6	10	1	7	12	2	18	3	12	10	0
Present traffic intensity		540	360	133	18	96	54	10	88	28	69	96	26
				2	0	0	0	8	8	8	6	0	4

The research on the traffic accidents showed that a large number of them occurred in the "conflict zones". This is the place where different movements of vehicles intersect in the same zone. Often, this happens at interchanges. Some conflicts occur at transpositions of cars in the lines (maneuvering) and during walking of pedestrians on the road but not at the interchange.

There is an opportunity to assess the potential danger areas according to the number of "conflict zones".

The number of interflows and junctions determines the traffic intensity in conflict zones. The intensity in the "conflict zones" is calculated by the formula (1):

$$m = 0,01 \left[ 1 \sum_{i=1}^{n_o} N_{oi} + 3 \sum_{i=1}^{n_c} N_{ci} + 5 \sum_{i=1}^{n_n} N_{ni} \right], \quad (1)$$

where  $n_o, n_c, n_n$  are the number of inflows and junctions;

$N_{oi}, N_{ci}, N_{ni}$  is the lowest intensity.

We determine the index for the existing interchange (before reconstruction):

$$m = 0.01 [1(264+288+360+180+360+696) + \\ +3(960+108+288+540+696+180)+5(888+888+360+360+696+888+888+360+540+360+1 \\ 80+180+180+180+180+108+108+108+108+108+108+360+888+888+360+360+360+180 \\ +696+696+108)] = 0.01 [1*2148+3*2772+5*12672] = 0,01*73824 \approx 738.$$

Figures 1 and 2 show the "conflict zones" at the interchange.

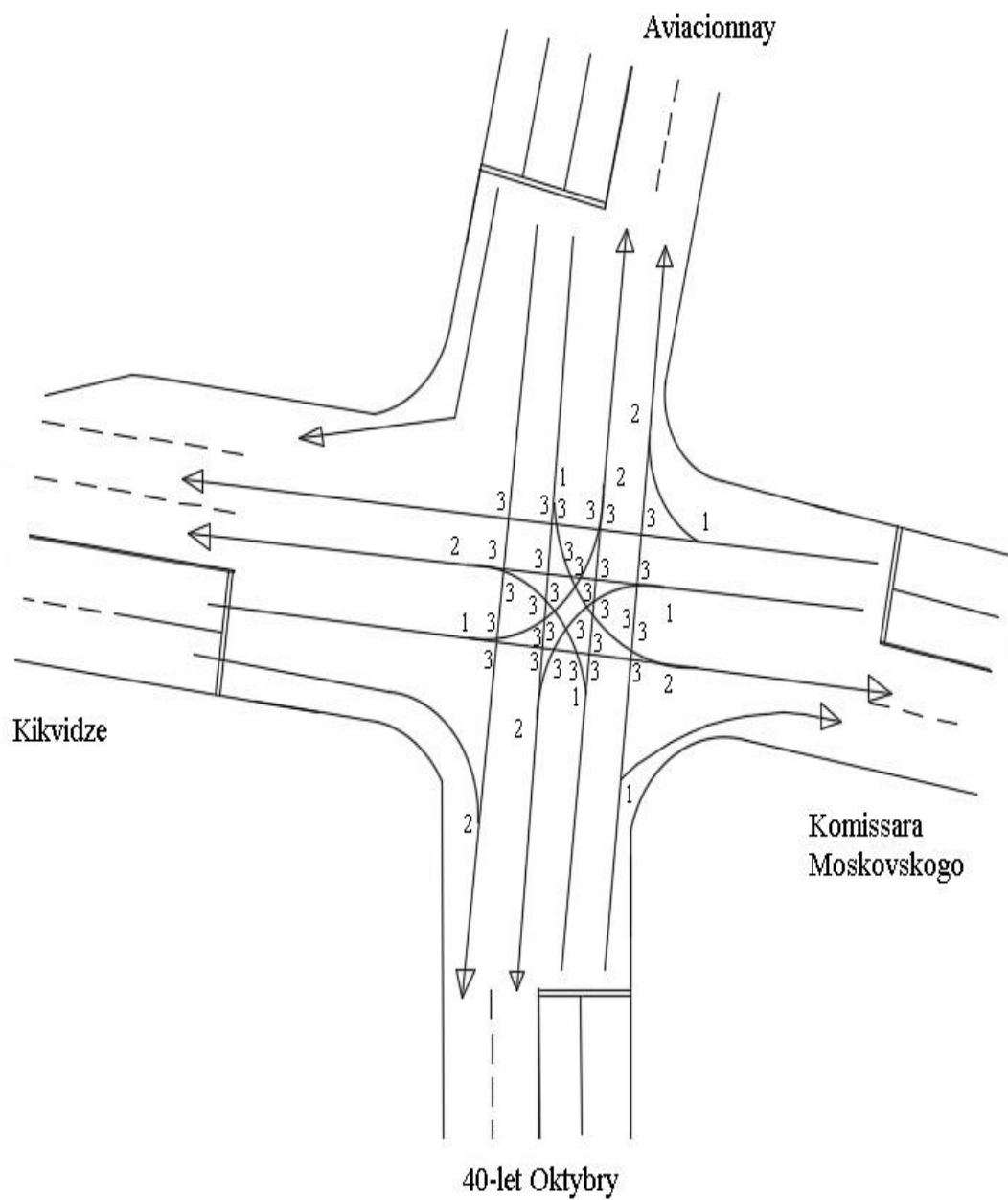


Fig. 1. "Conflict zones" at the interchange. 1 – deviation zones; 2 – inflow zones; 3 – intersection zones.

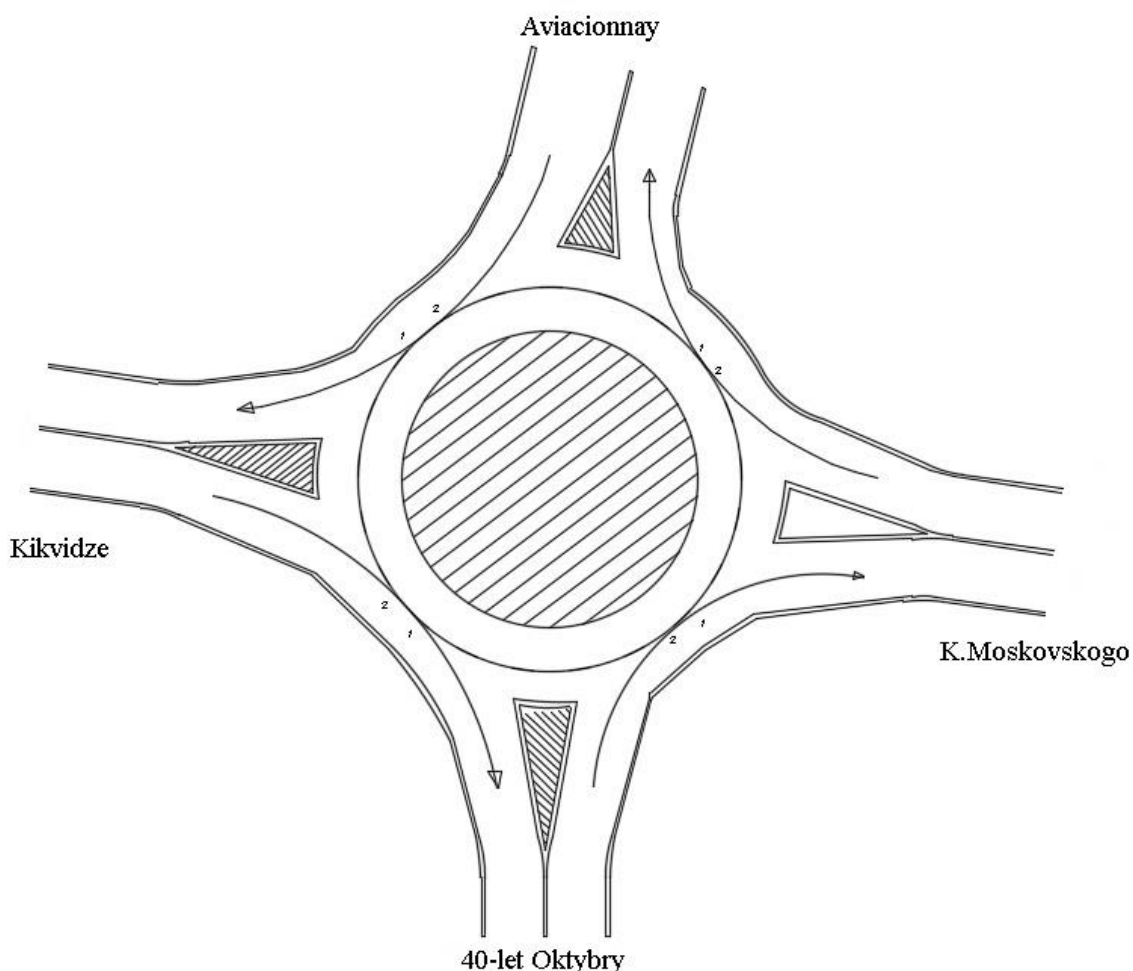


Fig. 2. "Conflict zones" at the interchange. 1 - deviation zones; 2 - inflow zones.

We calculate the index of conflict at the interchange after reconstruction:

$$m = 0.01[1(180+108+108+108) + 3(180+108+108+108)] = \\ = 0.01[1*504 + 3*504] = 0.01*2016 \approx 20$$

The analysis of "conflict zones" before the reconstruction and after the reconstruction showed that the number of accidents is lower at the roundabouts.

The construction of roundabouts can help to increase the road capacity and the speed, as well as reduce accidents.

### References

1. Municipal'naja programma goroda Tambova "Povyshenie bezopasnosti dorozhnogo dvizhenija v gorode Tambove" na 2013 - 2020 gody". [The municipal program of Tambov "Improving road safety in the city of Tambov" on 2013 - 2020 years.]. (Rus)
2. OTD Metodicheskie rekomendacii po proektirovaniju avtomobil'nyh dorog na podhodah k krupnym gorodam. [OTD Guidelines for the design of roads at the approaches to major cities] - Moscow, 2010. – 186s. (Rus)
3. Pugachev I. N. Organizacija i bezopasnost' dvizhenija. [Organization and traffic safety] / I. N. Pugachev. - Habarovsk: Izdatel'stvo HGTU, 2004. – 231s. (Rus)

# СОВЕРШЕНСТВОВАНИЕ ОРГАНИЗАЦИИ ДОРОЖНОГО ДВИЖЕНИЯ НА ПЕРЕКРЕСТКАХ В ГОРОДЕ ТАМБОВ

А.М.Стрижевский

Тамбовский государственный технический университет, Тамбов, Россия  
e-mail: strizhstrizh72@yandex.ru

*Аннотация:* Исследуется проблематика дорожного движения в городе Тамбове, предлагается совершенствование организации дорожного движения на одном из перекрестков города Тамбов.

*Ключевые слова:* дорожная “пробка”, пропускная способность дороги, задержки движения, транспортный поток, интенсивность движения, пробка, затор.

---

УДК 656.13  
ББК 39.3

## THE ANALYSIS AND WAYS OF REDUCING ROAD ACCIDENT RATE

D.A. Tarabrin, D.A. Syshnikov

Tambov State Technical University, Tambov, Russia  
e-mail: tarabrin.94@inbox.ru

*Abstract:* Accident rate on the roads is one of the main problems in the world. Road accidents in the world result in 1.3 million casualties and from 20 to 50 million people are injured. To reduce the accident rate we propose to increase traffic safety by taking the following measures: improve drivers training in driving schools; solve the problem of technical inspection of cars; increase the sizes of penalties; improve the condition of the road surface; to improve the organization of traffic on the road.

*Keywords:* road accidents, organization of road traffic, traffic regulations, traffic safety.

Road accidents (RA) in the world result in 1.3 million casualties and from 20 to 50 million people get injured. Most of them are young people aged from 15 up to 30 years. The growth in the accident rate and the number of road accidents is increasing because of the following problems: ignorance of traffic regulations, issue of medical certificates to people who for health reasons should not be allowed to drive cars; problem of technical inspection of cars, alcoholic or drug intoxication, organization of traffic, poor quality of roads, etc.

In the Russian Federation, the growth of road accidents fell in 2006 - 2007 and 2010 - 2013. Since 2013 a considerable recession of road accidents has been observed. In 2015, there were more than 180 thousand road accidents in which more than 23 thousand people died and more than 230 thousand were injured (Fig 1). [1]

In 2016, during the period from January to April there were already more than 40 thousand road accidents in which more than 4 thousand people died and more than 55 thousand were injured. [1]

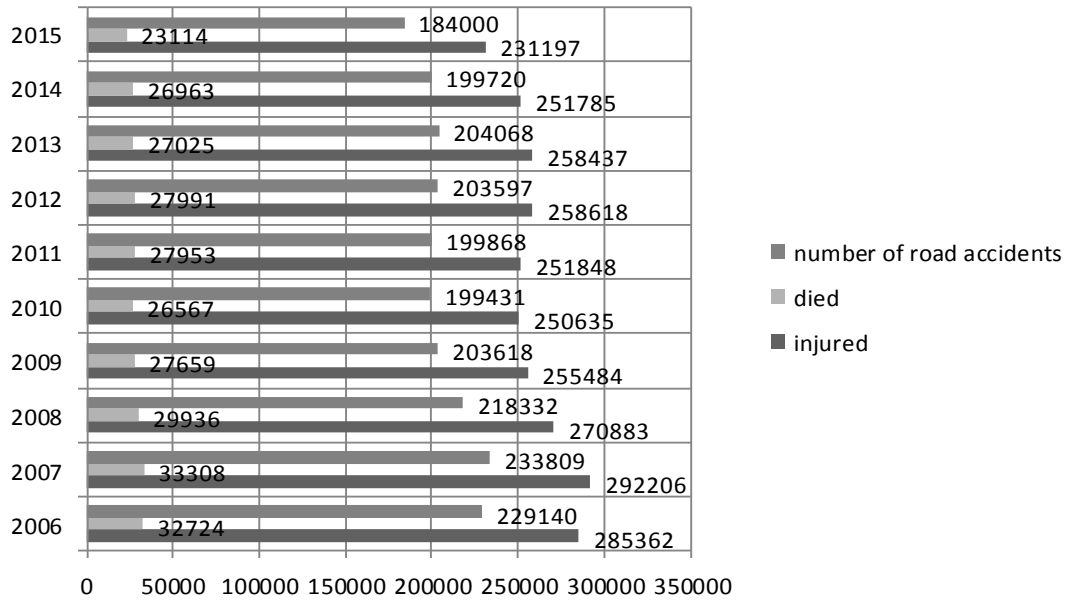


Fig.1 – The analysis of road accident rate in the Russian Federation for 2006-2015.

Generally, road accidents happen because of non-compliance with traffic regulations. In 2015, there were more than 26 million violators of traffic regulations including 23 million of drivers, more than 2 million of pedestrians and more than 190 thousands of passengers. [1]

In the Voronezh region the number of accidents decreased for 2012 – 2015. In 2015, there were more than 3 thousand traffic accidents, in which more than 500 people died and more than 4 thousand were injured (Fig 2). [1] From January till April, 2016 there were about 800 road and transport incidents in which more than 100 people died and more than 1 thousand were injured. [1]

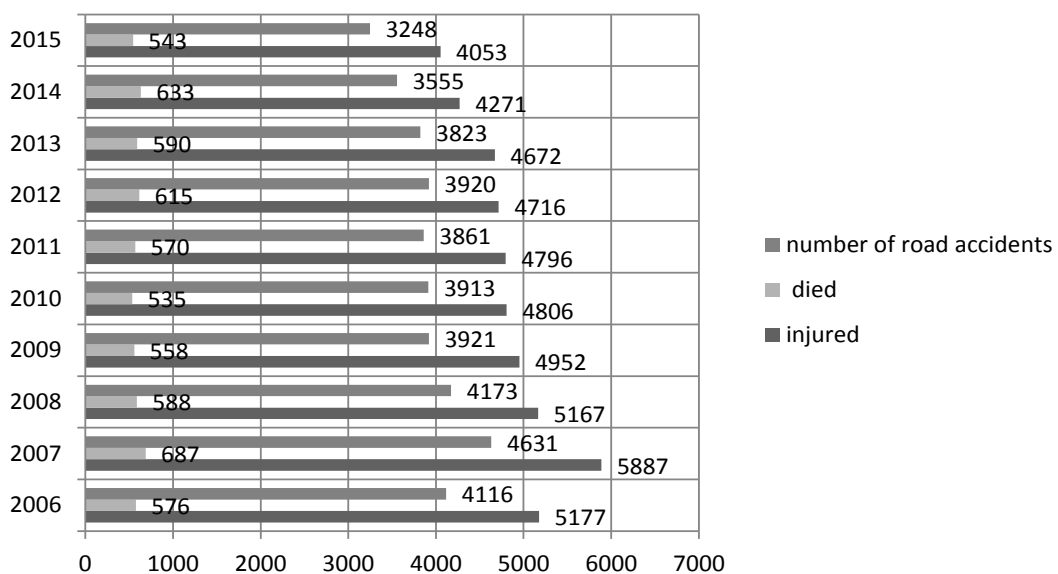


Fig. 2 - The analysis of road accident rate in the Voronezh region for 2006 - 2015.

In the Voronezh region in 2015, there were 230 thousand violators-drivers. Passenger cars registered more than 250 thousand violations, trucks had more than 20 thousand, buses had more than 4 thousand, and motorcycles had more than 4 thousand. [1]

To reduce the accident rate we propose to increase traffic safety by taking the following measures:

- improve drivers training in driving schools; organize a final examination on driving both in summer and in winter. It will allow drivers to behave more surely when driving in all seasons of the year.

- solve the problem of the technical inspection of cars. It is necessary to eliminate the human factor in conducting the technical inspection. The main technical inspection task is to ensure the safety of the vehicle on the road. The driver must be very interested in the fact that his car was undamaged. Because due to a faulty vehicle, of road accident can happen.

- to increase the sizes of penalties.

- to improve the condition of the road surface. The set of accidents happens because of an unsatisfactory condition of highways. To hold various events among road services.

- to improve the organization of traffic on the road: to organize various outcomes in different levels; roundabout; the unilateral, reversible movements; installation of traffic light objects; installation of the video cameras and radars monitoring violations of traffic regulations; for safety of pedestrians to build underground and elevated passages; to pay much attention to the movement in night-time, etc.

#### **References:**

1. Website State Traffic Safety Inspectorate Internal Affairs of Russia [Sajt UMVD GIBDD Rossii]. Available at: <http://www.gibdd.ru>
2. Pen'shin N.V. Obespechenie bezopasnosti dorozhnogo dvizhenija Avtotransport [Ensuring road safety Auto transport:]/ N.V. Pen'shin. V.A. Molodcov, V.S. Gorjushinskij - Izd-vo: FGBOU VPO «TGTU», 2012. - 115 s. (Rus)
3. Gus'kov A.A. Organizacija i bezopasnost' dorozhnogo dvizhenija: metod. ukazanija po vypolneniju rabot (kursovyh, diplomnyh, otchjotov po praktike) [Organization and road safety; guidelines for course and diploma projects] / A.A. Gus'kov, V.A. Molodcov. – Jelektron. dan. (871 Kb). – Tambov: Izd-vo GOU VPO «TGTU», 2010. (Rus)
4. Molodcov, V.A. Pravila i bezopasnost' dorozhnogo dvizhenija: uchebnoe posobie [Rules and road safety: guidebook] / V. A. Molodcov, A. A. Gus'kov. - Jelektron. dan. (88,5 Mb). - Tambov: FGBOU VPO "TGTU", 2015 (Rus)



# АНАЛИЗ И ПУТИ СНИЖЕНИЯ АВАРИЙНОСТИ

Д.А. Тарабрин, Д.А. Сыщиков

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: tarabrin.94@inbox.ru*

**Аннотация:** Аварийность на дорогах является одной из главных проблем в мире. В результате дорожно-транспортных происшествий (ДТП) в мире ежегодно погибает 1,3 миллиона человек и еще от 20 до 50 миллионов получают травмы. В статье приведен анализ аварийности в России и Воронежской области, а также рассмотрены следующие мероприятия по ее снижению: более тщательно относиться к обучению водителей в автошколах; решить проблему техосмотра; увеличить размеры штрафов; решить проблему дорожного покрытия; улучшить организацию дорожного движения на УДС.

**Ключевые слова:** безопасность дорожного движения, дорожно-транспортные происшествия; организация дорожного движения; правила дорожного движения.

---

УДК 656.025.2

ББК 39.808

## PROBLEMS OF PASSENGER TRANSPORT

М. А. Ushakova, Yu. O. Dmitrieva

Tambov State Technical University, Tambov, Russia

*e-mail: ushakova.marina@yandex.ru*

**Abstract:** The article considers the problems safety and quality of passenger transport, discusses the proposals of different authors and offers the author's point of view.

**Keywords:** method, passenger transport, problems of passenger transport, safety traffic, quality.

### Introduction

I report here on the studies of problems on public transport. There are several problems that influence the quality and safety of traffic: traffic capacity, wear of vehicles and qualification of drivers.

For many years now scientists have speculated about problems of quality and safety (Varelopulo, 1990; Mirotin, 2004; Gudkov, 2008; Penshin, 2010).

Each author offers his assessment criteria, but single approach has not been worked out.

### Methods and Materials

In this research I will analyze approaches of different authors in assessment of the quality and traffic safety.

The basic principles of sustainable development of passenger transport system in the cities are quality assurance and safety on public transport. For this purpose many researchers offer the methods for their assessment.

The approach proposed by L. B. Mirotin, the quality of transport service is

determined by total costs of time for a trip and distance of pedestrian approaches to the closest urban passengers stop. Also important are the following requirements: traffic safety, speed, convenience and comfort of a trip, low price. [2]

G. A. Varelopulo determines the quality of service of urban passenger transport many indicators: availability, comfort of a trip, minimum costs of time for trip around the city, high reliability of work of vehicles, movement regularity. [4]

N. V. Penshin gives the following assessment of the quality of service indicators: reliability of travel (it is determined by time of travel of the passenger by a route); availability (frequency of trip in a certain period of time); high culture of servicing of passengers; necessary requirements on the way. [3]

V. A. Gudkov considers that the most important components in evaluating the quality of service can be: environment (purity of interior, technology equipment, type of the vehicle and staff); reliability (lack delays of transport, execution «just in time»); responsibility (guarantee of performance of service); completeness (availability of necessary skills, knowledge and competence of personnel); availability; comfort; safety (lack of risk); politeness of staff; skill to communicate of personnel. [1]

N. V. Penshin defines safety of transport as a trouble-free work, a property of vehicles to execute their functions for a given period of time. [3]

Many researches offered to use annual intensity of transit of places of concentration of road accident on a route as the main quantitative characteristic of the level of traffic safety.

Another evaluation method of safety is the method of assessment of potential danger of road accident. The method investigated the potential danger determined for each point of the conflict, which is summed up within the conflict zone, for each then defines the probable number of road accidents. It is equal to the amount of accidents in the conflict zones of the crossroad.

The classic approach to traffic safety evaluation is classification of accidents by type and severity.

### **Results and Discussion**

The passenger transport is an important part of modern life in cities. The main purpose of urban public transport is transporting people with minimal time and money, high comfort and minimum cost of operation of transport companies.

One of the main problems of the public transport is strong wear and unsatisfactory rate of renewal of vehicles.

To understand the scale of this problem, we will address Table 1 in which the degree of wear of vehicles of different types of passenger transport in Russia for 2015 is shown.

As a result of wear of vehicles, the level of technical reliability and safety of passenger transport falls, the number of the working buses decreases. The fullness of interior of vehicles increases and in rush hours it reaches a physical limit. The minimum level of comfort and necessary conditions for safety is not provided.

*Table 1 – The degree of wear of vehicles of different types passenger transport in Russia in 2015*

Vehicles	The degree of wear, %
Bus	70
Trolleybus	65
Tram	65
Underground	80

In spite of the fact that the absolute measure of number of road accidents with participation of passenger transport has decreased, problems on roads are still relevant. The causes of accidents with the regard to public transport are as follows:

1. Low skill level and transport discipline of drivers and non-compliance with Traffic regulations.
2. Unsatisfactory technical condition of vehicles.
3. Insufficient development of a road net of cities, leads to formation of road accident.
4. Insufficient control of work of drivers on the route.
5. Imperfection of the legislation regarding responsibility of legal entities and individual entrepreneurs for life and health of passengers.
6. Insufficient level of pre-trip and post-trip inspections of drivers.

These problems can be solved by taking the following actions:

- to oblige transportation companies every 5 years to confirm the license;
- to renew license on the transportation which is used for business purpose;
- to deprive the license of transportation companies which do not carry out pre-trip medical examinations and allow to driving of vehicles drivers who are in a condition of alcoholic or drug intoxication;
- to create a single city base of technical inspection and repair, at the same time passenger transport will be tested under control of officers of State Inspection for Road Traffic Safety;
- to normalize harmful emissions on passenger transport;
- to register requirements to a sanitary condition and appearance of buses;
- to designate requirements of the category of driver rights, describe methods of selection and training,
- to constitute timetable of passing of instructing and courses of retraining for drivers.

In actual practice can be more important a comparative characteristic of the quality of transport service which performed by one transportation company with the same characteristic which perform by other transportation company.

I offer for assess the quality on passenger transport to use the following

indicators: coefficient of filling of buses, release coefficient, movement interval, average time of a trip and number of claims to the transportation company per year.

For traffic safety assessment, I propose the following indicators: the number of road accident per year in the company, the number of road traffic violations by drivers, the number of failures of vehicle on a route, the severity of consequences from road accident, volume of transportations and road density.

### **Conclusion**

Due to the growth and development of the city load of public transport increases, there are problems connected with provision of transport service to the population.

The biggest problems in the provision of service to passengers on public transport arise because of wear of vehicles, limited road capacity, reduced quality of service and safety. The taken measures for the solution of these problems have insufficient character.

### **References**

1. Gudkov V.A. Kachestvo passazhirskih perevozok: vozmozhnost' issledovaniya metodami sociologii: uchebnoe posobie [The quality of passenger service: the ability to study the methods of Sociology] / V.A. Gudkov [i dr.]. – Volgograd: VolgGTU, 2008. – 163 s. (Rus)
2. Mirotin L.B. Effektivnost' logisticheskogo upravleniya: uchebnik [Logistics management efficiency] / L.B. Mirotin. – M.: Ekzamen, 2004. – 448 s. (Rus)
3. Pen'shin, N.V. Konkurentosposobnost' uslug avtomobil'nogo transporta v usloviyah post-krizisnoj modernizacii ekonomiki Rossii [The competitive of road transport service in the context of post-crisis modernization of economy of Russia] / N.V. Pen'shin. – Tambov: Izdatel'stvo TGTU, 2010. – 156 s. (Rus)
4. Varelopulo G.A. Organizaciya dvizheniya i perevozok na gorodskom passazhirskom transporte: uchebnoe posobie [Organization of traffic and transportation on the passenger transport]. - M.: Transport, 1990. – 208 s. (Rus)

## **ПРОБЛЕМЫ ПАССАЖИРСКОГО ТРАНСПОРТА**

**М. А. Ушакова, Ю. О. Дмитриева**

Тамбовский Государственный Технический Университет, Тамбов, Россия

*e-mail: ushakovamarina@yandex.ru*

***Аннотация:** статья содержит описание проблем безопасности и качества пассажирского транспорта, рассматриваются подходы различных авторов, и предлагается авторская точка зрения.*

***Ключевые слова:** безопасность движения, качество, метод, пассажирский транспорт, проблемы пассажирского транспорта.*

## THE INFLUENCE OF TRAFFIC ON THE NOISE LEVEL IN RESIDENTIAL BUILDINGS

**D.G. Frolov**

Tambov State Technical University, Tambov, Russia

*e-mail: Dfrol18@yandex.ru*

**Abstract:** *The article touches upon one of the urgent problems of Russian cities - increase in the level of traffic. This process contributes to the growth of urban population and an increase in the level of material life. The traffic noise impact on adjacent residential buildings is explored using the example of one of the newly built rote pipes.*

**Keywords:** *traffic; growth; noise.*

The growth rate of cars leads to a constant increase in the influence of the traffic noise on the population living in the areas adjacent to the road. Because of this, the inhabitants of these areas do not have time to adapt to it, resulting in a detrimental effect on their health. Also, the increased traffic noise adversely affects the productivity and quality of people`s life.

The structure of the internal historical transport links in Tambov cannot withstand modern traffic load and therefore requires adjustment. In this context, the object of the study of traffic noise impact on the surrounding buildings is a newly built road pipe in Magistralnaya Street. The project was developed in 2011. The basis for the design was Decree №7928 of 10.09.2010 "On approval of the plan of perspective development of the street and road network of city district - the city of Tambov for 2010-2012".

The development of the project was based on the intensity of traffic of motor transport on the territory of Tambov in 2011. Currently, in Magistralnaya Street a significant increase in traffic associated population growth in the northern part of Tambov and increasing motorization level in the Tambov region is recorded.

To evaluate the utilization of the area of the street under the SP 34.13330.2012 the estimated traffic volume should be total in both directions on the basis of field survey data. In this case the settlement should take the intensity, reduced to the cars.

Based on the above, we can conclude that the growth of car ownership in the city of Tambov leads to an increase in the influence of all city highways on the noise situation in the residential areas. Thus, the problem requires a more in-depth study and implementation of measures to protect the people from noise discomfort.

### **References:**

1. Guidelines for the protection of traffic noise territory adjacent to roads.
2. SP 34.13330.2012 "SNIP 2.05.02-85 \* Highways

# ВЛИЯНИЕ УРОВНЯ АВТОМОБИЛИЗАЦИИ НА ГОРОДСКИХ МАГИСТРАЛЯХ НА ШУМОВУЮ СРЕДУ ЖИЛОЙ ЗАСТРОЙКИ

Д.Г. Фролов

Тамбовский государственный технический университет, Тамбов, Россия  
e-mail: Dfrol18@yandex.ru

***Аннотация:** Рассмотрена одна из актуальных проблем российских городов – рост уровня автомобилизации. Этому процессу способствует рост численности населения городов и увеличение уровня материальной жизни. На примере недавно построенного и введенного в эксплуатацию путепровода исследуется влияние транспортного шума на прилегающую жилую застройку.*

***Ключевые слова:** автомобилизация; интенсивности; шум.*

---

УДК 65-05  
ББК 39.1

## TRAFFIC ORGANIZATION ON THE PRINCIPLE OF USING THE "GREEN WAVE".

V.A.Chukanova, D.A.Sviridov

Tambov State Technical University, Tambov, Russia  
e-mail: lerka-chukanova@mail.ru

***Abstract:** Traffic light control is one of the main means of ensuring safety at intersections. The number of intersections equipped with traffic lights in big cities with a high level of car ownership is constantly increasing, and in some cases reaches the ratio: one traffic light object on 1.5-2 thousand residents of the city. In recent years in our country and abroad intensively working on the creation of complex automated systems with control of electronic computers, automation, remote control, dispatch communication and television for traffic management on the scale of a large area or a city. Experience in the operation of such systems is convincing evidence of their effectiveness in solving transport problems.*

***Keywords:** traffic management, transportation delays, automatic coordinated control system.*

Road traffic, which involves almost the entire population of the state and millions of cars, plays an important role in modern society. Currently, traffic management is not possible without technical means of traffic organization (TMTO) and construction of roads. The constant increase in the vehicle fleet has set humanity serious problems related to the prevention of accidents and at the same time ensuring high speeds.

This theme is currently very topical, because the number of vehicles is increasing exponentially over time and this leads to an increase in traffic. The rapid growth of car ownership leads to serious problems such as increasing transport delays, congestion and traffic jams.

All this leads to a decrease in traffic flow, excessive fuel consumption, increase in

wear of vehicles, an increase in road accidents.

Organizations of traffic on the existing (current) road network contribute to the quality of traffic in cities. Architectural and planning activities require a significant capital investment, quite a large period of time, while organizational activities can bring a relatively rapid effect. In some cases, organizational measures can be the only tool to solve transport problem.

Automation of traffic management is one of the leading places in the complex of measures aimed at the solution of the problem to ensure quick and safe movements in modern cities, in terms of increased motorization. The process of implementation of coordinated motion control passes extensively automated systems in recent years. The experience of operation of such systems indicates that they are effective in reducing delays at intersections, increasing speeds, increasing the capacity of urban roads and the level of traffic safety.

We mean the organization of movement in the historical part of town, which is not subject to reconstruction. Because it architectural monument. In addition, the development of the road network is often associated with the elimination of green space that is not feasible. When implementing measures for the organization of movement, a special role belongs to the introduction of technical equipment: traffic signs and road markings, traffic light control means, guiding traffic devices. Traffic light is one of the main means to ensure traffic safety at intersections.

The aim of the development activities is to improve traffic management in the real sections of the road network of the city. The development of alternative technical solutions and their assessment on the effectiveness of the existing criteria.

Coordinated traffic control ("green wave") helps to reduce waiting time of vehicles before the intersection. Traffic lights united into a single control system enable to perform uninterrupted traffic flow on the main roads of the city. However, we must take into account that, depending on the time of day, the load on the RN is different. After a full-scale investigation, we can determine that in the morning and evening the traffic flow is different, depending on the direction of flow. Green wave must cover major highways, considering secondary streets. Taking into account all the nuances and adjusting the system of co-ordinate traffic management can ensure the discharge of the road network.

### References

1. Klinkovshtejn G.I., Afanas'ev M.B. Organizacii dorozhnogo dvizhenija [Traffic organization]. Dlja VUZov.- 4-e izd. pererab. i dop. - M.: Transport, 1997-231s. (Rus)
2. Kremenec, Ju.A., M.P. Pecherskij, M.B. Afanas'ev. Tehnicheskie sredstva organizacii dorozhnogo dvizhenija : Uchebnik dlja vuzov. [Technical means of traffic management: textbook for universities] - M.: IKC «Akademkniga», 2005. – 279 s. (Rus)
3. Pen'shin N.V. Organizacija i bezopasnost' dvizhenija Uch. posobie. [Organization and traffic safety]. Izd. TGTU, 2006 – 96 s. (Rus)

## ОРГАНИЗАЦИЯ ДОРОЖНОГО ДВИЖЕНИЯ ПО ПРИНЦИПУ ИСПОЛЬЗОВАНИЯ «ЗЕЛЕННОЙ ВОЛНЫ»

**В.А. Чуканова, Д.А. Свиридов**

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: lerka-chukanova@mail.ru*

***Аннотация:** Светофорное регулирование является одним из основных средств обеспечения безопасности движения на перекрестках. Количество перекрестков, оборудованных светофорами, в крупнейших городах с высоким уровнем автомобилизации непрерывно возрастает и достигает в некоторых случаях соотношения: один светофорный объект на 1.5-2 тыс. жителей города. За последние годы в нашей стране и за рубежом интенсивно ведутся работы по созданию сложных автоматизированных систем с применением управляющих электронно-вычислительных машин (ЭВМ), средств автоматики, телемеханики, диспетчерской связи и телевидения для управления движением в масштабах крупного района или целого города. Опыт эксплуатации таких систем убедительно свидетельствует об их эффективности в решении транспортной проблемы.*

***Ключевые слова:** организация дорожного движения, транспортные задержки, автоматизированные системы координированного управления.*

---



### III. ECONOMICS

---

УДК 629.4.084.13

ББК 65.052.21

#### THE SPECIFICS OF COMPANY MATERIALS ACCOUNTING

**O. A. Kashirina**

Tambov State Technical University, Tambov, Russia

*e-mail: oksana.kashirina@list.ru*

**Abstract:** *The paper discusses the ways of improving materials accounting through the effective use of document management system. The author focuses on the importance of using automated workstations for company accountants. The applicable documents and usernames registers must be constantly improved and the level of automation of the accounting and computing operations must be increased.*

**Keywords:** *accounting; inventories; materials accounting; accounting documents; improvement.*

Materials accounting plays a significant role in the economic sector of any organization. Materials accounting is a time-consuming and challenging task for organizations of all forms of ownership.

Economic indicators and company performance rely on data accuracy. A lot of attention is paid to automation of solutions for accounting, control, analysis and audit of inventories using 1C software package.

Improvement of materials accounting in the enterprise should meet the following requirements:

- simplification of operations on inventory receipt and consumption of materials;
- improvement of methodology of inventories accounting;
- monitoring of timely inventory.

Rationalization of document management is an important aspect in the improvement of the organization of timely materials accounting. The variety of forms of accounting documents considerably complicates the work of accounting materials in warehouses of industrial divisions. The problem is that accounting documents are formed for certain periods and their processing and at the end of the month is a big challenge for the company warehouse.

Therefore, documents used for accounting of raw materials and other supplies must be standardized. It is possible to offer the use of quota cards that reduce the number of single documents. Calculations of limits and issuing of quota cards using modern computers make it possible to increase the validity of countable limit and reduce the complexity of operations.

It is also possible to introduce quota cards in case of centralized delivery of materials from the storage space to production halls. Procurement services issue a special operational document (plan-card), reflecting the limits and terms of delivery of materials. Based on this document, the staff issues an invoice for the materials

within the monthly limit and make the transfer of materials.

The problem of materials accounting can be solved using modern computer technologies. By introducing an effective automated accounting system, it is possible to organize less time-consuming accounting and control of materials.

Another important issue is raising individual and social responsibility of the staff involved in materials accounting. Organizations should comply with the rules of industrial reserves of the materials used.

Document management system, automation of the materials accounting can improve materials accounting of resources. Currently, it is very important to have automated workstations for accountants.

### References

1. Prikaz Minfina RF ot 09.06.2001 № 44n (inred. ot 25 october 2010) «Ob utverzhdenii Polozhenija po buhgalterskomu uchjotu «Uchjot material'no-proizvodstvennyh zapasov» (PBU 5/01)» [RFMinistryof Finance Order of 09.06.2001 # 44n (as amended on October 25, 2010) "On Approval of the Regulations on Accounting" Accounting of inventories"(PBU 5/01)"] (Rus)
2. Bulavina, L.N. Buhgalterskij uchjot i audit material'no-proizvodstvennyh zapasov [Accounting and auditing of inventory] / L.N. Bulavina – M.: 2012. – 144 s. (Rus)
3. Volkov, N.G. Uchjot neofakturovannyh postavok i materialov, nahodjashhihsja v puti [Accounting of unbilled supplies and materials in transit] / N.G. Volkov – M.: Buhgalterskij uchjot №9, 2014. (Rus)
4. Zhukov, N.V. Uchjot operacij po priobreteniju i zagotovleniju material'no-proizvodstvennyh zapasov [Accounting operations on inventories] / N.V. Zhukov – M.: Buhgalterskij uchjot, 2013. – 248 s. (Rus)
5. Zahar'in, V.R. Uchjot materialov: uchebnoe posobie [Accounting for materials: Textbook] / V.R. Zahar'in – M.: DiS, 2012. – 326 s. (Rus)

## ОСОБЕННОСТИ ОРГАНИЗАЦИИ УЧЁТА МАТЕРИАЛОВ НА ПРЕДПРИЯТИИ

**О.А. Каширина**

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: oksana.kashirina@list.ru*

***Аннотация:** Рассмотрены способы усовершенствования организации своевременного и складского учёта материалов. Отмечается необходимость создания возможностей для формирования автоматизированных рабочих зон бухгалтеров. Рационализация складского документооборота заключается в совершенствовании применяемых документов, учётных регистров и повышении уровня автоматизации учётно-вычислительных работ.*

***Ключевые слова:** бухгалтерский учёт; материально-производственные запасы; учёт материалов; учётные документы; усовершенствование.*

## PR-TECHNOLOGIES TO ATTRACT INVESTMENTS IN NON-PROFIT ORGANIZATIONS

**M.V. Lyutikova**

Tambov State Technical University, Tambov, Russia  
*e-mail: shishovayana@mail.ru*

**Abstract:** *This article is dedicated to the problem of attracting investments for realization of specific projects of non-profit organizations. The article considers PR-technologies to attract funds to the «third sector». The author reveals the main trends in financing, as well as the motives of banks, funds, commercial entities to invest money in social and cultural projects. A specific example of using PR-technologies to attract investment in a non-profit organization for the implementation of a big PR-project.*

**Keywords:** *fundraising, non-profit organizations, investments, project, PR-technologies, sponsor, sponsoring.*

The search for investments to fund specific projects remains an urgent problem. In many ways, this problem concerns non-commercial organizations using funds collected by themselves. G. Broom and S. Cutlip, the authors of the well-known book «Effective public relations. » believe that non-profit organizations in solving the most important problems rely on PR more than the other public sector [1].

In the first stage of development of PR-concept the organization's mission, as well as its image should be in the centre of attention. These two components create a single image of a non-profit organization, both for employees and its customers and partners. Funding depends on the latter to a large extent.

What kind of projects are likely to get financial support in Russia? Serious research in this area has not been carried out, but according to the results of local surveys and the experience of many non-profit organizations, the following projects have better chances of attracting investment (descending popularity): social assistance, namely, social and medical rehabilitation; assistance for children; culture and art; health care; ecology; social services; education; human rights protection.

What drives banks, foundations, commercial entities to invest funds in social and cultural projects? This can be: a request, a personal interest in solving the problem, a great public interest in the project, advertising, religious motives, good reputation, a similar field of interest.

The most widespread PR-technologies used to attract investments are sponsorship and fundraising.

According to A.N. Chumikov, sponsorship is a kind of support provided by the sponsor to the organization to finance a certain event. It involves working out of sponsor's development package, selecting and organizing of the event at the request of the sponsor, preparing and publishing a report covering sponsor's participation in the project.

Fundraising is a purposeful systematic use of sponsor's funds for the implementation social and meaningful projects (programs and actions) and support of social and meaningful institutions [2].

Fundraising can get different forms. They include donations, grants, direct funding, arrangement of purposeful or charitable activities.

Targeted activities, which are organized by members of non-profit organizations within those social groups whose interests they represent, firstly, allow collecting a sufficient amount of cash if concrete and realistic achievable goals are set. Secondly, the organization has the right to dispose of the collected funds at their own discretion. Foundations have some limitations in distributing funds.

Sponsorship and fundraising involve several options for participation of sponsors in the project: major sponsor (pays 100% of the project cost); general sponsor (pays 50% of the project cost); official sponsor (pays 25% of the project cost); sponsor party. The amount of advertising resource depends on the investments in the project.

I consider an example involving the sponsor in the charity event. Since 2006, the "Lifeline" foundation has been holding an annual charity event "Red Nose - Good Heart". The organizers pursued the two goals. Firstly, they intended to raise funds for operations for children with cardiac diseases and purchase medicines for their subsequent recovery. Secondly, they wanted to promote a charity "Helping people is pleasant and joyful".

How did they do it? During the campaign the foundation partners were selling rubber red noses, and the money was spent on treatment of seriously ill children. The main partner of the action was "Svyaznoy". Red noses were sold in all stores of the company. So a small share grew into a major PR-project. Organizers used a variety of PR-tools: media coverage, running the official site, endorsement. Celebrities who endorsed the event were Oscar Kuchera, Andrei Malakhov, Elena Malysheva, etc.

Each organization has its own traditional approaches to fundraising. Here is an incomplete list of possible ways to attract investment, which are widely used in many non-profit organizations: distribution of calendars, mailing letters, sports competitions, excursions, charity events, marathons, selling things, distribution of advertising materials, lectures, auctions, contests.

To sum up, financial resources and non-profit organizations are two inseparable concepts. The main thing is not how much money the organization can raise and what methods it uses. Without effective sponsorship and fundraising, very few projects would get a decent response in society.

## References

1. Cutlip, S.M., Center, A. H., & Broom, G. M. (2006). *Effective public relations* (9th edn). Upper Saddle River, NJ: Prentice Hall.
2. Chumikov, A.N., Bocharov M.P. *Svyazi s obshchestvennost'yu. Teoriya i Praktika*. [Public Relations. Theory and Practice] / A.N. Chumikov, M.P. Bocharov.- M, Williams, 2003. 624 p. (Rus)
3. Astakhova, T. *Svyazi s obshchestvennost'yu dlya tret'ego sektora*. [Public Relations for the third sector] / T. Astakhova. -M, Znak, 1996.- 133 p. (Rus)
4. Petrova, T.M. *Sponsoring i phandraizing*. [Sponsoring and fundraising]. Available from: <http://www.sbornet.ru/publics/show-3.html> (Accessed 15 December 2016) (Rus)

## PR-ТЕХНОЛОГИИ ПРИВЛЕЧЕНИЯ ИНВЕСТИЦИЙ В НЕКОММЕРЧЕСКИЕ ОРГАНИЗАЦИИ

**М.В. Лютикова**

Тамбовский государственный технический университет, Тамбов, Россия  
*e-mail: shishovayana@mail.ru*

**Аннотация:** *Статья посвящена проблеме поиска инвестиций на реализацию конкретных проектов для некоммерческих организаций. В статье рассматриваются наиболее популярные PR-технологии привлечения инвестиций в «третий сектор», с помощью которых можно достичь желаемых результатов. Автором выявлены основные тенденции в финансировании, а также мотивы банков, фондов, коммерческих организаций вкладывать денежные средства в социальные и культурные проекты. На конкретном примере показано, как с помощью PR-технологий можно привлечь инвестиции в НКО и организовать большой PR-проект.*

**Ключевые слова:** *фандрайзинг, некоммерческие организации, инвестиции, проект, PR-технологии, спонсор, спонсоринг.*

---

УДК 657  
ББК 65.052.2

## PROBLEMS OF RAISING WAGES IN MODERN RUSSIA

**Zh. V. Mikhailova**

Tambov State Technical University, Tambov, Russia  
*e-mail: zlataesen@mail.ru*

**Abstract:** *The paper explores the problem of motivation lack of employees. The necessity of application of the system of incentives with the aim of increasing the efficiency of labor is justified.*

**Keywords:** *accounting; bonus payment; motivation; salary.*

In modern conditions of development of Russian society, the problem of labour remuneration is one of the most important. Western economists E. Lawler, J. Kind, R. Walton, A. Cairns, and V. Elsker argued that the main factor of the employee's work must be job satisfaction as a result of self-realization and expression. Such motives as wages, career growth and promotion are of secondary importance. In modern society, people's attitudes towards material evaluation of their work and career growth have changed. One of the main principles of the organization of wages in the modern economy is the principle of material interest of workers in the results of their work.

A few decades ago, the state covered the costs and cared about the lives of people, providing them with jobs, housing, salary, pension. Employees worked not only for wages but also for the opportunity to obtain housing, social benefits and promotion, etc. The public consciousness played an important factor; people worked

"for idea".

In modern conditions, the wage is practically the only way to buy housing, pay for children's education, accumulate savings, and often just a means of survival. Therefore, the predominant number of workers in modern Russia cannot afford to obtain job satisfaction and a sense of their value and usefulness detriment of their wages. The vast majority of employees determine the material factor as paramount.

For the employer, wages are one of the cost items and the most powerful material incentive to arouse employees' interest in the growth of labor efficiency. Thus, it raises the effectiveness of production in general. For employees, wages are income, which they receive for the work performed. Ideally, wages should entirely depend on the quality and volume of work performed, as well as skills, knowledge and efforts of employees. That is, the efficiency of the enterprise and maximization of profits largely depends on the system of motivation of employees. Unfortunately, many employers believe that it is sufficient to provide employees with a decent salary to encourage them to work. They tend to forget that in order to get something, it is necessary to give something.

One of the tools of the motivation system is bonuses. Oddly enough, in many companies bonus is not a mean of promotion and but also the way of punishment for violations and misdemeanors. This happens in cases where the bonus amount is predetermined and, as if that is a part and parcel of wages. The scheme occurs when the prize doesn't need to work better – need to work not worse than usual. The employee is not motivated to improve efficiency in their field of activity, increase working time, if necessary, develop new projects, etc., he seeks to do its work in the framework of the previous months. The negative role played by this award and in the socio-psychological atmosphere of the team. If the person is related with a greater responsibility and interest in their duties than an employee with similar functions, does not see tangible result of the effort in the form of promotions or increase in pay, it is possible that he will reduce his efforts to the level necessary minimum, which will undoubtedly affect the efficiency of the department or the whole enterprise.

In addition, the incentive system can be applied to services and benefits for employees: medical care, life insurance, financial assistance, additional leave, free meals, use of car, stay in motels, etc.

Thus, we can conclude that proper motivation of personnel to improve efficiency ensures enterprise success in the market and making a profit.

#### **References:**

1. Geleta I.V., Shabanova V.A. Kachestvo truda rabotnikov kak instrument uspehnogo funkcionirovanija predpriyatija // *Ekonomika i menedzhment innovacionnyh tehnologij* [The quality of work of employees as a tool for the successful functioning of the enterprise // Economics and innovations management]. 2015. № 6 // electronic resource (date accessed: 06.11.2016). (Rus)
2. Berezhnaja Je. V., Opaleva O. D. Problemy sovershenstvovanija formirovanija zarabotnoj platy v sovremennyh uslovijah [Problems of improvement of wages formation in modern conditions]// *Molodojuchenyj*. — 2015. — No. 12. — 383-386p. (Rus)
3. Kaverin S.B. Motivacija truda [Labor motivation]. M.: Izd-vo «Institut psihologii RAN», 1998. – 224 p. (Rus)

# ПРОБЛЕМЫ СОВЕРШЕНСТВОВАНИЯ ЗАРАБОТНОЙ ПЛАТЫ В СОВРЕМЕННЫХ УСЛОВИЯХ

**Ж.В. Михайлова**

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: zldataesen@mail.ru*

*Аннотация:* Рассмотрена проблема отсутствия мотивации работников. Отмечается необходимость применения системы поощрений с целью повышения эффективности труда.

*Ключевые слова:* бухгалтерский учёт, мотивация, оплата труда, премирование.

---

УДК 574

ББК0145

## THE NATURE, PROBLEMS AND PROSPECTS OF THE ANALYSIS OF FINANCIAL AND ECONOMIC ACTIVITIES

**I. Yu. Tulupova, E. P. Baznamina**

Tambov State Technical University, Tambov, Russia

*e-mail: baznamina.elena@yandex.ru*

*Abstract:* The article examines the experience gained in the field of the analysis of financial-economic activity of enterprises, the set of indicators used in the analysis and their normative values, problems and prospects of development of the analysis of financial-economic activity of enterprises.

*Keywords:* analysis of financial and economic activity of the enterprise, assessment of the prospects of the analysis, indicators of financial condition of the enterprise, problems of the analysis of financial and economic activity.

### **Introduction**

Nowadays in market conditions, it is necessary to have an idea of a financial position not only of your own enterprise, to make timely effective management decisions, but also of the partner enterprises. The instrument of receipt of information on a financial position of the entities is the analysis of their financial and economic activities. It allows to estimate a property status of an enterprise, degree of its dependence on loan sources of financing, a capability of an enterprise to repay its liabilities, availability of the equity for financing of its current activities, then by its results to make reasoned short-term and long-term management decisions.

The examination of the nature and problems of the analysis of financial and economic activities, assessment of its prospects.

Domestic and foreign practice of the analysis of financial and economic activity has gained a lot of experience. However, there are discussions about the stages and structure of the indicators used in the analysis.

Table 1 presents the approaches to the understanding the analysis of financial and economic activity of various authors.

The table allows us to draw a conclusion that the result of the analysis of financial and economic activity is to provide information about the financial position of the economic entity, its development opportunities in the implementation of its financial policy and the identification of factors influencing the current dynamics.

Author	The essence of the analysis
Bogdanova L. S.	Analysis and management of financial resources of the enterprise as main and priority type of resources.
Kovalyov V. V.	The process of systematization and analytical processing of information of a financial nature to provide recommendations to the user - is the basis for management decisions.
Liferenko G. N.	The method of the financial mechanism of the enterprise, of the processes of formation and use of financial resources for its operational and investment activities.
Novashina T. S.	The method of scientific research that applies to information processing about financial activities of an economic entity.
Savitskaya G. V.	A comprehensive and systematic studying of the financial condition of the company and the factors of its formation in order to assess the degree of financial risk, and for prediction of the level of return on capital.

*Table 1 - Approaches to understanding the essence of the analysis of financial and economic activity*

In practice there are problems when carrying out the analysis of financial and economic activities in the Russian conditions.

Firstly, the analysis of financial and economic activity is often reduced to the calculation of the structural relationships of indicators and their dynamics. In this case, the depth of the research is limited to the identification of improvement or deterioration trends.

Secondly, in many cases, results of the analysis may be based on unreliable data that can be distorted by both objective and subjective reasons. Therefore, to assess the reliability of the source of information it is necessary to conduct an independent audit to detect of intentional and unintentional distortions.

Thirdly, a comparative analysis of financial and economic activity of Russian companies is difficult due to the lack of available industry average indicators, which would allow assessing more precisely the strengths and weaknesses of the enterprises and their development prospects in the industry. Existing normative values of the indicators make it impossible to adequately take into account the peculiarities of the functioning of all enterprises.

Finally, due to inflationary processes there are difficulties during carrying out horizontal analysis, and therefore in the assessment of trends in the dynamics of indicators of financial and economic activity it is necessary to calculate the comparable prices on the basis of application of official indicators-deflators.

In the process of development of market economy, new challenges are put before the analysis of financial and economic activities, new directions are determined. First



and foremost the further development of the analysis is reduced to the solution of existing problems. Promising prospects are opened up with the advent of new information technologies. In recent years, intelligent systems are actively developing, allowing automating the process of collecting, processing and use of the knowledge of highly qualified specialists. These expert systems are one of the priority directions in the development of the analysis of financial and economic activity.

Recently computers are also successfully used for modeling of the continuous dynamic objects working the mode of real time. For this purpose the special algorithms that allow to program modeling tasks in the most rational way are developed.

In market conditions the system of indicators characterizing the activity of the enterprises, is constantly changing. The new indicators require new methods of research and higher professional level of specialists.

### **Conclusion**

Thus, in the existing system of the analysis of financial and economic activity, there are some problems and difficulties associated primarily with insufficient or inaccurate information base. They require further development and improvement of the theory and practice of the analysis. Prospects of development of the analysis consist mainly in the expansion of analytical framework, as well as in the introduction of modern technologies.

### **References**

1. Askerov, P. F. Analiz i diagnostika finansovo-hozjajstvennoj dejatel'nosti organizacii [Analysis and diagnostics of financial and economic activity of the organization]. Moskva. Nauchno-issledovatel'skij centr INFRA-M, 2015. 176 p. (Rus)
2. Bogdanova L. S., Lyashko E. F. Finansovo-jekonomicheskij analiz v aviastroenii [The financial and economic analysis in aircraft industry]. Ul'janovsk. UIGTU, 2006. 18 s. (Rus)
3. Kovalyov, V. V. Analiz hozjajstvennoj dejatel'nosti predpriyatija [Analysis of economic activity of the enterprise]. Moskva. Prospekt, 2014. 42 s. (Rus)
4. Liferenko G. N. Finansovyj analiz predpriyatija [Financial analysis of the enterprise]. Moskva. «Jekzamen», 2014. 16 s. (Rus)
5. Novashina, T. S. Finansovyj analiz [Financial analysis]. Moskva. MFPA, 2005. 19 s. (Rus)
6. Savitskaya, G.V. Analiz hozjajstvennoj dejatel'nosti predpriyatija [Analysis of economic activity of the enterprise]. Moskva. Novoeznanie, 2012. 74 s. (Rus).

## **СУЩНОСТЬ, ПРОБЛЕМЫ И ПЕРСПЕКТИВЫ АНАЛИЗА ФИНАНСОВО-ХОЗЯЙСТВЕННОЙ ДЕЯТЕЛЬНОСТИ**

**И.Ю. Тулупова, Е.П. Базнамина**

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: baznamina.elena@yandex.ru*

*Аннотация: Исследуется опыт, накопленный в области анализа финансово-хозяйственной деятельности предприятий, набор показателей, используемых при анализе и их нормативные значения, а также проблемы и перспективы развития анализа финансово-*

хозяйственной деятельности предприятий.

**Ключевые слова:** анализ финансово-хозяйственной деятельности предприятия, оценка перспектив анализа, показатели финансового состояния предприятия, проблемы анализа финансово-хозяйственной деятельности.

---

УДК621.384.3  
ББК 32.97

## INVENTORY MANAGEMENT IN THE ENTERPRISE

**V.A. Uglyanskiy**

Tambov State Technical University, Tambov, Russia

e-mail: vuglyanckiy@bk.ru

**Abstract:** *This article focuses on cost management of the enterprise. Inventory management plays an important role in improving the efficiency of companies, their competitive position in the market. Inventories have become one of the main conditions characterizing the performance and profitability of firms. The way we organize management of inventories influences the rate of production and the quantity of material resources, the degree of service and satisfaction of end consumers.*

**Keywords:** *inventories, the profitability of firms, the efficiency of the company*

In the existing situation, companies are challenged to find a balanced solution between the immensely considerable inventory, and this allows course continuity of production within the designated cycle, and low level of losses when organizing inventory, minimizing possible lack of material resources.

At the same time, companies with the lowest costs earn a higher degree of service and quality products. Companies are seeking reserves to reduce costs. In this context, the need for improving management of production inventory in large diversified companies through the establishment of a mechanism for good governance at each step of the inventory management process and make interdependent decisions on the best allocation of the resource user groups is considered to be timely and relevant.

By definition, inventories are "idle" production. However, this is only refers to "stocked" products in the process of production or consumption. The fact is that these processes are continuous. Production is impossible to interrupt or stop without big losses for the producer.

The development of economy and growth of stocks of products is caused by:

1) the increase in the scale of production (The more products are made, the greater is the value of stock to be constantly engaged in the process of creating new products.);

2) the increase in traffic (Production is concentrated in some centers, and its customers are often located around the world. The increase in the amount of products

influences the process of transportation.);

3) the process of division of labor (The division of labor leads to the emergence of new industries, and therefore the emergence of new reserves (some of the parts, components, etc.));

4) the increase in the range of products (The increase in the types of products leads to increased inventory).

All inventories (raw materials, materials, etc.) are items that involve human labor to make the finished product. In contrast to the means of labor, and spare production process, the objects of labor include travel costs for this product and are replaced after each production cycle. Industry uniformly increases the expenditure of inventory items.

Depending on the importance played by the different inventories within the production, they are divided into the following categories:

- 1) raw materials,
- 2) auxiliary material,
- 3) purchased semi-finished products,
- 4) waste fuel,
- 5) spare parts,
- 6) accessories and household accessories.

Inventories need to be managed, that is why there are many management technologies. The basis of inventory management is the notion of order, i.e., quantity of production, which is necessary to make up for decrease in the relevant stock required for smooth functioning of the company.

The organization has the opportunity to choose accounting policies for production costs. New chart of accounts offers the use of a choice of several schemes of accounting of production costs. The choice of a particular option depends on a number of factors, such as the specifics activity, organizational structure, technological structure, organization management.

In all cases two concepts – standard costs and estimated costs are widely used. The standard costs are used to assess unit cost of production, and estimated costs are used to calculate the entire volume of activity. The standard method of cost accounting per unit of product allows us to perform a detailed analysis of the differences between actual and planned estimates and provides more effective cost management, including planning.

Monitoring of inventories should ensure a persistent mapping of normative parameters with the actual ones, i.e. to act as a "tracking system".

### **References**

1. Agarkov A.P. Organizaciya proizvodstva na predpriyatiyah [Organization of production enterprises.]. Patient Russia, no.2198586.2003 (Rus)
2. Ionova A.F. Upravlenie zapasami [Stock management]. Patient Russia, no.2198586.2011 (Rus)

## УПРАВЛЕНИЕ ЗАПАСАМИ НА ПРЕДПРИЯТИИ

**В. А. Угрянский**

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: vuglyanskiy@bk.ru*

***Аннотация:** Данная статья посвящена вопросам управления затратами на предприятии. Технологии кадастров управления играют важную роль в повышении эффективности функционирования предприятий, повышении их конкурентоспособности на рынке. Запасы в сегодняшней ситуации становятся одним из основных условий, характеризующих результативность и прибыльность фирмы. Управление запасами во многом определяет не только темпы производства и количество материальных ресурсов, извлекаемых из сферы обращения, но степень удовлетворения конечного потребителя.*

***Ключевые слова:** материальные запасы, прибыльность фирмы, эффективность деятельности предприятия.*

---

УДК 372.881.111.1

ББК 81.2

## **VIDEO RESOURCES FOR DEVELOPING LEARNERS' LISTENING SKILLS IN A FOREIGN LANGUAGE**

**Yu.V. Akinshina**

School № 1315 with Intensive Study of English, Moscow, RF

*e-mail: juliakinshina@mail.ru*

**Abstract:** *The paper explores the possibilities of using video-resources in teaching English as a foreign language to secondary school learners. The advantages of using video-resources for developing listening skills as well as selection criteria for video-resources are determined.*

**Keywords:** *listening comprehension; skills; video-resources.*

Domestic and foreign experience in organizing educational activities shows that educational system is undergoing dramatic changes, which include the integration of innovative methods of teaching with traditional ones. The use of video-resources in teaching foreign languages has become a common practice for many reasons. The feasibility of using video in the learning process is explained by: 1) the availability of video materials through a variety of media, including open access resources, such as the Internet; 2) availability of video equipment and other digital devices; 3) possibility of organizing more creative activities in the classroom.

Development of communicative competence in a foreign language is a challenging task. Authentic movies, audio and video courses can be used to cope with this challenge and make learning more enjoyable.

Authentic materials are created by native speakers and can be used in the learning and teaching process. This agrees well with the communicative approach to teaching a foreign language which empathizes the importance of exposing the learners to real, genuine language without any cuts or adaptations. What is more, authentic audio and video materials simulate “immersion” of the learners into a target language.

Video-resources include any TV products (news, interviews, talk shows, ad units, and so on. D.), as well as feature films, documentaries, animated films used as didactic materials in a multiple viewing mode with a possibility of quick search of the desired fragment [1, p. 8].

Dave Willis distinguishes the following positive characteristics of using video in the learning process:

- the room does not require a blackout, and hence contact of the teacher and learners is continuous;
- a teacher can use different working modes, for example stop-overs, video track only (audio track turned off), etc.;
- different types of work can be organized: individual work, pair work, group work[2,

p. 17].

Margaret Allan adds to the above one more positive feature: video equipment allows you to divide a movie into desired number of video fragments, depending on the objectives, individual needs and characteristics of students and work further with each fragment separately [3, p. 20].

Video-resources are used to intensify the educational process and make it more communicative. They create a simulated language environment and reproduce the speech situation using audio and visual means. Within a short period of time learners receive a large amount of information from two channels: visual and auditory. Visuals help memorize language structures, expand vocabulary, and stimulate the development of listening skills. Facts perceived visually become learners' personal experience, while verbal explanations reflect mediated experience. Visual support is important for better understanding of the video. It facilitates segmentation of speech stream, improves the accuracy and completeness of understanding because the capacity of the auditory analyzer is many times smaller than that of the visual one.

Video-resources are extremely useful for the development of listening skills as they help to cope with two types of difficulties. The first difficulty lies in the fact that the work on the development of listening skills is closely connected with the ability to acquire the language without translating it into your mother tongue. A prerequisite for the development of listening skills in conditions of limited linguistic materials and underdeveloped skills is inner speech. In this case, learners acquire the language by non-translation method in a similar way as native speakers acquire their own language. Non-translation method can be used an early stage of learning foreign languages. The second difficulty is related to the fact that understanding of foreign speech of one person does not guarantee understanding of speech of others who speak the same language. Video-resources can greatly help overcome the difficulties mentioned above.

To overcome these difficulties, a teacher has to use the right approach to the selection of authentic video-resources. The selection of authentic video-resources must meet the following criteria:

- compliance of linguistic content of video-materials with the level language proficiency of learners;
- relevant content adequate to learners' interests;
- high quality of sound and picture;
- compliance of video content with learning goals;
- sociocultural and sociolinguistic information reflecting various spheres of communication and communicative situations;
- genre and compositional diversity.

These criteria have been developed on the basis of the functional approach to the selection and presentation of video-materials. The approach is prevalent in the domestic methodology of foreign language teaching. It focuses on the communicative value of authentic video-resources. In this approach, linguistic information is introduced and acquired naturally.

To sum up, video-resource and interesting, diverse materials and exercises can

help teachers to turn a time-consuming process of learning a foreign language into emotionally engaging activity, increase learners' motivation and fuel sustained interest in learning a foreign language.

**References:**

1. Il'chenko, E. Ispol'zovanie videozapisi na urokah anglijskogo jazyka [Using videos in English lessons] / E. Il'chenko // Pervoe sentjabrja, Anglijskij jazyk. – 2003. – № 9. – pp. 7–9. (Rus)
2. Allan, M. Teaching English with Video [Text] / M. Allan // Video-applications in ELT. – Oxford: Pergamon Press, 1983. – P. 20.
3. Willis, D. The potentials and limitations of Video [Text] / D. Willis // Videoapplications in ELT. – Oxford: Pergamon Press, 1983. – P. 17.

## **ВИДЕО-РЕСУРСЫ ДЛЯ РАЗВИТИЯ НАВЫКОВ АУДИРОВАНИЯ ОБУЧАЮЩИХСЯ НА ИНОСТРАННОМ ЯЗЫКЕ**

**Ю. В. Акиншина**

Школа № 1315 с углубленным изучением английского языка, г. Москва, РФ  
*e-mail: juliakinshina@mail.ru*

***Аннотация:** Рассмотрены возможности использования видео-ресурсов в преподавании английского языка как иностранного учащимся средней школы. Определены преимущества использования видео-ресурсов для развития навыков аудирования; сформулированы критерии отбора материалов.*

***Ключевые слова:** аудирование; навыки; видео-ресурсы.*

---

УДК 574  
ББК 0145

## **TEACHING PROFESSIONAL VOCABULARY TO CIVIL ENGINEERING STUDENTS**

**O. N. Apraksina**

Tambov State Technical University, Tambov, Russia  
*e-mail: Apraksina-Olga@rambler.ru*

***Abstract:** The article considers some aspects of English for Specific Purposes (English. English for Specific Purposes, ESP), on the example of the professional language of Civil Engineers.*

***Keywords:** civil engineers, English for specific purposes, professional communication.*

The word "communication" comes from the Latin "communico" - do general, associate, communicate. There are a lot of definitions of "communication". American scientist Jurgen Ruche calls 40 different approaches to communication in various fields, including architecture, anthropology, psychology, politics, and many others.

[1] Business communication singled out in a separate area of research as "interpersonal communication for the purpose of the organization and optimization of a particular type of object activity: Industrial, scientific, commercial, management, construction, etc." [2] Business communication is characterized by the specifics of the speech situation, members of which are official representatives performing their duties. The purpose of business communication is the organization of cooperation, built on mutual respect and trust.

Recently, various types of professional communication have been actively investigating, in particular the medical field [3], economic [4], in the language of modern architects [5; 6]. The work by N.G. Kuznetsova and O. Stepicheva shows development of architectural and constructional terms on the material in German. [7] This article raises to demonstrate language features of professional communication used by civil engineers, and to characterize the word-formation means, enriching the terminological apparatus of the communicants by the examples in English and Russian.

The analysis of online dictionaries [8; 9] revealed such a feature as the use of the metaphoric and metonymic description of the building structures. In the first case the mechanism involved is derivation association by similarity. For example: the horse (English a roof skate.) is the part of construction located at the highest point of the horizontal edges of the roof, which is formed by the junction of roof rays. Different elements are also attached to the edge by the ridge. There is ventilation of both the roof and the roof space through this point. The name comes from the resemblance by association with posture "rider" in the performance of roofing work on the highest point of the roof. Similarly a synonym of the term "horse" was formed - a comb (English A ridge.), denoting the upper point of the roof. Metaphorical transfer is based on a comparison with a cock or hen, namely the upper part of the poultry head. In the second case the association by contiguity is used. The certain connection is seen in the basis of the replacement, such as:

- shape: hip roof / a hipped roof; Dome roof / domed roof; window box / a window box; Fan box / a fan-shaped window, a fanlight; door leaf / a door leaf;
- function / purpose: the window in the form of a keyhole / a keyhole window; accordion folding door / a folding door (in the last example is seen similarities with the actions inherent in playing a musical instrument);
- color: brick color / a brick color; the color of wet asphalt / a the color of wet asphalt; the color of bottle glass / bottle green;
- place of origin: Portland / a Portland cement (the name is associated with the city of Portland, which began commercial production of this type of concrete).

Qualitative adjectives are widely used in the categories of building materials: light concrete / a light weight concrete; heavy concrete / a heavy weight concrete. There is a significant percentage of borrowings from English language into Russian. For example:

-Big-bag (from the English. Big-bag) -soft containers for transporting and storing bulk goods, they are used for the warehousing, storage of secondary raw materials and waste disposal.



-Town House (from English townhouse.) - A complex of low-rise houses with separate entrances, combined with each other by side walls and has its own small plots of land.

-Spacer ( from the English «spacer») - the thin hollow perimeter frame between the panes of glass; inside the spacer is a desiccant.

-Split (from the English Split-system.) - Air conditioning split type, consisting of 2 or more blocks.

-Sandwich panels (from the English Sandwich panels.) - The name of the panel, made of thermally insulating core, made of mineral wool mostly, expanded polystyrene and polyurethane foam. The outer and inner surfaces of the sandwich panels are typically rigid steel, aluminum or plastic sheets.

Thus, even a brief overview of word-building features that are used in the formation of terminological apparatus used by civil engineers, reveals the creative possibilities of Russian and English languages, on the one hand, and on the other hand, demonstrates the common and national specific methods in the nomination. It appears that further investigation of linguistic features of professional communication of civil engineers can lead to interesting conclusions concerning not only the lexical communication design, but also its linguo-cognitive and pragmatico linivistical characteristics.

#### **References:**

1. Kashkin V.B. Vvedenie v teoriju kommunikacii: uchebnoe posobie. [Introduction to communication theory: a tutorial.]/Kashkin V.B. Voronezh, 2000, pp 23-24. (Rus.)
2. [Psychology and ethics of business communication: the textbook for universities] (Rus.) / ed. V.N. Lavrinenko. Moscow. 2008, pp 111-113.
3. Zubkov O.S. Nekotorye lingvokul'turnye osobennosti reprezentacii professional'noj metafory v medicinskoj kommunikacii [Some Linguistic and Cultural Aspects of representation of professional medical metaphors in communication] /Herald of Chelyabinsk State University. Serie: Philology. Arts. 2008. Vol. 60, № 33 (248). 2011. pp 53-55. (Rus.)
4. Borodulina N.Ju., Glivenkova O.A., Guljaeva E.A. Lingvokognitivnoe issledovanie metafory v jazyke dlja special'nyh celej (na primere jazyka jekonomiki) [Lingvo-cognitive study of metaphor in language for special purposes (at examples of language of the economy)] / Vestnik CIE Moscow State University. 2015. №4. p.7-12.(Rus.)
5. Borodulina N.Ju., Guljaeva E.A., Makeeva D.D. Lingvokognitivnye harakteristiki professional'nogo jazyka arhitektorov: perevodcheskij aspekt [Lingvo-cognitive characteristics of professional language of architects: translation aspect] / Collection of scientific conferences, 2015. № 1-2 (1). Scientific works of Tambov State TechnicalUniversity.p.80-84.(Rus.)
6. Kuznecova N.G., Zajceva I.E., Stepicheva O.N. Professional'nyj jazyk arhitektorov: sistemnyj podhod k slovarju (na materiale anglijskogo, nemeckogo i francuzskogo jazykov) [Professional architects language: a systematic approach to the dictionary (on the material of English, German and French Philology) ]./ Questions of theory and practice., Tambov: Diploma, 2016. № 6 (60):. Vol 3, Part 2.p.98-107.(Rus.)
- 7 Kuznecova N.G., Stepicheva O.N. Nazvanija novyh stroitel'nyh materialov v arhitekturno-stroitel'noj terminologii nemeckogo jazyka [Names of new building materials in architecture and construction terminology] / German Philology. Theory and practice Issue № 9-2 (51), 2015. p.122-126. (Rus.).

# ПРОФЕССИОНАЛЬНАЯ КОММУНИКАЦИЯ ИНЖЕНЕРОВ - СТРОИТЕЛЕЙ: СЛОВООБРАЗОВАТЕЛЬНЫЙ АСПЕКТ

**О.Н. Апраксина**

Тамбовский государственный технический университет, Тамбов, Россия  
*e-mail: Apraksina-Olga@rambler.ru*

***Аннотация:** В статье рассматриваются некоторые аспекты английского языка для специальных целей (ESP), на примере профессионального языка инженеров-строителей.*

***Ключевые слова:** инженеры-строители, английский для специальных целей, профессиональная коммуникация..*

---

УДК 378.14  
ББК 74.5

## REFORMS OF ARCHITECTURAL EDUCATION

**I.P. Volkova, K.M. Savelyeva**

Tambov State Technical University, Tambov, Russia  
*e-mail: volkovaii@yandex.ru*

***Abstract:** Problems of training young specialists in architectural sphere have been identified, primary tasks in the new system of education have been set. Mechanisms of future architects' adaptation to practical activity have been regarded.*

***Keywords:** architect, architectural education, vocational training.*

At all times architectural heritage has not only been masters' creative expression but also included all the spheres of life such as social, economical, political, technical and others. Most countries describe our time as a period of rapid transformation of the system of education. They realize that today the system of education has transferred from conservative to dynamic. Education is modifying and it changes all the aspects of our social life. That is why reforms in education nowadays is one of the major factors of development of social sphere.

At present training of competent specialists in architecture in our country faces some problems. During the period of reformation of higher professional education (change to two-level European system Bachelor/Master's degree program) there is a reduction of period of training and redistribution of study hours between various disciplines; intensity of information transmission and perception increases. Moreover, it should be mentioned, that there is some gap between national building industry and the western one. First of all it concerns technology of materials and construction manufacturing, designing engineering systems and etc. These circumstances project automatically into the process of future architects' training. Engineering disciplines are not always taught closely correlated with architectural

design, and this aspect degrades quality of students' architectural projects. Additional difficulty is the fact that according to our legislation architects are responsible for "drawing issue" only, while technical clients are in charge of all the other stuff. In western countries an architect passes all the stages of designing and constructing together with a client and is responsible for the final product - an erected building. Such responsibility allows architects to improve themselves as specialists after graduation.

Difficulties listed above demand reforming of traditional method of design training existing in our country.

Future architects' training, combining art and technical component, is always a unique, individual, "piece" process. Primary tasks in new system of architectural education are identification of individuality; development of an ability to express thoughts and ideas; search for original problem solving; moving beyond stereotypical thinking ("pattern gap"), which was formed by the environment and completed buildings, generally accepted standards of construction and well-known structures. In such a situation it is important to reveal the main essence of architecture as a type of creative activity which aim is to combine an idea and its realization, conception and space. Understanding and realization of this aspect is one of the major tasks of architectural education that should be performed in the first years of training and in direct relationship between several disciplines such as architectural design, compositional modeling, architectural graphics, breadboarding, engineering structures. For this purpose we should make adjustments to existing course projecting right now. While modernizing architectural education the following pedagogical aspects should be taken into consideration: introduction of intermediate express tasks, which lead to performing course projects; the change of the approach to performing clauzuras (combination of graphical and three-dimensional components); introduction of competition elements etc.

At this stage of teaching it is important to introduce some points to educational process for students: an opportunity to document design stages; exchange opinions; accept both teachers and other students' criticism; an opportunity to experiment with the shape, image and functions and also ways of expression of architectural idea (presentation of course project materials).

The process of discussion ideas at the first stages of designing generates such skills as discussion skill, ability to evaluate an object and environment they create; ability to take up a role of who and for whom and for what purpose they do the project. This should become an integral part of the specialty. After the stage of creative self-expression there goes another one - ability to give a competent analysis of designing task; program conditions, opportunities and ways of solving, limitations. Modeling situations for designing is an essential component for architects' training. Academic designing forms students' architectural and town-planning worldview, helps them understand social, economical and engineering problems; settlement patterns; dimensional organization of living environment, which takes into account the interests of a person and society, relationship between nature and architecture. It is important for a student to realize that future prediction is an integral part of his/her

present-day architectural training. Architectural education today should set project tasks as research ones.

So, it is important to provide a wide range of diverse variants for a course project within one theme. That can be a real environment for designing (sub-base, photo fixation) either set by the teacher or chosen by the student himself; restrictive factors (population category, job, town environment context), designing in a certain architectural style (bionics, ecological architecture, high-tech), working out an unusual, exceptional constructive solution etc. All these aspects will help students to bring the situation of course design closer to real projects in their practical work after graduating. Also it will help them to analyze and realize that in variety of conceptions of architectural process development the main aspect is its openness, accessibility and objectivity.

If we address commercial and competitive projects the striking thing is a thorough analysis, the quality of which is very close to a scientific research. And that is what we would like to see in students' course projects. An opportunity to participate in practical work being undergraduates is a giant step towards professional realization of future architects.

Today we suffer from a lack of mechanisms of students' adaptation to practical activity. Both students of baccalaureate and magistracy (Bachelor and Master's degree) and teachers do not have an opportunity to take part in real project work, design complicated (in terms of architecture and construction) structures. But this may become real when competitive workshops, studios and small enterprises attached to architectural universities are opened. So, students could adapt to practical work quicker and easier and also do scientific and applied research.

Thus, traditional approaches to architectural education nowadays, from the point of view of solving urgent problems at present and in the future, should be reformed. This is a result of unjustified attempts to solve psycho-pedagogical problems in architectural sphere within educational section. Necessity of substantial change is not in doubt any more, that is why the history of formation and development of architectural education, methods and techniques of this profession have become a subject of enormous polemics and fundamental discussions. Theoretical research leads to the development of fundamentally of teaching subjects new methodology and testing them by scientists and practitioners of architecture.

#### **References:**

1. Ledeneva G.L. Mehanizmyi produktivnogo myishleniia v tvorchestve architectora. [Mechanisms of productive thinking in an architect's creative work: monograph]/ G.L. Ledeneva. - Tambov: Pershin's Publ., 2011.- 184 p. (Rus)
2. Melodinskiy D.L. Architekturnaia propedevtika. [Architectural propedeutics: history, theory, practice.] 2 publ.- M.: Knizhniy dom "LIBROKOM", 2011.-400p. (Rus)
3. Metlenkov N.F., Stepanov A.V. Arhitektura. [Architecture: Training Manual for comprehensive schools].- 2 publ. - M., Architecture-C, 2004.- 176p.: il. (Rus)

## РЕФОРМЫ АРХИТЕКТУРНОГО ОБРАЗОВАНИЯ

**И. П. Волкова, К. М. Савельева**

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: volkovaii@yandex.ru*

**Аннотация:** Выявлены проблемы подготовки молодых специалистов архитектурной сферы, поставлены первоочередные задачи новой системы образования. Рассмотрены механизмы адаптации будущих зодчих к практической деятельности.

**Ключевые слова:** архитектор, архитектурное образование, профессиональная подготовка.

---

УДК 574  
ББК 0145

## SOME WAYS OF IMPLEMENTING DRAMA TECHNIQUES INTO ENGLISH LANGUAGE TEACHING

**M.D. Kozintseva, N.I. Igolkina**

Saratov State University, Saratov, Russia

*e-mail: marin15121991@mail.ru*

**Abstract:** This article discusses several ways of using drama to support language learning at any level particularly for development speaking skills. Up to the present moment many teachers still prefer making use of routine ways of teaching English giving emphasis only on grammar teaching. However, it is not the most productive way to teach speaking a foreign language. This is one of the reasons for language learners to fail to communicate with native speakers. Another reason is that lessons are not enough motivating and do not represent real communication, as a result, students do not use another language full-scale. Here some possibilities and benefits of using drama to make lessons more fruitful and true to life for different types of learners are presented.

**Keywords:** English Language Teaching (ELT), drama technique, young learners, adult learners, alternative assessment

Anyone would agree that the most effective way to teach ESL (English as a Second Language) is to provide learners with opportunities to acquire English in the context of everyday situations with the emphasis on communicational skills. Drama is one of the most promising technique to achieve this. Moreover, drama methods can be successfully used for adults teaching, because it helps them to go dip in the foreign language culture, which is very important for any language studying. One of the benefits to implement drama into language teaching is to organize effective alternative assessment for learners of different ages. Alternative assessment is a way to evaluate learner's language skills, because it shows his or her ability to use the language. This technique is used widely because of its effectiveness.

Alternative assessment has become a very important part of learning and teaching

foreign languages [1]. The alternative assessment method is based on students' evaluation of their own learning and results, so they can try to reflect on their linguistic development. With alternative assessment students make real use of the language for an actual purpose, and learners' motivation might increase, because they can demonstrate achievements they have gained and take responsibility for their learning. What is even more important, they can see their progress.

Moreover, alternative assessment uses a wide variety of formats, such as checklists, journals, logs reading, portfolios, role-play videos, audio-tapes of discussions, self-evaluation, questionnaires, teacher observations, and anecdotal records to assess the performance of students [2]. There are many issues that teachers should consider when they are going to use alternative assessment in the class. These issues are multifaceted. The teacher must integrate them properly into an ongoing lesson plan in the instructional program. They range from the purpose, focus, and setting to the stakes and shareholders of assessment [2].

It is well known that bringing real-life situations into the classroom improves the student's sensibility to the language studying. The method of drama teaching include all four integrating skills that are needed for mastering foreign languages: writing, reading, speaking and listening. This is a key part of alternative assessment. Consequently, the use of drama in ELT is a perfect way to evaluate the development of learners' language skills.

Drama may include mime, role-playing, extended role-playing (or improvisation), simulation, interaction activities such as various forms of dialogues, and dramatized story telling. So drama takes several forms in the language classroom, but it should always be a communicative activity. It should not be just the performance of plays before passive audiences, but the activity where student makes the choices [3]. In general, drama is concerned with both the product (the performance) and the process of language learning [4]. Topics for scenarios can come from students' personal lives, their communication with other students and teachers at school, work environments, or scenes taken from readings or literature [5].

It is very fruitful to use dramatizing with young learners. Dramatizing means that the children become actively involved in a text [4]. Most of the young learners are always very shy to speak a foreign language, and dramatizing makes lessons more meaningful and memorable than drilling or mechanical repetition.

Drama helps children to activate their language abilities and have fun. Using drama activities has clear advantages for language learning [4]. It helps children start to speak and gives them the chance to communicate. Learners even with low language level can overcome the language barrier and start speaking a foreign language. The use of nonverbal communication, such as body movements and facial expressions, can help them to feel free and reduce the pressure that students feel. So, the use of drama helps the learners to talk sooner.

Drama involves children at many levels such as their bodies, minds, emotions, language, and social interaction [4]. Dramatizing allows children to be emotionally developed which is very important for them. Dramatizing can be effectively used after some lesson routine as it can add a change of mood to the classroom. It is

especially important for young learners.

Besides, the methods of drama are widely used even for adult teaching English. One of the reasons is that it is authentic. Using drama enables students to use English appropriately in real conversations, expressing emotions and ideas and listening to the feelings and ideas of their peers. In other words, English is taught in the context in which it will be used in real life situations, which are far removed from lists of vocabulary and work sheets and which makes students aware of the language primarily as a means of communication.

This conversational use of language promotes fluency. While learning a play, students are encouraged to listen to, potentially read and then repeat their lines over a period of time. By repeating the words and phrases, they become familiar with them and are able to use them with increasing fluency. In addition, drama also teaches them to state their words properly and to project their voices when they speak, helping them to become clear and confident speakers. Drama also helps to improve the understanding and retention of a word. Most and least are very useful advantages of this method that help adult students to learn proper language that is used in real life. Drama helps students to start even thinking in the different language and to approach to the more proficient level of mastering the language.

Drama can be helpful for the adult students who need to learn English for their job. Drama can provide context for the learning of specialized vocabulary for the meetings, for making appointments, for using during business dinners, etc. Students can see the behaviour of the characters acting in the scene. They also see what the actors are thinking about. It is very important to train this ability for those adult students who work with the people of other nationalities. It can be clearly learned from dramatizing.

It is important to emphasize that using method of alternative assessment such as drama activities helps the students to activate their language abilities and start speaking. Dramatizing is motivating and it is fun for the learners of all ages. Even the children it can work successfully and in most cases, they like drama activities very much. Drama activities also develop students' intelligence, their imagination and creativity because. Dramatizing is very effective for teaching oral communication among adult learners of English as a second language. Thus, English language skills will be developed successfully.

### **References**

1. Reflective practice: assessment of assignments in English for Specific Purposes, G. Kavaliauskiene, L. Kaminskiene & L. Anusiene, *IBÉRICA* 14, 2007: 149-166
2. Using Cooperative Learning to Alternative Facilitate Assessment, Ghazi Ghaith, July, 2002, English Teaching Forum
3. The Use of Drama in English Language Teaching, Paul Davies, *TESL Canada Journal/Revue TESL DU Canada*, Vol. 8, NO.1, November 1990.
4. Using Drama with Children, Galina Zalta, 2006, Number 2, 24-46, English Teaching Forum
5. Topics for scenarios can come from students' personal lives, their communication with other students and teachers at school, work environments, or scenes taken from readings or literature, Rick Rosenberg, 2009, Number 4, English Teaching Forum

# О НЕСКОЛЬКИХ СПОСОБАХ ВНЕДРЕНИЯ ЭЛЕМЕНТОВ ДРАМАТУРГИИ В ПРАКТИКУ ПРЕПОДАВАНИЯ АНГЛИЙСКОГО ЯЗЫКА

М.Д. Козинцева, Н.И. Иголкина

Саратовский государственный университет, Саратов, Россия  
e-mail: marin15121991@mail.ru

***Аннотация:** В данной статье обсуждаются способы использования элементов драматургии в преподавании иностранных языков обучаемым с разным уровнем владения аспектами речевой деятельности. До сих пор многие преподаватели отдают предпочтение обучению грамматическим навыкам. Данный подход не гарантирует обучение говорению как аспекту речевой деятельности, что объясняет неспособность обучаемых осуществлять коммуникацию с носителями иностранного языка. Еще одна причина заключается в том, что обучаемым не всегда хватает мотивации для моделирования реальных коммуникативных ситуации. В статье рассмотрены возможности и преимущества использования элементов драматургии с целью повышения эффективности занятий для обучаемых разных возрастов.*

***Ключевые слова:** обучение английскому языку, элементы драматургии, обучение детей взрослые обучаемые,*

---

УДК 378  
ББК 74.58

## E-LEARNING IN EUROPEAN AND RUSSIAN HIGHER EDUCATIONAL INSTITUTIONS

L.Yu. Korolyova

Tambov State Technical University, Tambov, Russia  
e-mail: korolyova-lyu@yandex.ru

***Abstract:** The article focuses on the problem of using e-learning in higher educational institutions of Europe and Russia. The results of the survey conducted by the European University Association on the attitude of European HEIs to e-learning are given. The approach of Russian HEIs to this form of teaching is analyzed. The advantages of e-learning and its role in the future of the educational process in Russia and Europe are considered.*

***Keywords:** e-learning, higher educational institution, information technologies, massive online open courses, online learning.*

### Introduction

The internet communication nowadays allows every person to participate in various activities which are arranged all over the world. These activities also include the process of getting a higher education online. It has become possible due to the emergence of numerous massive online open courses as well as the use of modern information technologies for teaching students by higher educational institutions



(HEIs) themselves. But the problem is the impact of e-learning on higher education and its future role in the educational process. Different countries have their own approaches to this problem. However it is clear that HEIs are adapting to the requirements of the contemporary society trying to use state-of-the-art information technologies to get students interested in the teaching process and involve them into all activities which must result in the education appropriate for highly qualified specialists.

In general e-learning includes four stages:

courses on CD-ROMs;

distance learning with teachers;

e-learning itself implying the use of special interactive programs;

massive online open courses (MOOC) [1].

The advantages of e-learning are as follows:

its flexibility;

its availability for people;

the opportunity of getting an education without leaving your home (it is especially necessary for disabled people as well as for those who do business and care about children etc.);

the transparent structure of the educational process (well-planned courses with clearly formulated goals and results as well as control systems);

the opportunity to get the latest information;

the ability to discuss the course and its modules with a large audience from all over the world;

in general, the opportunity to get an experience of communicating and dealing with representatives of different cultures in different contexts.

### **E-learning in European and Russian HEIs**

Let us consider the experience of European and Russian HEIs concerning e-learning and the extent to which it is used in the educational process.

The European University Association conducted a survey between October and December 2013 on the use of e-learning in HEI. 249 answers from higher education institutions, in their majority universities, from 38 European systems (EU and wider Europe), were received. The survey asked about the type of e-learning institutions use, their experiences in this area and their expectations for the future. It considered blended and online learning in various formats. The survey posed questions regarding support structures and services, intra-institutional coordination, quality assurance and recognition. The results of the survey show – with very few exceptions – that practically all higher education institutions of the sample have started to embrace e-learning. Most of the surveyed institutions are using blended learning (91%), integrating e-learning into conventional teaching, but surprisingly 82% of institutions also indicate that they offer online learning courses. Less frequent, but seemingly also on the rise, are other forms of provision such as joint inter-institutional collaboration and online degree courses. Online examinations are likely to become more widely used for all students in all or most disciplines, also for conventionally taught courses.

Besides pedagogical and economic motives, the institutions refer to a growing need for flexibility of time and place, and better use of resources, benefiting both residential students and a wider range of professional and other lifelong learners [3].

As for Russia e-learning is officially included into the teaching process according to the Federal law “About the education in the Russian Federation” of December 29, 2012 [2]. It is used quite frequently but mainly by major higher educational institutions due to the greater availability of information technologies and financial opportunities in these institutions. Therefore, such universities as Moscow State University named after M.V. Lomonosov, St.Petersburg State Pedagogical University can be considered as examples of those HEIs which provide public online courses in various disciplines depending on the level of students’ training and interests. It is also a good opportunity for teachers of higher educational institutions to improve their qualification with the help of such courses.

HEIs located in smaller towns of Russia are focused on conventional teaching although blended learning is used in some of them but the percentage of such institutions is not so high as in European countries.

Online examinations are not widespread in Russian HEIs as teachers do not trust their results relying on conventional systems of controlling students’ knowledge.

According to this Russia seems to be falling behind in applying e-learning techniques in education, as indicated by the 2012 report of the SeeMeadia e-learning service agency, which conducts webinars and on-line training. Educational experts say Russia may be lagging five-to-seven years behind the rest of the world [4].

But the problem is whether e-learning has only advantages or there are some drawbacks as well.

The European respondents have no doubts about the value of e-learning. Three quarters of the institutions surveyed acknowledge that e-learning can change the approach to learning and teaching, and 87% view it as a catalyst for changes in teaching methods. Amongst other positive features, they endorse its potential for enhancing learning in mass education settings.

But while only 8% state that they are not certain about the general benefit of e-learning, opinions remain divided on some of its more specific pedagogical merits: for example, 45% are either not certain of the benefits of the flipped classroom, or negate them. Likewise, about half of the respondents either think that e-learning does not improve the quality of learning and teaching, or are not sure that it does. Interestingly only a fraction of respondents are outright negative on these issues whereas a relatively large number appear to be indecisive [3].

In Russia e-learning is only becoming more and more popular but at the level of public courses rather than higher education. It can be supposed that this fact is explained by some conventional and sceptical approach towards e-learning as a form of education which has not proved to be fully trustful yet.

### **Conclusion**

Summing up the information given above it can be said that e-learning is a unique and modern method which can be used in the educational process in higher educational institutions but still its effectiveness and the quality of the knowledge

received must be proved. It is clear that in European countries it is applied more than in Russia due to the educational traditions in the latter and the availability of resources in the former. Hence, e-learning can be accepted as an official form of getting a higher education in Europe in the near future unlike Russia where it will take some time.

### References

1. E-learning. Available from <https://ru.wikipedia.org/wiki/электронноеобучение>. (Accessed 30 October 2015).
2. Federalniy zakon "Ob obrazovanii v Rossiiskoi Federatsii" [Federal law "About education in the Russian Federation] of December 29, 2012 No 273-FZ. Available from <https://минобрнауки.рф/документы/2974>. (Accessed 10 January 2017).
3. Gaebel M., Kupriyanova V., Morais R., Colucci E. E-learning in European higher educational institutions. Results of a mapping survey conducted in October-December 2013. Available from [www.eua.be](http://www.eua.be). (Accessed 9 January 2017).
4. Koshkin P. E-learning in Russia: Proceed with caution. Available from <http://www.russia-direct.org/analysis/e-learning-russia-proceed-caution>. (Accessed 16 January 2017).

## ЭЛЕКТРОННОЕ ОБУЧЕНИЕ В ЕВРОПЕЙСКИХ И РОССИЙСКИХ ВУЗАХ

**Л.Ю. Королева**

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: korolyova-lyu@yandex.ru*

**Аннотация:** В статье рассматривается проблема использования электронного обучения в высших учебных заведениях Европы и России. Даны результаты исследования, проведенного Европейской Ассоциацией Университетов, об отношении вузов Европы к электронному обучению. В работе анализируется подход российских вузов к данному вопросу и рассматриваются преимущества электронного обучения и его будущая роль в образовательном процессе в Европе и России.

**Ключевые слова:** высшее образовательное учреждение, информационные технологии, онлайн обучение, открытые публичные онлайн курсы, электронное обучение.

---

## PROJECT-BASED LEARNING IN ESL CLASSROOM

**E.E. Kriventsova**

School № 1315 with Intensive Study of English, Moscow, RF

*e-mail: iamokay@mail.ru*

**Abstract:** *The paper discusses the advantages of using project-based learning in ESL classroom. The types of projects have been identified; the requirements to their practical implementation have been formulated. The experience of using the method of project-based learning has been described.*

**Key words:** *project-based learning; ESL; creativity; communicative competence.*

**Project-based learning** is a teaching method in which students gain knowledge and skills by working for an extended period of time to investigate and respond to an authentic, engaging and complex questions, problems, or challenges. Its main advantage is that a teacher can create an atmosphere where every student is engaged in an active learning process based on collaboration techniques.

The main goal of project-based learning in English language teaching is to help learners develop the communicative competence in a foreign language so as to use the language effectively in real life situations. Another advantage is that this method is good for developing learners' critical thinking skills. In addition, students are required to find and select information independently, which is good for raising independent learners able to analyze the data from different perspectives.

When using the method of project-based learning in the classroom it is important to consider the following requirements:

- 1) formulation of the task, problem or challenge in a thought-provoking and interesting way;
- 2) practical and theoretical importance of the learning outcomes;
- 3) independent (individual, pair and group) activity of students in the classroom or after school;
- 4) structuring of the content of the project (expected results, distribution of roles);
- 5) the use of research methods.

The majority of researchers distinguish the following types of projects:

1. Research projects.

Such projects require a well-designed structure, defined goals, rationale for the research subject for all participants, reference to sources of information, methods, results.

2. Creative projects.

Creative projects usually do not have a detailed structure but they require the presentation of the project results in the appropriate manner.

3. Role playing projects.

In such projects, the structure is planned, but it remains open until the end of the project. Participants take on certain roles because of the nature and content of the project, nature of the problem being addressed.

#### 4. Information projects.

This type of project was originally aimed at gathering information on any object, phenomenon. The participants collect project information, analyze, synthesize and present the facts to a wider audience. Such projects require a well-designed structure, the possibility of systemic adjustments in the course of the project.

#### 5. Interdisciplinary projects.

This type of project vary in size, they can be small projects involving two or three subjects, as well as quite big ones aimed at solving a rather complex issue that is relevant to all project participants. Such projects require coordinated work of several creative groups with clearly defined research tasks, presentation of intermediate and final results.

In practice, students work on different types of projects, in which they collect information on the subject, and give presentations of project results.

The work on any project is divided into several stages.

##### Stage I. Preparation for the project.

The first stage involves a set of communicative exercises that will help learners acquire the necessary vocabulary and skills. Students must be fluent in the active vocabulary and grammar within the framework of the addressed topic, before moving on to the discussion of problems and presentation of the project. I define a few situations that can be used in the classroom to identify the problems to be addressed in the project. The project normally takes three to four weeks.

##### Stage II. Organization of the project participants.

Learners are divided into small groups. Each of these groups works on a particular assignment. The responsibilities are shared in the group given the students' abilities and interests.

##### Stage III. Project implementation.

This stage involves search for information, discussion of this information, and its documentation, selection of research methods for the project. Projects can be implemented at home on their own, or in class. The main thing is not to suppress learners' initiative and treat with respect all ideas they put forward. A teacher acts as a facilitator, trying to create a situation of "success".

##### Stage IV. Project tuning.

The teacher and the students look through the selected material, rearrange it, focus on the most interesting and relevant information.

##### Stage V. Project presentation.

In this stage, learners present the results of the project to their classmates. Projects can be presented in the form of posters, drawings, maps, wall newspapers, etc. Student give their presentations, express their views discuss and answer questions.

##### Stage VI. Summing up.

In this stage, the teacher praises the students for their contribution to the project and encourages them to work on other projects.

Project-based learning can be used in ESL classroom at all levels of studying the language, including elementary students. For example, for secondary school learners I designed a project “Festivals in Britain”. In this project, students worked in small groups to give a presentation on one festival. Each member of the group took responsibility for a particular area of work. Students worked independently and collaboratively. In class, they presented the results of their research in the form of posters and presentations.

To sum up, project-based learning gives students plenty of opportunities to study the topic deeply, broadens their minds, teaches communication, work independently, select materials and present the results of their work. Students take a fresh look at themselves and realities of their daily life, the history and culture of the country and, of course, raise motivation for learning a foreign language.

### References

1. Bell, S. Project-Based Learning for the 21st Century: Skills for the Future. The Clearing House: A Journal of Educational Strategies, Issues and Ideas -2010, Vol. 83 (2). pp 39-43.
2. Thomas, J. W. A review of research on project-based learning. 2000. [Online]. Available at: [http://w.newtechnetwork.org/sites/default/files/news/pbl\\_research2.pdf](http://w.newtechnetwork.org/sites/default/files/news/pbl_research2.pdf) (Accessed: 18.12.2016).

## ПРОЕКТНАЯ МЕТОДИКА ПРИ ОБУЧЕНИИ АНГЛИЙСКОМУ ЯЗЫКУ В СРЕДНЕЙ ШКОЛЕ

**Е.Э. Кривенцова**

ГБОУ «Школа № 1315 с углубленным изучением английского языка», Москва, Россия  
*e-mail: iatoka@mail.ru*

***Аннотация:** Рассмотрены преимущества использования проектной методики при обучении английскому языку в средней школе. Определены типы проектов; сформулированы требования к их практической реализации на уроках английского языка. Описан опыт использования проектной методики на уроках английского языка.*

***Ключевые слова:** проектная методика; английский язык как иностранный; креативность; коммуникативная компетентность.*

---

## COMPARATIVE ANALYSIS OF THE METHODS OF USE OF THE ENGLISH PREPOSITIONS IN THE KAZAKH LANGUAGE

M.M. Lekerova

Buketov Kazakhstan State University, Karaganda, Kazakhstan

e-mail: meruert.lekerova.1982@mail.ru

**Abstract:** *The article discusses ways of translating the English prepositions into the Kazakh language. From a linguistic point of view, the Kazakh language belongs to the Turkic group of languages, and the English language belongs to a group of German languages. Considering the two languages, their similarities and differences were observed. The comparative analysis of prepositions in two languages was made. The English prepositions are translated into the Kazakh language by declensional endings. Due to the fact that the English language has no declensional endings, the word order and prepositions take an important role in the sentence. In this case, they lose their lexical meaning and individual words are not translated into the Kazakh language. The nouns in the English language used various prepositions.*

**Keywords:** *auxiliary words, declensional endings, function words, infinitive turnover, noun, pronunciation of prepositions.*

### Introduction

From a linguistic point of view, Kazakh language belongs to the Turkic group of languages, and the English language belongs to the group of German languages. Both languages share some similarities and features. Examining ways of using prepositions, they can be seen through the declensional endings of the Kazakh language. Prepositions are called function words showing the relation of a noun or pronoun to other words in a sentence. Due to the fact that English has no declensional endings, word order in a sentence and prepositions play a significant role. In the English language nouns are used with various prepositions.

Thus, prepositions are called function words that show a direct relation of a noun, pronoun, number, gerund to other words in a sentence.

These relationships include: space, time, cause, purpose and others.

In the Kazakh language, they are expressed through declensional endings. In the English language declension does not exist as it does in the Kazakh language; also in English, prepositions are only between words.

Auxiliary words: *of, to, with, by, from* refer to declensional relations.

Who? what? - the; who? whose? – of the; to whom? to what? – to the; where? – to the; with whom? – by the; who? what? – the; who? from what? – on, in, between, over the etc.; from whom? from what? from where? – from; with what? – with the.

As well as other function words, prepositions cannot be used independently. and do not change. [1]

Many English prepositions are multifunctional, and only in the context of the speech they have precise and definitely different relationships. For example:

He's brought a letter for you.

Ол хатты сен үшін алып келді.

He's been here for two weeks.

Ол осында екі апта аралығында

жүр.  
 Did they pay you for the work? Олар сенің еңбегін үшін ақы төледі ме?  
 They went out for a walk. Олар серуендеуге шықты.  
 There is a man waiting for you. Сені бір адам күтіп тұр.

Most English prepositions (simple and compound) are used with no difference of meaning in both styles of speech – formal and informal. But this is not always so. Some of the prepositions (usually simple) are preferred in colloquial speech whereas others (most of them compound and synonymous with the simple) are restricted to formal English.

Preposition of direction: *up, down, along*.

He walked *along* the street. (2) He walked *up/down* the street. Sentence (2) does not necessarily mean that the street was on a hill. As in the sentence *He walked up/down the hill*. Informally, the prepositions up and down are used with practically the same meaning as *along*. Thus, sentences (1) and (2) can be treated as having the same meaning. Note. In American English the word downtown means simply the central or business part of a town: *He drove downtown*. [2, 220 p.] In Kazakh language the above sentences are used in such a way: (1) Ол көше бойында серуендеп жүр. (2) Ол көшеден жоғары/төмен қарай кетті. Note. In Kazakh the word downtown means the central part of a town and used with two words: *Ол қаланың ортасына жол жүріп кетті*.

### **Grammar function**

Some English prepositions perform a purely grammatical function, in conjunction with a noun (or pronoun) expressing the same relationship that in our case in the Kazakh language expressed by a declensional ending but without prepositions. In this case, they lose their lexical meaning and individual words are not translated into the Kazakh language. Such examples include:

1. Preposition of, which in combination with the noun (or pronoun) corresponds to the Kazakh Genitive: The roof *of the house* is painted green. – *Үйдің* төбесі жасыл түске сырланды. The theatre is at the end *of the street*. – Театр *көшенің* соңында орналасқан.

2. Preposition to, which in combination with the noun (or pronoun) corresponds to the Kazakh Dative, indicating the person who is drawn to the action: I showed the letter *to the director*. – Мен хатты *директорға* көрсеттім. He explained the rule *to the student*. – Ол *студентке* ережені түсіндірді.

3. Preposition by, which in combination with the noun (or pronoun) corresponds to the Kazakh instrumental case denoting identities person or active force after the verb in the passive voice: The letter was signed *by the director*. – Хатқа *директормен* қол қойылды.

4. Preposition with, which in combination with the noun (or pronoun) is also consistent with the Kazakh instrumental, indicating the subject, with which the action is performed: He cut the paper *with a knife*. – Ол қағазды *пышақпен* кесті.



Every preposition is used with the self-lexical meaning (including prepositions *of, to, by, with*, when they are not using in the number of grammatical function).

Many excuses have several meanings. For example, preposition *in* is used to denote the location (the question where?): He lives in Moscow. – Ол Мәскеуде тұрады. They will arrive in May. – Олар мамыр айында келеді. He will return in an hour. – Ол бір сағаттан кейін келеді. The house was built in three months. – Үйді үш ай ішінде тұрғызды.

In many cases, the use of a different preposition depends solely on previous word – verb, an adjective or a noun. [3, 310, 311 p.] For example, verb *to depend* calls behind preposition *on*: It doesn't depend on me. – Ол маған байланысты емес.

Verb *to laugh* requires behind preposition *at*: He laughed at her. – Ол оны күлкіге салды.

Adjective *sure* requires behind preposition *of*: He was sure of it. – Ол осыған сенімді болды.

Noun objection (as a verb to object) behind preposition *to*\*): I have no objections to that. – Бұған қатысты/қарсы ешқандай қарсылығым жоқ.

### **Pronunciation of prepositions**

In the English sentence monosyllabic prepositions are not usually stressed, and so the vowels are reduced in many prepositions. Look at the blackboard, please. Тақтаға қараңыздаршы.

Note. Prepositions *of* and *on* are never reduced. [4, 540 p.]

Prepositions can be stressed, for example, in the alternative questions: Is your pen on the table or under it? Сіздің қаламыңыз үстелдің үстінде ме, әлде астында ма?

### **Infinitive construction with a preposition for**

Infinitive construction with a preposition (For-Complex) is a combination of an excuse for + noun (pronoun) with the infinitive and can serve the sentence in the functions of various members of the:

#### 1) subject

It's important for a student of History to be well-read in this field. – Тарихшы-студентке осы салада жақсы оқымысты болуы өте маңызды.

#### 2) addition

The travelers waited for the river to open. – Саяхатшылар өзеннің ашылғанын күтіп отырды.

#### 3) definition

The best thing for him to do is to leave this place. – Ең дұрысы (істейтін ісі) оған осы жерден кету керек.

#### 4) Nominal part of the predicate

It is for him to take the final decision. – Соңғы шешімді ол өзі қабылдауы тиіс. [5, 332 p.]

### **Conclusion**

In conclusion, prepositions in the English language are used as a part of speech. In the Kazakh language they correspond to auxiliary words. In a sentence, they play an important role. Comparing foreign language with its own language and given their similarities and differences, we need to learn both languages both in everyday life and

in practice.

### References

1. Bekseitova, M.Z. Doklad. Predlogi v anglijskom jazyke. [Report. Prepositions in English] / M.Z. Bekseitova. <http://sc0017.astrahanka.akmoedu.kz>, 2014. (Rus)
2. Buzarov, V.V. Uchebnoe posobie dlya studentov vysshyh uchebnyh zavedenij. Prakticheskaya grammatika razgovornogo anglijskogo jazyka. [Textbook for university students. Essentials of conversational English Grammar] / V.V. Buzarov. 3 - M.: Akademija, 2010 – 220 p. (Rus)
3. Kachalova, K.N., Israilovich, E.E. Prakticheskaya grammatika anglijskogo jazyka s upraghnenijami i kljuchami [Practical English Grammar with exercises and keys] / K.N. Kachalova, E.E. Israilovich. St.P.: KARO, 2012 – pp. 310-311 (Rus)
4. Bonk, K.A., Kopij, G.A., Luk'anova N.A. Uchebnnik anglijskogo jazyka [English textbook] / K.A. Bonk, G.A. Kopij, N.A. Luk'anova. M.: GIS, 1992 - Vol. 2, Issue 1, 540 p. (Rus)
5. Bondi, E.A. – Uchebnnik anglijskogo jazyka dlja studentov-istorikov [English textbook for students of History] / E.A. Bondi. M.: Izdatel'stvvskogo universiteta, 1977 - 332 p. (Rus)

## СРАВНИТЕЛЬНЫЙ АНАЛИЗ СПОСОБОВ УПОТРЕБЛЕНИЯ АНГЛИЙСКИХ ПРЕДЛОГОВ В КАЗАХСКОМ ЯЗЫКЕ

**М. М. Лекерова**

Карагандинский университет имени Е. А. Букетова, Караганда, Казахстан  
*e-mail: meruert.lekerova.1982@mail.ru*

***Аннотация:** В статье рассматриваются способы передачи английских предлогов на казахский язык. С лингвистической и грамматической точки зрения, казахский язык относится к тюркоязычной группе языков, а английский язык к германской. Рассматривая два языка, наблюдается их сходства и отличия. На предлоги показан сравнительный анализ, включая примеры приведенные в двух языках. Также четко описано, что английские предлоги передаются в казахском языке через надежные окончания. В связи с тем, что в английском языке нет надежных окончаний, порядок слов и предлоги занимают важную роль в предложении. В этом случае они теряют свое лексическое значение и на казахский язык отдельными словами не переводятся. Существительные в английском языке употребляются различными предлогами.*

***Ключевые слова:** вспомогательные слова, инфинитивный оборот, надежные окончания, произношение предлогов, служебные слова, существительное.*

## USING PRAGMATIC TEXTS IN ESL CLASSROOM TO DEVELOP LEARNERS' COMMUNICATIVE COMPETENCE

**N.S. Lobatsevich**

Secondary School № 2100, Moscow, Russia

*e-mail: natalya.irbis@gmail.com*

**Abstract:** *The paper focuses on the possibility of using pragmatic texts for the development of communicative competence in ESL learners. The term "pragmatic text" is understood as an authentic text used in everyday communication of native speakers. The text is considered as a source and a tool for the development of communication skills in a foreign language in secondary school learners.*

**Keywords:** *pragmatics, communication skills, pragmatic text, speaking skills, communication.*

The main aim of teaching a foreign language is the formation of learners' communicative competence, that is, the ability to effectively communicate in a foreign language in accordance with speaker's intention. At the same time, the sociolinguistic competence of communicants plays an important role. Its development is impossible without extra-linguistic knowledge accumulated in the process of studying the culture, traditions, norms of speech behavior of native speakers.

Authentic or pragmatic texts can form the basis for the formation of the communicative competence. The term "pragmatics" was first used by Charles Morris in his studies on semiotics in the 1970-s. According to Morris's classification, semiotics consists of semantics, syntax, and pragmatics. Thus, pragmatics is directly related to the actual process of communication [1, p.3].

The development of pragmatics in linguistics, particularly, the theory of speech acts stimulated interest in the study of verbal behavior and the communicative function of the language. For the first time, there was a shift in the paradigm of linguistic research, which primarily manifested in new approaches to the study of language as a means of communication.

The theory and methodology of linguistic pragmatics determined the role of the communicative situation as a set of factors that influence the nature, aims and ways of communication. This fact was the starting point for the development of the communicative approach, the purpose of which is to teach communication in a foreign language through interaction in the target language. Based on the understanding of language as an active mental and verbal activity, communicative approach to teaching implies the involvement of students in active work on the development of communication skills in a foreign language.

Creating a communicative situation in the classroom dictates a certain logic of presentation of educational materials. According to the communicative approach, assignments and activities performed by the students should recreate a situation of

real communication and its parameters. The types of communicative activities include interactive exercises, role-playing situations, simulations of real communication.

The effective speech practice aimed at the development of communicative skills in real communication situations cannot be implemented without careful selection of linguistic material. A speaker must be able to perform a range of different intentions: to request information, ask a question, express gratitude, etc.

Creation of communicative situations close to real conditions of communication is impossible without understanding of the pragmatic nature of the language. The prominent Russian linguist Yu.S Stepanov noted the role of pragmatics, stressing that the central category of contemporary pragmatics is the subject. The subject-oriented nature of communication implies a choice of language means appropriate to the circumstances [3, p. 326]. The formation of the communicative competence is closely related to the selection of linguistic resources, which would allow the speaker to realize their speech intentions. To do this, a learner must have an idea about how native speakers use the language. In today's practice of teaching a foreign language a variety of sources is used to get this kind of knowledge. These include authentic materials, i.e., those that are not originally intended to be used for training purposes.

The necessity of formation of communicative skills in the process of learning a foreign language determines a special role of pragmatic texts, which are directly involved in daily communication. For the first time the term "pragmatic text" was used in in the context of the requirements for proficiency in a foreign language for high school students. According to I.L. Bim, pragmatic texts are defined as simple authentic texts of various genres that are used in the daily communication of people (ads, billboards, posters, etc.) [2]. There are four main types of pragmatic texts: informative, instructional, persuasive, and documented [4, p. 95].

*Table 1. Classification of pragmatic texts*

Informative	Instructional	Persuasive	Documented
menus, signs, informational signs, ads, reference materials, programs schedules, weather forecast, astrological forecast, poster, plan, map, diagram, etc.	User manuals, guidelines, instructions, guidebooks, recipes, etc.	advertisements, posters, announcements, labels, etc.	identity cards, health insurance, driver's license, birth certificate, certificate of education, financial documents (check, receipt), etc.

Specificity of pragmatic texts is their communicative orientation, namely, the interaction of the speaker (the author of the text) and the recipient (the reader of the text).

The speaker determines:

1. the aims and objectives of the message;
2. the type of verbal behavior;
3. the attitude to reported information and its assessment (or lack thereof);

4. the structure of the text message.

The recipient:

1. interprets the text, including indirect and hidden meanings;
2. experiences intellectual, aesthetic and emotional influence.

When teaching a foreign language it is important to simulate speech situations, which are consistent with the intended purpose of study, namely, teaching real, live communication. It is noteworthy that both the text itself and visual images convey a certain message. By using pragmatic texts in teaching communication in a foreign language, students accumulate impressive "baggage" of extra-linguistic knowledge that will help them form sociolinguistic competence, and build up their understanding of the language as a cultural phenomenon. The use of authentic materials makes it possible to simulate the natural language environment; it is a powerful means of creating an adequate verbal behavior, it helps to make the right choice of language means in the context of a communicative situation.

### References

1. Arutjunova, N.D. Istoki, problemy, kategorii pragmatiki [Origins, problems of pragmatics]. // *Novoe v zarubezhnoj lingvistike: Vyp. 16. Lingvisticheskaja pragmatika.* - M.: Progress. 1985. - pp. 3 - 43. (in Russian)
2. Bim, I.L. Profil'noe obuchenie inostrannym jazykam na starshej stupeni obshheobrazovatel'noj shkoly [Profile training in foreign languages in high school] Tekst. / I.L. Bim. — Moskva: Prosveshhenie, 2007. 168 p. (in Russian)
3. Stepanov, Ju. S. V poiskah pragmatiki (problema sub#ekta) [In search of pragmatists (the problem of the subject)]. // *Izvestija AN SSSR. Ser. lit. i jazyka*, t. 40, 1981, № 4. (in Russian)
4. Chicherina, Ju. V. Metodika obuchenija chteniju pragmaticheskikh tekstov kak osnova formirovaniya mezhdkul'turnoj kompetencii starshih shkol'nikov [Methods of teaching reading of pragmatic texts as a basis for formation of intercultural competence of senior learners] // *Dis. kand. ped. nauk Tekst.* / Ju.V. Chicherina. Nizhnij Novgorod, 2009. - 242 p. (in Russian)

## ИСПОЛЬЗОВАНИЕ ПРАГМАТИЧЕСКИХ ТЕКСТОВ НА УРОКЕ АНГЛИЙСКОГО ЯЗЫКА ДЛЯ ФОРМИРОВАНИЯ КОММУНИКАТИВНОЙ КОМПЕТЕНЦИИ ОБУЧАЮЩИХСЯ

**Н. Лобацевич**

ГБОУ СОШ №2100, Москва

*e-mail: natalya.irbis@gmail.com*

***Аннотация:** Рассматриваются возможности использования прагматических текстов для развития коммуникативной компетентности обучающихся на уроке английского языка. Термин "прагматический текст" понимается как аутентичный текст, используемый в повседневном общении носителями языка. Текст рассматривается как источник и инструмент для развития коммуникативных навыков обучающихся общеобразовательных школ при изучении английского языка.*

***Ключевые слова:** прагматика, коммуникативные навыки, прагматический текст, навыки говорения, коммуникация.*

## ROLE-PLAY AS AN EFFECTIVE FOREIGN LANGUAGE TEACHING TOOL

**A. E. Mayerbekova, A. A. Karmanova**

Academician E. A. Buketov Karaganda State University, Karaganda, Kazakhstan

*e-mail: aida-maerbekova @inbox.ru*

**Abstract:** *This article is devoted to consideration of role-play as an effective foreign language teaching tool. The basic purpose of a foreign language as a discipline consists in helping pupils master the ability to communicate in a foreign language. A foreign language opens to pupils the access to huge spiritual wealth of another nation, therefore it plays the essential part in the solution of major tasks that modern school faces in formation of personality and entrance into the world community. Thus one of the urgent problems of modern methods of teaching foreign languages is the organization of training children of different ages by means of games. Owing to game not only children, but also students and teenagers have their memory and attention developed and their perception improved. And the most important is that pupils gradually begin to perceive educational process as something joyful and creative.*

**Keywords:** *children's creativity, motivation, skills and abilities, communication, role-play, self-expression.*

Due to the dynamic changes in political and economic life of society in the 21st century we come to the need of studying English as a means of cross-cultural communication. The creating of the near-real-communication conditions at the lesson of English will be possible with the help of role-play. Thereby the role-play gives ample opportunities for activation of educational process and can become an effective tool for teaching a foreign language.

The training opportunities of games are well-known long ago. Many outstanding teachers fairly paid attention to efficiency of using games in the course of training. Now the problem of using a conversational game in teaching a foreign language is widely covered in domestic and foreign methodical literature.

Game is "a specially organized activity demanding tension of emotional and intellectual strength" [1]. The nature of game, its high educational potential is determined by the age and psychological particularities of children's development. From the earliest age game is one of the major activities of a child. Through the game children get acquainted with the world surrounding them, gain new skills and knowledge. They, like little spectators in a big theatre, watch the fascinating performance called "Life" with wide-open eyes and absorb everything that occurs around them. And then in game with peers their genius to «acting» gets revealed. In game a child learns to communicate, he grows and develops. Games help children become creative persons, teach them to treat any deal informally. Games bring children joy of communication, enthusiasm, possibility to manifest the abilities and talents. Creativity is inherent in pupils by nature. They like to compose, invent, fancy, pretend, and perform. Children's creativity withers quickly if no interest in it is shown

from people around. Cooperative creative games pull pupil and teacher together. This reveals one of the main principles of effective education. While playing pupils all the time seek to go forward, to better results.

American psychologist George Herbert Meade in his book "Mind, Self, and Society" saw in game the generalized model of formation of what the psychologists call "self-sufficiency" of a person, "collection" of the "self" [2]. Game is a sphere of self-expression, self-determination, self-examination, self-realization of a person.

Game always assumes decision-making — what to do, what to say, how to win. The desire to solve these issues accelerates cogitative activity of players. If a child thinks in a foreign language, a game in this case gives rich training opportunities. Of course, children do not seriously think of these opportunities. For them game is first of all a fascinating activity in which all are equal. As T. G. Lyubimova precisely marks out in her work "We develop creative activity", game "is level even to weak pupils" [3].

Game stimulates learning motivation, raises school students' interest and desire to perform a task well. Role-play becomes an effective tool for teaching a foreign language, as it considerably defines the choice of language means, promotes development of speech skills and abilities, and allows modeling the communication of pupils in various speech situations. Role-play represents the exercise for mastering skills and abilities of dialogical speech in the conditions of interpersonal communication. Game helps to rally children's group, timid and shy pupils are involved in vigorous activity, which promotes the assertion of everyone in group. Role-play cultivates the conscious discipline, diligence, mutual aid, readiness to join different types of activity, self-sufficiency, ability to argue the point of view, to show an initiative, to find the optimal solution in certain conditions. However, conducting a game demands observance of some requirements. Role-play needs to be well-prepared and accurately organized. It is important to convince pupils of the need to play this or that role well. Only in this case their speech will be natural and persuasive. It is very important to get a game accepted by all pupils of group.

The same games can be carried out differently, take different forms, but improvisation is a cornerstone of all of them. Of course, it is necessary to consider that each age period is characterized by its type of leading activity. So at the initial stage various role-plays with the use of children's favourite literary and fairy tale characters may be held. For example, when teaching questions children willingly play curious Buratino, judicious Sherlock Holmes. The dialogue-inquiry preconditioned by Buratino's character allows making teaching of various interrogative patterns in a fascinating form [4]. With complication of a training material games also become complicated. At an average and senior levels a game can be a means of reconstructing subject and social content of future professional activity of expert. As an example can serve the game "Meeting of a Big Eight" during which pupils do not only practice necessary lexical and grammatical means, but also study business etiquette at the same time. After introduction and practicing the words on the topic "Appearance" in the 7th grade, it is possible to organize role-play "The friend is lost". Pupils receive a task: "Imagine that you are in Great Britain, on a tour travel. Your friend is lost. The

police officer approaches you and offers help, asks to describe the appearance of the lost friend" [5].

One more plus of role-plays is that they help to develop pupils' feeling for language, stimulate their desire to develop the skills and abilities, allow feeling the language as something alive and in each situation something new and important. Role-plays do not only attract great interest of pupils at different levels, they also see in them big practical benefit, as role-plays give the chance of mastering oral forms of foreign-language communication in various situations taking into account socio-cultural context, clearly demonstrate ways and possibilities of practical use of the knowledge gained.

However there are also minuses in carrying out role-plays: so, successful organization of role-play demands big preparatory work in which it is desirable to bring elements of role-play and modeling, which is definitely time-consuming. Also teacher can face the pupils' unwillingness to participate in a game which is also one of the negative features of role-play. For creation of favorable atmosphere at a lesson teacher needs to learn to come into contact with all pupils. The benevolent, creative atmosphere causes school students to feel content and pleasure. The more free a pupil feels in role-play, the more initiative he will be in communication.

Role-plays help to make process of teaching a foreign language interesting and informative. The feeling of equality, the atmosphere of dedication give children the chance to overcome shyness, restraint, to overcome a linguistic barrier, fatigue.

Thus, the role-plays reflecting pupils' psychology and their natural need for self-expression are one of effective tools of teaching English and foreign-language communication, and also can serve as a means of bridging the language gap.

### References

1. Kashina E.G. Role-playing and linguistic games. — Samara: Publishing house of SAMGPU, 1992. — Page 5.
2. Meade J. G. Favourites. — M.: RAS INION, 2009. — Page 47.
3. Lyubimova T. G. We develop creative activity. — Cheboksary: Clio, 1996. — Page 15.
4. Kolesnikova O. A. Role-playing games in training in foreign languages. // IYaSh M., 1998. - No.
5. <http://festival.1september.ru/articles/211062/>

## РОЛЕВАЯ ИГРА КАК ЭФФЕКТИВНОЕ СРЕДСТВО ОБУЧЕНИЯ ИНОСТРАННОМУ ЯЗЫКУ

**А. Е. Маербекова, А. А. Карманова**

Карагандинский университет имени Е. А. Букетова, Караганда, Казахстан  
*e-mail: aida-maerbekova @inbox.ru*

*Аннотация:* Данная статья посвящена рассмотрению ролевой игры как эффективного средства обучения иностранному языку. Основное назначение иностранного языка как предметной области состоит в овладении учащимися умением общаться на иностранном языке. Иностранный язык открывает учащимся доступ к огромному духовному богатству другого народа, поэтому ему отводится существенная роль в решении важнейших задач, стоящих перед современной школой в плане формирования личности и ее вхождение в



мировое сообщество. Поэтому одной из актуальных проблем современной методики преподавания иностранных языков является организация обучения детей разных возрастов с помощью игр. В результате игры у детей (и не только у них, но и среди студентов и подростков) развивается память, внимание, улучшается восприятие. И что самое главное, учащиеся постепенно начинают воспринимать учебный процесс, как нечто радостное и творческое.

**Ключевые слова:** детское творчество, мотивация, навыки и умения, общение, ролевая игра, самовыражение.

---

УДК 378  
ББК Ш13(Ан)

## CLIL VS “LANGUAGE IMMERSION”: DIFFERENCES AND SIMILARITIES

**T.V. Mordovina**

Tambov State Technical University, Tambov, Russia  
*e-mail: tvmordovina76@mail.ru*

**Abstract:** One of the ways of foreign language learning improving is the implementation of Content and Language Integrated Learning (CLIL) programmes, because this kind of approach is the best way to increase students' foreign language proficiency without it taking up additional time in an already crammed curriculum. CLIL is fundamentally based on methodological principles of “language immersion” and these terms are often used indiscriminately. The purpose of this paper is to answer the question “what exactly does CLIL involve?” and to highlight the differences and similarities between CLIL and language immersion.

**Keywords:** Content and Language Integrated Learning (CLIL), language immersion.

Content and Language Integrated Learning (CLIL) is a competence-based teaching approach that created in 1994 by David Marsh. It is an approach for learning content through an additional language (foreign or second), thus teaching both the subject and the language. CLIL encourages the use of curricula which promote the right interpersonal skills, cultural sensitivity and communication and language abilities which are in demand by today's employers. [1]

This kind of approach has been identified as very important by the European Commission because: "It can provide effective opportunities for pupils to use their new language skills now, rather than learn them now for use later. It opens doors on languages for a broader range of learners, nurturing self-confidence in young learners and those who have not responded well to formal language instruction in general education. It provides exposure to the language without requiring extra time in the curriculum, which can be of particular interest in vocational settings." [2]

CLIL is fundamentally based on methodological principles established by research on “language immersion”, which does not require any particular talent and is suitable for all learners and all social backgrounds. It promotes the cognitive development of learners and is the method for learning languages that leads to

attaining a far higher level in the foreign language than through conventional language courses.

Although different immersion models exist, some features are common to all of them (Arnau, Comet, Serra, and Vila 1992). The following five principles encompass clear psycholinguistic and methodological elements not only of immersion programmes but also of any CLIL programme:

1. The final goal of immersion programmes is that the students become proficient in both the L1 and the L2, without any detriment to the acquisition of academic knowledge.

2. The language the students are taught in must be new to them, so that its learning resembles the L1 acquisition process.

3. The teaching staff must be bilingual, both to be able to implement the programme with the greatest guarantee of success and to ensure that throughout the school day all school activities can be smoothly carried out in the L2.

4. The communicative approach is fundamental to all immersion programmes. The objective is to obtain effective communication. For that reason, it is essential to have a learning environment that motivates students through significant situations and interlocutors who are really interested in their development and linguistic progress. [3]

In spite of the above similarities, several issues highlight the differences between CLIL and immersion programmes.

1. The language used in CLIL is not a language spoken locally: unlike immersion programmes, which are carried out in languages present in the students' context (be it home, society at large, or both home and society), the languages of instruction for CLIL programmes are foreign languages and many of the students only have contact with them in formal instruction contexts.

2. A high percentage of the teaching staff in immersion programmes is made up of native speakers who have an excellent command of the language of instruction, whereas this is not usually the case in CLIL programmes. Moreover, immersion teachers have undertaken specific university training in order to prepare them for the needs of CLIL programme. However, the majority of university teacher training courses in Russia do not include any kind of training for CLIL programmes. This is a highly topical issue, and one of the main objectives of this process is to increase the international competitiveness of European universities through a wide range of actions, such as promoting the mobility of citizens, designing joint study programmes, establishing networks and exchanging information. This process is closely linked to the use of foreign languages in the curriculum as a key way of promoting citizens' mobility and employability.

It is also necessary to provide future teachers with training not only in the specific subjects but also in the methodology that will allow them to teach these subjects effectively in a foreign language.

3. The vast majority of immersion programmes are of the starting age type, whereas the CLIL approach shows certain similarities with the late immersion programmes. This means that the amount of exposure to the local and the foreign

language is far from comparable.

4. The goal of immersion programmes is to reach L2 proficiency similar to that of native speakers, whereas CLIL programmes cannot have such a far-reaching objective. For example, by the end of higher education, in the case of English as a foreign language, students are required to reach just level B1.[4]

English has become the predominant foreign language in all CLIL programmes. The CLIL approach stems from immersion programmes, and the psycho-pedagogical foundation, methodological principles, successful implementation in a wide array of contexts, and quantity and quality of research have established immersion as a significant element in the improvement of language teaching. But the differences between these two types of programmes are remarkable and they are connected with language of instruction, teachers, starting age and language objectives.

It can be assumed, that research and teaching practice have to focus on the contributions of each approach and, above all, the idiosyncrasy of teaching content in a foreign language such as English. This leads us to conclude that further research into CLIL and “language immersion” is of great importance. The establishment of reasonable language objectives considering the characteristics of each particular context would make a very useful contribution to CLIL programmes.

### References

1. Lasagabaster D., Sierra J.M. Language attitudes in CLIL and traditional EFL classes. *International CLIL Research Journal*. 2009, Vol. 2, Issue 1, pp. 4–17. (Eng)
2. Eurydice. *Key Data on Teaching Languages at School in Europe*. 2008, Brussels: European Commission. (Eng)
3. Arnau J., Comet C., Serra J. M., Vila I. *La educación bilingüe*. 1992, Barcelona: University of Barcelona/Horsori. (Span)
4. Lasagabaster D., Sierra J.M.. Immersion and CLIL in English: more differences than similarities. *ELT Journal*. 2010, Vol.64, Issue4, pp. 367-375. (Eng)

## СХОДСТВА И РАЗЛИЧИЯ ПРЕДМЕТНО-ЯЗЫКОВОГО ИНТЕГРИРОВАННОГО ОБУЧЕНИЯ И "ЯЗЫКОВОГО ПОГРУЖЕНИЯ"

**Т.В. Мордовина**

Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: tvmordovina76@mail.ru*

**Аннотация:** Одним из способов совершенствования изучения иностранных языков является реализация программ предметно-языкового интегрированного обучения, поскольку такой подход является лучшим способом улучшения владения студентами иностранным языком без выделения на это дополнительного времени в их и без того загруженном учебном плане. Предметно-языковое интегрированное обучение фундаментально базируется на методологических принципах «языкового погружения», и эти понятия часто подменяют друг друга. Целью данной работы является ответ на вопрос: «Что именно включает в себя предметно-языковое интегрированное обучение?» и выделение сходств и различий между предметно-языковым интегрированным обучением и «языковым погружением».

**Ключевые слова:** предметно-языковое интегрированное обучение, «языковое погружение».

## THE ROLE OF AN ENGLISH TEACHER WHEN USING CASE STUDY METHOD

**O.V. Pechkurova**

Moscow International Academy, Moscow, Russia

*e-mail: gamovaolga@yandex.ru*

**Abstract:** *The paper explores the role of an English teacher using case study method to develop the communicative competence in high school learners. The main principles of case study method for ESL teaching are given. The method is considered as a step-by-step technology involving a variety of learning activities.*

**Keywords:** *The algorithm works in the classroom of a foreign language using the method of case study, communicative competence, teacher, learner, problem-solving.*

Case study is an innovative teaching method used in ESL classroom to develop the communicative competence. Its peculiarity lies in the fact that the problem described in the case is not given in a finished form; rather, it is formulated by a teacher through a real learning situation. This pedagogical technology allows the teacher to select a problem to focus on linguistic aspects and use the language as a means of communication.

The technology of case study is based on the following principles:

- 1) The teacher should encourage students to search a variety of possible solutions to the given problem;
- 2) All participants of the discussion have equal rights as the emphasis is placed on their own acquisition of knowledge, rather than acquisition of ready-made solutions offered by the teacher;
- 3) Students do not just accumulate knowledge, but also gain experience, form their personal value system [1, p. 45].

Thus, one of the main tasks of a teacher using the case study method is the engagement of students in the analysis, discussion and problem solving. To this end, it is important to fulfil the two conditions: case study material have to be interesting and provide an opportunity for personal contribution of each learner in the acquisition of knowledge. On the one hand, interesting materials in terms of content cause a desire to study them carefully and encourage participation in the debate. On the other hand, learners build up their vocabulary and learn new syntactic structures.

According to E.A. Sidelnik, when a teacher creates a case, it is important to consider the following factors:

- 1) a learning situation is modeled so that a teacher could maintain creative, but at the same time deliberately controlled atmosphere;
- 2) a learning situation should be in the framework of the training course or program in which it is used; it aims to teach students to analyze specific information, to find causal relationships, highlight key moments [2].

We propose to add a list of requirements for the organization of work using

case study technology:

- 1) The information must be relevant and understandable;
- 2) Teacher instructions should be clear and understandable;
- 3) The information should be sufficient to ensure that learners can discuss the problem and suggest methods to solve it;
- 4) The teacher should organize provide clear step by step instructions for gathering the necessary information, preparing presentations, or creating an end product of the case;
- 5) The solution to the problem must be within the given timeframe;
- 6) The participants of the discussion need to know where they can find the necessary sources of information.

When developing a training case it is important to consider the level of language proficiency of students, their interests, psychological and age characteristics.

It is noteworthy that case studies are particularly useful when students have a general knowledge on the problem, but they have not used it for specific tasks. It provides novelty of the material and promotes rigorous training. In other words, it is important to be able to match the learners' knowledge and skills with the content of the case. It makes no sense to use a case, if learners do not have the necessary language proficiency, cannot identify the main points, as they have no prior experience [3].

When creating a case, the teacher must take into account the following steps:

- Determination of the learning goal of a case study;
- Identification of the specific situation in accordance with the learning goal;
- Preliminary work on finding sources of information for the case study;
- Collection of data from different sources;
- Preparation of the primary version of the presentation material;
- A permit for publication of the case;
- Discussion of the case, involving a wide audience;
- Preparation of guidelines on the use of case.

The teacher can use different sources for a case: materials from a textbook, fiction and nonfiction books, newspaper or magazine articles, and Internet websites. For example, in the study of the topic "Shopping", it is advisable to use real data from sites online stores so that their choice is interesting for students. Statistical data taken from different sources can make a case more "scientific" and "realistic".

The work of the teacher and students in the classroom using case studies can take many forms. For example, I.N. Kuznetsov identifies six stages of working with the case. First, students get the description of the in the printed form for self-study. Then they exchange opinions in order to identify the missing information. The third stage is a group discussion on the identification of the main issues or problems. The fourth stage aims to create a model of finding solutions to the main problem. The fifth stage is a general discussion aimed at the development of common criteria for to select the best solution. The last stage is decision-making [4, p. 114-115].

Considering the possible options, I propose the following algorithm to work

with a case in ESL classroom.

Table 1. The algorithm for case study in ESL classroom

Giving assignment to learners	
Timing of the assignment	
Familiarization of learners with the evaluation criteria for case study solutions	
Determining the model of class	
Consultations	
Work on the case in the classroom	Opening remarks by the teacher; setting of the problem
	Organizing small groups (4-6 people in each group)
	Supporting learners' work in small groups, selecting speakers
	Helping with presentations in small groups
	Organizing group discussion
	Closing remarks of a teacher, analysis of the case and its solutions
	Peer evaluation

It is important to note that the teacher has to undertake a serious preparatory work. First, it is necessary to analyze the case in detail, prepare questions that encourage students to seek solutions, stimulate brainstorming of the problem. During the collaborative work of learners, the teacher observes a contribution made by each learner.

Case study method is effective for developing both communicative and linguistic competences in students. Dialogues and discussions organized in the course of case study help learners to master the vocabulary and grammar structures acquired in the previous classes. When working on vocabulary and grammar, it is necessary to pay attention to the linguistic aspect of the texts used in the learning process. Another important learning objective is to develop students' ability to create coherent written and oral texts.

The case study method is the technology of active learning, the content of the case should be close to the real situation and promote the development of the ability to make decisions under conditions of uncertainty. Thus, the choice of content and topics for case studies should be relevant to high school students.

Thus, it can be assumed that the case study method used in the ESL teaching is an effective tool and contributes to the development of learners' communication skills.

#### References:

1. Panfilova, A. P. Innovacionnye pedagogicheskie tehnologii. Aktivnoe obuchenie: ucheb. posobie dlja stud. uchrezhdenij vyssh. prof. obrazovanija [Innovative pedagogical technologies. Active learning: teaching manual for university students]. 3-e izd-e, ispr. M.: Akademija, 2012. 192 s. (Rus).
2. Sidel'nik Je.A. Osobennosti ispol'zovanija metoda "case study" v obuchenii inostrannym jazykam v neязыkovom vuze [Features of using a "case study" method in foreign language teaching in non-linguistic universities] // Izvestija Juzhnogo federal'nogo universiteta. Tehnicheskie nauki. 2011.

Вып. 10. Т. 123 (Rus).

3. Zolotova M.V., Demina O.A. O nekotoryh momentah ispol'zovanija metoda kejsov v obuchenii inostrannomu jazyku [Some aspects of using case method in teaching foreign languages] // Teorija i praktika obshhestvennogo razvitija 2015 (4). <http://teoria-practica.ru/vipusk-4-2015/> (Rus).

4. Kuznecov, I. N. Nastol'naja kniga praktikujushhego pedagoga: ucheb. Posobie [Handbook of a teacher: textbook]. M.: GrossMedia; ROSBUH, 2008. 544 s (Rus).

## РОЛЬ УЧИТЕЛЯ АНГЛИЙСКОГО ЯЗЫКА ПРИ ИСПОЛЬЗОВАНИИ МЕТОДА КЕЙС-СТАДИ

**О.В. Печкурова**

Московская международная академия, Москва, Россия

*e-mail: gamovaolga@yandex.ru*

***Аннотация:** Проанализирована роль учителя английского языка при обучении учащихся старших классов с использованием метода кейс-стади с целью формирования коммуникативной компетенции обучающихся. Перечислены основные принципы организации работы с использованием метода кейс-стади в практике преподавания иностранного языка. Метод кейс-стади представлен как педагогическая технология, включающая различные этапы работы.*

***Ключевые слова:** метод кейс-стади, коммуникативная компетенция, учитель, ученик, поиск решения проблемы.*

---

УДК 372.881.111.1

ББК 81.2

## FORMATION OF POSITIVE MOTIVATION OF STUDENTS WITHIN FOREIGN LANGUAGE LEARNING

**I.N.Sokolova, T.A. Pastushenko**

Buketov Karaganda State University, Karaganda, Kazakhstan

*e-mail: irinapl04.12@mail.ru*

***Abstract:** The article discusses the problem and the necessity of formation of students' positive motivation within foreign language learning from the very beginning. It gives the opinions of different outstanding psychologists and teachers about the essence of motivation and its vital role in foreign language learning, reveals the types of motivation and basic approaches to its formation.*

***Keywords:** communication, early learning, foreign language teaching, motivation, motive, motivational stage, student behavior.*

One of the major challenges facing modern Kazakhstan school is forming a fully developed socially active person. Achieving this goal is possible only under consideration of the interests and needs of students, and with proper exposure to their motivational sphere. Particularly urgent is this question in connection with the teaching of foreign languages at secondary school. According to the Conception of foreign language education in Kazakhstan at the present stage of society

development, the need to introduce early learning of a foreign language to the further development and mastering it in variable continuity structure of educational institutions of basic, intermediate profile, post-secondary vocational and higher education is not in doubt [1].

Thus, since 2013 English has been studied from the first grade at every school. However, in the absence of a natural language environment and, consequently, the real opportunities to use the foreign language as a medium of communication in the process of immediate everyday communication, only a few students are in need of this kind of knowledge and skills. Moreover, even the initially motivated pupils to the end of the primary stage of learning have motivational decline. In this regard, special significance has the search for ways and means to maintain the motivation to learn a foreign language at an optimum level throughout the study period.

The problem of motivation developing of educational activity is avital problem of psychology and pedagogy at the present stage, as well as at the modern school. This issue has attracted and attracts not only leading representatives of pedagogy, but also philosophy, sociology, psychology.

Diagnosis and essence of motivation of educational activity was developed in the works of V.G.Aseeva J.K. Babanskiy, D.A.Leontiyev, S.L. Rubinstein, G.I.Shchukina, L.I.Bozhowich, V.F.Panamarchuk, V.S. Merlin, P.M. Lkobson, V.S. Ilyin, A.K. Markova, N.V.Kuzmina, V.V.Davydova, N.F.Talyzina and others. In their research, the scientists show the structure of motivation of educational activity, the mechanism of occurrence of educational reasons, as well as the role of motivation in the implementation of training activities.

These days there is no systematic approach to the review of process of motivation, views on the essence of motives among psychologists and educators are different: a particular psychological phenomenon is taking for the motive. For example, in some works the motive is seen as a necessity (stimulus action, human activity), in others - the motive as a goal, in the third - the motive is regarded as a stable personality characteristics (typical for Western psychologists). To the term "motivation" different authors put different meaning. For example, I.A.Zimnyaya calls the motivation as a "run-up" of all human activity [2].

Let us consider the concept of "motivation" from the point of view of psychology and pedagogy. Motivation in psychology is a wide range of phenomena, encouraging people to work. The word "motive" is from the Latin moveo - "move". For the first time the term "motivation" A. Shopenhauer used in the article "Four principles of a sufficient reason" [3]. Currently, there are many interpretations of the concept "motivation" that often complicates an unambiguous understanding of it.

The term "motivation" is a broader concept than the term "motive". The word "motivation" is used in modern psychology in a double sense: as denoting a system of factors determining the behavior (this includes, in particular, needs, motives, goals, intentions, aspirations, and many others), and as a characteristic of a process that encourages and supports behavioral activity at a predetermined level. Motivation, therefore, can be defined as a set of psychological reasons to explain the behavior of the person, its origin, direction and activity.



In this article, we adhere the definition by A.K. Markova, a prominent researcher in the field of motivational sphere of the person, who defines motive as the orientation of the student on the individual aspects of academic work related to the internal relations of the student to it (i.e. the goal, for what a student is learning, something that prompts him to learning), and motivation doctrine - is a complex area determination of a student behavior [4].

The analysis of literature indicates the presence of different points of view with regard to the motivation and learning a foreign language. The peculiar characteristic of the understanding of the motivation is in Gestalt psychology. Kurt Lewin, a German-American psychologist who developed the methodology for the experimental study of the motives, understands them as something independent. He singled out the motive in a separate category. In his understanding, the motives are objects - various areas of "living space" in which a person needs or quasi-need - intention.

One of the earliest studies of personal motivation, as you know, was the work of H. Murray. Out of many motivators of behavior, he has identified four basic needs: to achieve, to dominate, to be independent, to be affiliated. M. Argyle studies these needs more broadly. Here are the needs for the study of foreign languages: 1. non-social needs, which may cause social interactions (biological needs for water, food, money); 2. need for dependence. For example, need for some aid, protection; 3. need for affiliation, which is expressed in the need to communicate, to have emotional contacts, friendship and love; 4. need for domination, i.e. in putting oneself by others as the leader of the group; 5. need for self-esteem, identity, i.e. in the decision to take oneself as meaningful one [5].

The most comprehensive study of the problem was conducted by R. Gardner and W. Lambert. They identified two groups of motivation: instrumental and integrative [6].

Instrumental motivation suggests a desire to learn a foreign language for any practical purpose, such as getting a job, reading the foreign press and literature, taking an exam or getting enhance of the career ladder. This category also includes the more negative factors, such as fear of failure, etc.

Integrative motivation, it can also be called internal motivation is a desire to learn the language, to understand, to communicate with people of the country where they speak the target language. According to R. Gardner, that it is crucial. Initially it was thought that the trainees with integrative motivation more successfully master the language than learners with instrumental motivation.

Motivational stage is a message that explains why and for what students need to know this part of the program, what is the main objective of the training operation. On the lesson, the teacher tells and shows the students, but all of this information for some children is not significant: they listen but do not hear, look and do not see, they are very busy with other activities: dreaming, thinking about something personal.

This phase consists of 3 educational actions:

- establishment of a problematic situation leading into the content of the upcoming themes. Before you start teaching, the student must learn (understand,

accept for himself, set up himself a learning task. This is achieved by using the following techniques: setting up to students the tasks that can be solved only by studying the subject; the story of the teacher about theoretical and practical significance of the proposed topic; the story of how the problem was solved in the history of science;

- formulation of the main learning task as a result of the discussion of the problematic situation. The task for students is the goal of their activities on this lesson;

- consideration of self-control and self-assessment opportunities for the study of the topic. After the formulation of the problem is planned and plans for future work discussed, it turns out that you need to know and be able to study topics that students lack to solve. After the main learning task became clear, plans for future work of the students are planned and discussed.

It is necessary to tell the time allotted to the study of the study material. Some students can give self-esteem to their ability to study the threads, specify what material they will repeat and what else to do to prepare for the upcoming lessons. This whole stage of studying the topic is very important for the formation of motivation of educational activity of students. Therefore, undesirable to say: "Today we begin the study of the topic ..." and go directly to the study of new material. This "time-saving" is a negative impact on the entire nature of the learning activities of students. This creates the need for installation of the study material.

Creation of a problem situation, which introduces the subject matter of the upcoming topics of the program to students. It can be created in different ways: by formulation of the problem to students, which solution can only be based on the study of the topic, by the conversation (story) between teachers or students about the theoretical problems were solved in the history of science; by execution of practical work, which ends by staging problematic issue.

Statement of the main learning task, which is usually done as a result of the discussion of the problem situation.

Learning objectives show students what they should direct their activities to in the course of studying the topic. L.S. Vygotsky wrote that there could be no activity without the presence of any goals or objectives, set in motion the process that gives it a direction. Therefore, an essential condition for the organization of learning activities is leading students to self-setting and the setting up of educational problems. On operational-cognitive stage, students learn the content of the theme of the program and master the necessary training activities. The role of this stage in the formation of motivation of educational activity depends on whether the students understand the need for the content of all training actions addressing to the basic learning task. To solve these problems the method of learning the activity is best suited, which is being implemented in developing an educational programs. Its essence is that the students themselves open all the new knowledge; training is conducted in the "zone of proximal development" of each student. The main content of this phase should be modeling of objects and phenomena, as well as the study of constructed models. In this case, the activity of students gets creative, research

character.

Reflective-evaluation stage. At this stage, students learn to analyze their own learning activities, evaluate it by comparing the results with the set learning objectives. It is associated with the analysis done, error analysis, and the provision of necessary assistance, made in a comparison with the task and the evaluation of the work. Therefore, it is better to use such tasks as "Make a question or a task for which you can check the level of assimilation of studying the topic." For strong students the following assignment: "Write the main issues we have passed in the subject, and a number of ticks, as you have learned the material: good or not so good, or slightly learned." For the less able students here can be part of the questions and their tasks are to note the level of mastery of the material.

It is important that monitoring and evaluation do not only set the level of assimilation of the program material of students, but also be used to encourage them to continue working.

Formation of motives of activity is going on in the implementation of the activity itself. In other words, if the student is not included in the activities, the respective motives are not raised and will not form a stable motivation. In order for motives to be emerged, strengthened and developed, the student must begin to act. If the activity itself will cause a concern, it can be expected that he will gradually feel the needs and motivations of these activities.

#### References

1. Konceptcija razvitija inozazychnogo obrazovanija RK. [Development of foreign language education concept] - Almaty: Kazakh University Of international relations and world languages after Abylay Khan, 2006.
2. Zimnyaya, I.A. Lingvopsihologiya rechevoy deyatel'nosti. [Linguistic psychology of speech activity] — M.: Moscow psychological-social institute, Voronezh: NPO "MODAK", 2001. - 432 p.
3. Markova, A.K. Formirovanie motivacii ucheniya v shkol'nom vozraste: Teacher book. [The formation of learning motivation at school age]. M.: Prosveshenije, 2003. – 96 p.
4. Abraham H. Maslow. Motivation and Personality (2nd ed.), 1999. – с.139

## ФОРМИРОВАНИЕ ПОЛОЖИТЕЛЬНОЙ МОТИВАЦИИ СТУДЕНТОВ В РАМКАХ ИЗУЧЕНИЯ ИНОСТРАННОГО ЯЗЫКА

**И.Н. Соколова, Т.А. Пастушенко**

Карагандинский университет имени Е. А. Букетова, Караганда, Казахстан  
e-mail: irinapl04.12@mail.ru

***Аннотация:** В статье рассматривается проблема и необходимость формирования положительной мотивации школьников к изучению английского языка на начальном этапе. В статье представлены точки зрения разных выдающихся психологов и учителей о значении мотивации и ее важной роли в изучении иностранного языка; раскрываются виды мотивации и базовые подходы к ее формированию.*

***Ключевые слова:** общение, раннее обучение, обучение иностранному языку, мотивация, мотив, мотивационный этап, поведение обучаемых.*

## TEACHING ENGLISH TO SECONDARY SCHOOL LEARNERS USING DIGITAL TOOLS

**Yu.V. Chernysh**

Russian Defense Ministry Boarding School, Moscow  
*e-mail: chjuli@mail.ru*

**Abstract:** *The paper discusses the importance of using ICT in teaching English to secondary school learners. The author describes the ways an English teacher can employ in the classroom to make use of digital tools effective and efficient.*

**Key words:** *digital pedagogy, learning, teaching, Internet, multimedia.*

In recent years, the issue of using new multimedia technologies in teaching has been widely discussed. Researchers focus on new methods of teaching, which are emerging with the use of digital tools. The main objective of foreign language teaching is development of the communicative culture of students and communicative competence in a foreign language. The role of a foreign language (FL) teacher is also changing, shifting to creating conditions for practical language learning for each student. To achieve this a teacher has to select such training methods that would allow each student to show their activity and their creativity. The job of a FL teacher involves activating cognitive skills of students through learning a foreign language. Modern teaching methods such as cooperative learning, project-based learning, the use of new multimedia technologies, Internet resources help to implement the student-centered approach to learning, providing personalization and differentiation of learning abilities of children, given their level of proficiency, aptitude, interests, motivation, etc.

Digital tools in FL language lessons can be incorporated in teaching vocabulary, practicing pronunciation, training speaking skills, teaching writing and grammar. The possibilities of the Internet are enormous. The Internet is a great resource of all kinds of information for both students and teachers. They can have access to regional studies materials, news, articles from newspapers and magazines, fiction, etc.

In this article, I will focus on the methodology of teaching English at school in line with the development of modern information technology. The use of the Internet in English lessons can meet a variety of teaching goals, such as developing reading skills, using materials of the global network; improving writing skills; building up students' vocabulary, shaping students' sustained motivation for learning English.

The Internet technology can be used for broadening learners' horizons, finding and maintaining relations and contacts with their peers in English-speaking countries. Students can do tests, quizzes, participate in the Internet-based competitions and contests, chat with peers from other countries, use video conferencing, etc. Students can look for information on the project, which they are work at. This may be collaborative work of Russian schoolchildren and their foreign peers in foreign

countries.

One of the most revolutionary changes, which significantly influenced the educational process in the world, has become the creation of the World Wide Web, the Internet has received a name that literally means "international network". Using cyberspace for training purposes is a new direction of pedagogy. The use of new technologies brings about changes to academic requirements to students, encourages teachers to change their methods and style of teaching.

The main goal of teaching a foreign language at school is the formation of the communicative competence. The communicative approach involves teaching to communicate and interact in different cultural settings. The Internet fits well for this purpose as it is an international, multi-ethnic, cross-cultural communication tool used by millions of people around the world. Using the Internet in a FL class gives an opportunity to join this multicultural society a real dialogue.

Communicating in a real language environment of the Internet, students are involved in a wide range of meaningful activities. They are trained to respond spontaneously and adequately to their peers. It stimulates productive use of the language, rather than stereotyped manipulation of language formulas and clichés. Priority is given to understanding and transfer of content and expression of meaning. This motivates learner for mastering grammar and vocabulary of target language, encourages students to focus their attention on the usage of the language, rather than the rules.

“Computer” is tolerant to the diversity of student answers: it does not mark students’ papers with comments. As a result, learners become more confident and independent. Besides, the use of digital technology in the classroom creates favorable socio-psychological atmosphere, raises learners’ self-confidence, which is an important factor for personality development.

The development of education is interrelated with an increase in the level of its information capacity. This largely determines the evolution of education and the future of the entire society. To make learners confident users of technology, it is necessary to shape their information culture.

The Internet offers its users a variety of information resources. The basic set of services may include e-mail, newsgroups, video conferencing, social networks, search engines, messengers, and many other useful tools. These resources can be used in the classroom. Much of the time, teachers wish to encourage students to interact with resources and other students. The Internet made it possible to do that. Students can research information on the Web, discuss what they find with classmates or, if they are using e-mail, with students in another class or an expert in the field they are studying, and when they conclude their research they can publish their work on the Web.

Some of the most popular and exciting activities to be employed in the FL classroom are as follows:

- Using **Google Earth** lets learners immerse in the culture of other cities and countries. With this free online program they can explore the streets of small towns and big cities, giving them a glimpse into the culture of the target language.

- **Skype** can be used to invite a guest speaker from another country. This tool, designed for connecting people face to face from far away, can become a versatile classroom tool. Teachers can use it to connect with other students around the world or host guest speakers, regardless of where they are located.
- **Google Docs** can be used for collaborative work of students in real time. They can edit one document together, and a teacher can be in the document as well, adding comments and suggestions as they go.
- **Blogger.com** can improve learners' writing. Blogging teaches students about writing in the digital age. Students can submit homework and projects as a blog post. The teacher can encourage them to add images and videos, and share their work with friends and family.
- **YouTube videos are a great tool.** There are more than 30 YouTube channels that were made for teachers.
- **Prezi** as a replacement to PowerPoint is a modern program for creating presentation. This program can turn students' project into a powerful and animated presentation.

To sum up, digital tools can be a good supplement to traditional pedagogy in a FL classroom, as their potential is enormous.

#### References:

1. Podoprigrorova L.A. Ispol'zovanie interneta v obuchenii inostrannym jazykam [Use of the Internet in teaching foreign languages] // Inostrannye jazyki v shkole, 2003. – № 5. – S. 25–31. (Rus)
2. Al'breht K.N. Ispol'zovanie IKT na urokah anglijskogo jazyka [ICT in the English classroom] // Jelektronnyj nauchnyj zhurnal "Informacionno-kommunikacionnye tehnologii v pedagogicheskom obrazovanii". – 2010. <http://journal.kuzspa.ru/articles/45/>. (Rus)
3. Davis, R. (2006). "Utopia or Chaos? The Impact of Technology on Language Teaching". The Internet TESL Journal. Available from <http://iteslj.org/Articles/DavisImpactOfTechnology.html>

## ИСПОЛЬЗОВАНИЕ МУЛЬТИМЕДИЙНЫХ ТЕХНОЛОГИЙ НА УРОКАХ АНГЛИЙСКОГО ЯЗЫКА В СРЕДНЕЙ ШКОЛЕ

**Ю.В. Черныш**

Московский кадетский корпус Пансион воспитанниц Министерства обороны Российской Федерации, Москва  
*e-mail: chjuli@mail.ru*

*Аннотация:* Рассмотрена роль мультимедийных технологий в преподавании английского языка в средней школе. Представлены наиболее распространенные Интернет-ресурсы, обеспечивающие эффективность обучения иностранным языкам.

*Ключевые слова:* цифровая педагогика, обучение, преподавание, Интернет, мультимедиа.

Научное электронное издание

**THE WORLD OF SCIENCE  
WITHOUT BORDERS**

PROCEEDINGS  
OF THE 4<sup>th</sup> INTERNATIONAL SCIENTIFIC AND PRACTICAL  
CONFERENCE OF YOUNG RESEARCHERS

February 17, 2017  
Tambov

**МИР НАУКИ БЕЗ ГРАНИЦ**

МАТЕРИАЛЫ 4-й МЕЖДУНАРОДНОЙ НАУЧНО-ПРАКТИЧЕСКОЙ  
КОНФЕРЕНЦИИ МОЛОДЫХ УЧЕНЫХ

17 февраля 2017 года  
Тамбов

Компьютерное макетирование А. Б. Едапиной

**ISBN 978-5-8265-1681-2**



Подписано к использованию 07.02.2017  
Тираж 100 шт. Заказ № 31

Издательско-полиграфический центр  
ФГБОУ ВО «ТГТУ»

392000, г. Тамбов, ул. Советская, д. 106, к. 14.  
Телефон (4752) 63-81-08, 63-81-33.  
E-mail: izdatelstvo@admin.tstu.ru