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INNOVATIVE APPROACH TO THE DEVELOPMENT OF AUTOMATED LOGISTICS INFORMATION SYSTEMS

ИНОВАЦИОНЕН ПОДХОД ЗА ИЗГРАЖДАНЕ НА АВТОМАТИЗИРАНИ ЛОГИСТИЧНИ ИНФОРМАЦИОННИ СИСТЕМИ

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Abstract: *Technological advancement driven by innovation, fundamentally new industrial technologies and artificial intelligence, will naturally exert greater pressure not only on the growth of production but also on its structural properties which are expected to undergo significant changes. Moreover, the improvement of technological, auxiliary and information activities will invariably be regarded as a crucial factor in the development of modern production. Thus, with the structural transformation having been effected, the new communication and information achievements are more likely to reinforce the relationship of production with its external logistics components. In addition, it should be borne in mind that the production of the future will be constructed as a complete whole comprising the respective technical, technological and information processes along with the functionally integrated production components, including those of the logistics system. The purpose of the present paper is to explore the possibilities for designing automated logistics information systems and to propose an innovative approach incorporating not only the specific in-house (intra-company) logistics but also considering its interdependent relationship with the other logistics processes that have been excluded from the company's core business activities*.

Keywords: LOGISTICS, LOGISTICS INFORMATION SYSTEMS, AUTOMATED LOGISTICS SYSTEMS

1. Introduction

The vast range of information flows running inwardly within a given system of logistics and among its system components, as well as between the logistics system and its external environment join together to become part of logistics information systems.

Logistics information systems relate to a well-organised structure of interconnected electronic means, information technologies and software products delivering solutions to various functional tasks in order to gain control over the multiple flows of materials [2,4]. Logistics IT pertain to the class of so-called new information technologies, which are defined as a set of fixed ("embedded" within the organisation) management systems with principally new means and methods of data transfer and processing [6,9,10]. They act as integrated technologies and systems largely employed in the process of creation, transmission, storage and display of product information (data, ideas, knowledge, logistics support, etc.) at the lowest possible cost and consistent with the social environment legislation [3,5].

Key competency areas in logistics

All the necessary arrangements should be made for the logistics information that supplies the main strategic logistics resource to be distributed in the "supplier-consumer" model. Using computer technologies for processing of data helps to keep costs down as a result of a more effective management of the multitude of information flows, which, in turn, leads to increased speed and enhanced coordination [7,8]. The term "information resource" is established as an economic category, while that of information resource management implies:

1. An evaluation of the information needs at each level of logistics and in each function of logistics management;

2.Research and rationalization of documentation, organization of effective electronic document exchange;

3.Addressing data mismatch and incompatibility of data for the same purpose.

4.Development of a data management system.

Regarding logistics information as a resource involves, by analogy with the use of other resources, provision of an effective mechanism for its proper management through established uniform standards for information support.

Against the background of rapid development and proliferation of Internet technologies, the efficient supply chains occupy a crucial role in the successful growth of the Companies. Thence, the first step a Company takes in venturing out into the "Internet of Services" should be to define the role of the logistics processes as part of its effective management in addition to the creation of official company's website. Accordingly, the management of supplies is inextricably linked to the automation of internal resource planning. This means that the optimization of the business processes provides a sound basis for the creation of an effective delivery mechanism.

Logistics information systems based on digital dimensions

The process of material flow management is determined by the processing of logistics information circulating within the logistics system. Logistics information is a purposeful assemblage of facts, phenomena and events collected together to be submitted for further registration and processing and thus to ensure the company's process of logistics system management [1].

There are three forms of logistics information representation: symbolic, text, graphic. The symbolic form is based on the use of symbols - letters, numbers, and signs, including punctuation marks. The text form uses characters that follow each other in a predetermined sequence to form a text. The graphic form is the most extended and complex and covers multiple types of images. Equally applicable, furthermore, are the following concepts;

Logistics system architecture is a concept that describes the model, the structure, the functions performed and interconnectedness of the system components.

Information flow is a system of messages that are distributed within the logistics system, between the logistics system and its external environment that are considered strictly necessary for the management and control of the logistics operations. The information flow may be transferred on paper and electronic documents.

Digitisation of information flow based on digital conversion and transformation of the logistics processes.

Information processes being distributed across space and over time are regarded as high priority carriers capable of transmitting administrative influence within the structure of a certain organisation. The organisation's business (activity) data models and its environment determine the possibilities of effective collaboration and shift the focus onto the final outcomes (end results). In logistics systems, however, there is a critical need for information interaction

among participants in the real-time supply chain with the optimal cost-effectiveness for managing the system. A possible solution to this problem is offered by a relatively new sector of scientific knowledge - information logistics.

But let us first examine the most important characteristic features of the concept of information logistics under discussion.

Information logistics can be viewed on the one hand in a systematic way of organizing enterprise information resources as specified by the basic principles of logistics (consistency, rationality and precise calculation), and on the other hand, in its supportive function or in a regional perspective – a function of logistics management.

Information logistics can also be considered as a method for gathering, processing, storage and dissemination of information in industrial and economic systems and their immediate environment in compliance with the established logistics rules (the importance of information, in the right quantity, at the right time, in the right place and with optimal cost-effectiveness).

In light of this, the overall purpose of the information logistics can be described as a rational management of the flow of information throughout the entire logistics network and at all levels of hierarchy.

System connectivity in logistics information processes.

The levels of the logistics processes in terms of the systematic approach are presented in fig.1.

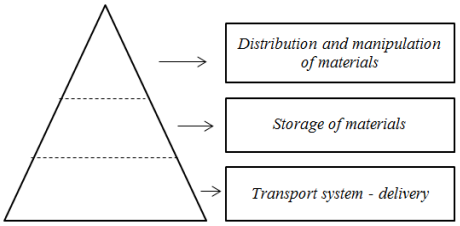


Fig.1*.Logistics connectivity in the system*

In line with the concept of logistics affiliation (relatedness), information systems, pertaining to different logistics groups are integrated into a single information system. Such integration takes place in a vertical and horizontal direction.

Vertical integration is the link between the planned, dispositive and executive (control) system transmitting vertical information flows.

Horizontal integration, being a medium for horizontal information flows, is the link between the individual sets of tasks in the dispositive and executive (engineering) systems.

Illustrated in fig.2 is the way in which the horizontal and vertical integration are brought together.

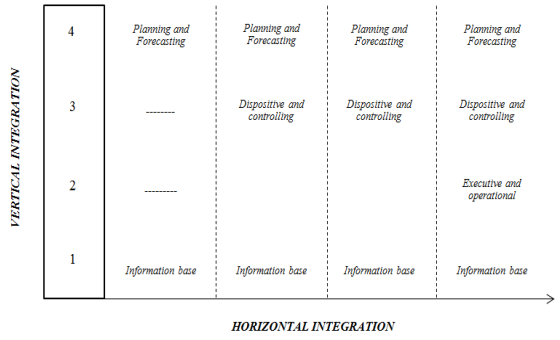


Fig.2*.Relationship between the horizontal and vertical integration*

Clarifying the relationship between horizontal and vertical integration proves necessary for a more accurate construction of logistics information systems through automation. These refer not only to separate logistics processes subject to specific integration requirements but also to all the business activities the company undertakes in-and out-of- house.

Viewed from the perspective of information and logistics, improvement in the company's integration activity is entirely consistent with automated management of the material flow.

Sequence of the steps in the development of automated logistics information systems

Constructing automated logistics information systems is controlled by the following sequence of events ensuring its proper implementation:

1.Establishing principles of identity and adherence to the belief that all the relevant operations, processes and activities should be integral to logistics. Distinct identification of the intersection points of the logistics processes with the other company's (business) processes.

2.Designing the structure of the system through the application of modern information technologies.

3.Determining the company's internal and external linkages and relationships.

4.Exploring the possibilities of gradual development of automated logistics information system.

5. Enhancing automated logistics information system with the possibility of using hardware and software modules based on digitisation.

6.Improving the logistics information system flexibility in meeting some specific requirements of the logistics subsystems.

7.Considering the potentiality of assuring the achievement of improved user-friendliness and compatibility with the abilities of the users from the lowest to the highest level of automation of logistics processes and activities.

8.Promoting synergies by integrating the logistics sub-systems between the vertical and horizontal distribution (dimensions).

The suggested sequence of steps in the development of automated logistics information system is further outlined in fig.3.

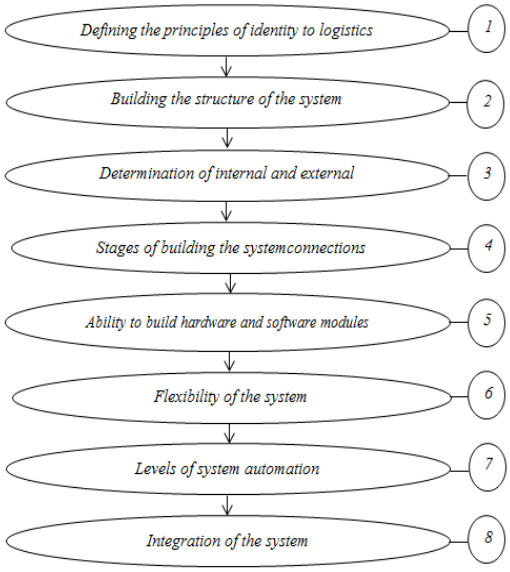


Fig.3.*Sequence of development of automated logistics information systems*

Provisions for the engineering of automated logistics information systems (ALIS)

1. E-logistics as a component of the automated logistics information system.

E-Logistics facilitates the processes of planning, execution and controlling of the respective logistics activities or tasks through the application of modern Internet technologies for the purposes of improving the existing logistics services and enhancing the collaboration between the separate partners in the supply chain (Supply Chain). More specifically, full account is taken for the provision of all the decisive steps towards the securance of smooth electronic commercial transactions as to the acceptance of an order, storage, commissioning, packing, franking and dispatch (delivery) of the corresponding articles.

Essential prerequisites and conditions for the implementation of electronic logistics:

1. Integration of Internet-based systems in the portfolio of existing IT systems;

2. Further support of the classical organisational processes and procedures;

3. Inter-company cooperation or inter-departmental collaboration with the clear objective of pulling together all the partners in the supply chain in order to overcome the barriers that restrict the flow of information.

4. The complexity of integrating electronic logistics solutions into the existing architectures and applications should not be underestimated.

The key advantage of electronic Logistics is the prospect of economic organisation and accomplishment of logistics tasks through the use of Internet technologies. Moreover, this might produce a steady improvement in the philosophy of the service itself (Service) in classical logistics and electronic commerce.

E-logistics is also perceived as the collective expression of the shared logistics processes in a given company that might be defined and accessed electronically.

Without electronic logistics, an effective and unimpeded processing, handling and transfer of goods in the field of the electronic commerce is inconceivable. Undoubtedly, this is associated with prudent planning and cautious development of all logistics processes and systems that are considered necessary for the electronic transaction processing. Electronic logistics is also the common denominator for future organisation and planning of the related logistics systems and processes, and thus, securing the successful realization of the electronic disposition of a company's business processes. In light of this, it could be deduced that E-logistics is one of the principal components of the automated logistics information systems.

2. Standardisation and self-regulation as an essential component in ALIS development.

The mechanism of self-regulation can serve as a basis for effective functioning of the integrated supply chain. Self-regulation is intended to optimise all the processes occurring in the chain (network) by transforming its structural elements according to stringent safety criteria and high performance achievement. Even more, it is precisely the increased value added by all the participants in the supply chain that accounts for its effectiveness and efficiency. Special attention, therefore, should be paid to various problem-solving methods in management, with an increased focus on the "critical points" of the supply chain integration.

Thus, in order for the self-regulatory mechanism to operate efficiently, ALIS is to be introduced as an inseparable part of the integrated supply chain since, with its strong effect on the "critical points", it is more likely to smooth over the violent fluctuations of the entire system.

Taking full advantage of modern logistics technologies would improve the industry's competitiveness and create the most important prerequisites for the radical transformation of the underlying infrastructure into self-regulating business communities.

3. Distinctive features of ALIS

ALIS can be readily distinguished from the other types of information systems by the level of integration of its information space through automation.

The systematization of the concepts in this field of research makes it possible for three existing approaches to defining ALIS come to the fore:

- ALIS is part of the corporate automated information system;
- ALIS has a higher degree of flexibility for integration of software solutions and is included in the corporate automated information system;
- ALIS is an independent self-contained structure isolated from other information systems.

The second, but no less important issue for building up ALIS is its functionality (functional structure).

ALIS functionality is contingent upon the types of information flows that penetrate into the system. The specificity of ALIS is determined by the fact that flow management takes place both within the particular business organisation and between the different participants in the logistics chain.

Conclusion

The issues that have been discussed so far in the present paper point to the conclusion that information is becoming a critical production factor of logistics activities.

Information logistics should be recognised as an area of logistics that explores and addresses issues related to the organisation and integration of information flows for decision-making in logistics management systems.

On the whole, automated logistics information systems are capable of integrating all the logistics subsystems, including supply logistics, inbound (production) logistics, distribution logistics, et al., with the intention of establishing connecting units (linkages), upon which the respective elements of the logistics system will be built up.

In closing, the paper strongly upholds the idea that automated logistics information system is a special case of the more general information systems, designed for automated receiving, transmission or processing of data related or integral to the processes of logistics.

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DISTINCTIVE FEATURES OF "SCIENCE-INTENSIVE PRODUCTS" AS INNOVATIVE WITH ESPECIALLY HIGH PROPERTIES

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Abstract: In this article the author grouped the main types of science-intensive products in the following types: precision alloys - soft magnetic with special physical properties, special electrotechnical alloys, deformable magnetic-hard materials, alloys with a specified temperature coefficient of linear expansion, alloys with specified elastic properties, alloys with high electrical resistance; special corrosion-resistant steels and alloys, special heat-resistant and high-temperature alloys by different characteristics.

Keywords: INNOVATION ACTIVITY, APPLIED RESEARCHES AND DEVELOPMENTS, METAL PRODUCTS, SCIENCE-INTENSIVE PRODUCTS

1. Introduction

Theoretical and methodological content of concepts: "innovation activity", "innovative" and "high-technology products" is examined in a number of researches of Russian and foreign economists.

2. Results and Discussion

According to the definition of the Russian Statistical Yearbook, "innovation activity" is a type of activity related to ideastransformation (the results of researches and developments, other scientific and technological achievements) into new or improved products and services introduced to the market.

This definition is quite complete and accurate, and the most significant is that it is based on all statistical processing of factual information about scientific and technological achievements in Russian industry and comparison with foreign indicators.

The results of innovation activity are realized both through the creation of fundamentally new technological processes and materials characterized by new consumer performances.

According to the definition proposed by the Organization for Economic Cooperation and Development (OECD) in conjunction with the EU's Bureau of Statistics, "Innovation is the introduction of a new or significantly improved product (service) or process, a new marketing method or a new organizational method in business practice, organization of workplaces or external relations " [1].

The OECD Recommendations distinguish four types of innovation: product, process, marketing and organizational.

The basis for creating fundamentally new technologies and products is new scientific knowledge obtained as a result of scientific researches.

The definition "scientific researches" is interpreted in the Russian Statistical Yearbook as "an increase and a search for new fields of knowledge applications".

The expert in the field of knowledge-based economy, a member of corr. RAS Kleiner G.B. evaluates knowledge (cognition) as the same resource as fixed assets, financial, managerial funds, etc. Knowledge embodied in a new technology and fundamentally new products acts as the most important resource for their creation [2].

Innovative activity combines new scientific knowledge and its materialization realized through innovative technologies and equipment into innovative products.

Scientific organizations are the main source of new knowledge formation, and scientific developments being a direct product of their activities are the basis for innovative technologies and products creation.

This particularly relates to applied researches and developments.

According to the definition given by Glukhov V.V. [3], "Applied scientific researches include studies aimed primarily at applying new knowledge to achieve practical goals and solve specific problems". And if "fundamental science studies the world irrespectively of the practical application possibility, applied sciences are oriented towards the knowledge application through their implementation in specific scientific developments transferred for later use by an industrial enterprise".

In market conditions, applied scientific developments have become a product which implementation determines the financial condition of scientific institutions.However, the studies conducted on the metallurgical complex show that due to the impossibility of modern equipmentmanufacturing by Russian enterprises, the scientific developments of Russian research institutions are unclaimed.

Over the years of market reforms the development of Russian engineering industry was systematically underfunded. Therefore, Russian metallurgical enterprises purchase 80-85% of equipment abroad in conjunction with new technologies.

The analysis of applied research institutes interaction with Russian metallurgical enterprises shows that every year it becomes more difficultto receive a contract from industrial companies. Orders are received only for the acquired technologies development, as well as partially for the modernization of existing ones.

Due to the need for more effective and widespread use and commercialization of scientific developmentsresults, the direct production of science-intensive products is becoming increasingly important for research institutes.

Innovative products produced directly by scientific institutions should be labeled as "science-intensive industrial products" in contrast to the generally accepted and broader concept of "innovative products" which is mainly produced in large quantities by industrial enterprises.

There are several features that allow naming innovative products as science-intensive ones:

- particularly high new characteristics (regarding to the basic structural material - ready-made metal products, particularly high strength and ductility, corrosion resistance in aggressive environments, frost-resistance at temperatures of -200 ° C, special magnetic properties and elasticity), provided by using a set of scientific knowledge, produced in research institutions;
- production based on the potential of scientific knowledge concentrated in applied scientific institutions, high-tech experimental equipment and qualified scientific and technical personnel;
- products output in relatively small quantities, regarding the production of high-tech metal products from several kilograms to 5-10 tons per year.

It would be incorrect to correlate the definition of science-intensive products to a share in research and development (R & D) costs (by some recommendations at least 10%).

Therefore in metallurgical production the structure of the cost price of innovative products is very much determined by the cost of raw materials. For instance in the production of metal products from high-alloyed steels, it is the costs of alloying elements that will have the largest, sometimes predominant share in the cost of production.

A high share of costs for expensive elements (for example, tungsten, molybdenum, etc.) sharply underestimates the share of even very high costs for the payment of highly qualified scientific and technical personnel.

Iron and steel industry produces different types of carbon, low-, medium- and high-alloyed steel products. The production cost

of each type of product is determined to a very large extent by the share of costs for alloying elements.

The costs of certain types of metal products production vary considerably depending on doping level (Table 1).

Table 1.1 -The structure of costs for the production of certain types of innovative products, differing in various doping levels,%

Structure of costs	Innovative products by doping level			Carbon metal products for mass production
	High alloyed steels	Alloyed steels	Low alloyed steels	
1. Sourcematerials (iron ore, alloying materials, etc.)	80	70	66	60
2.Process fuel	10	15	17	22
3. Expensesforprocessing, including:	10	15	17	18
3.1. salaries	3	4	5	6
3.2.depreciationdeductions	3	5	6	6
3.3. others	4	6	6	6

Separate evaluation of costsstructure for processing allows excluding the influence of the cost factor of alloying elements.

In some cases, due to the technological features of a particular production, the energy costs may be absolutely dominant in the processing costs particularly when smelting high alloyed steel.

Due to the dependence of costs structure on processing from a number of technological features, the use of the share of expenses for research and development as one of the reasons to name the products as science-intensive is also unjustified (Table 2).

Table 2 - The main factors and conditions for the production of high-tech science-intensive products in contrast to innovative products.

Indicators	Science-intensive products	Innovative products
Servicepropertiesofproducts	Particularly high service properties	New and improved service characteristics
The nature of demand and industrial scale	Small-tonnageshipments	Industrialproduction
Producer	Applied scientific institutions	Industrialenterprises
Scientific base	Fundamentalappliedscientificdevelopments	Scientific developments controlled by enterprises
Equipment characteristics	Experimentalscientificequipment	Innovativeindustrialequipment
Personnel	Highly qualified research and production personnel	Industrial personnel

A typical example of science-intensive products production in one of the leading scientific organizations of ferrous metallurgy is (FSUE) I.P. Bardin Central Research Institute for Ferrous Metallurgy) is a low-tonnage production of precision alloys of invar class, with high elastic properties, soft magnetic, magnetically hard alloys, amorphous materials, terbium metals [54-56].

Table 1.3 shows the main properties and applications of certain types of science-intensive products: soft magnetic and magnetically-hard materials.

Table 3 - Main properties and applications of soft magnetic and magnetically hard materials.

Alloy grade	Properties	Purpose and application
47NK	Soft magnetic alloy with low residual induction	Inductiveelements
34 NKMP	Soft magnetic alloy with a rectangular hysteresis loop	Magnetic amplifiers, non-contact relays
83NF	Soft magnetic alloys with the highest magnetic permeability in weak fields	Magneticfieldsensors
TKM-09-1 TKM-015-2	Linear dependence of saturation induction over a wide range of temperatures	Thermal backlashes compensation and magnetic systems drifts
52C7F	Alloyforhysteresismotors	Electricmotors for navigation systems
UNDK15, UNDK18	Deformablehardmagnetic alloy	Elements of navigation systems devices
32N4K	Linear expansion minimum temperature coefficient	Material for high-precision instrumentation
56DGNCh	Linear expansion minimum temperature coefficient in combination with increased corrosion resistance	Elements of navigation aviation systems devices
46 HXTYM	Low temperature coefficient of frequency andtargeted elastic properties	Gyroscopes torsionsuspensions
CM-2A, CM- 10	Increased strength characteristics at high temperatures	Elements of electronic sensors of nuclear power plants
36NGT	The specified temperature coefficient of linear expansion withintherange -200 +400 ° C	Specialdevices
EP288	Alloyforhysteresismotors	Actuation devices
NGK6	Heat-resistant nickel-based alloy	Aviation androcket production

These types of products are characterized by particularly high properties. Thus, non-magnetic high-strength alloys intended for the sensing elements of space instruments have the following characteristics:

- tensile strength σ 90-120 kg / mm^2;
- elastic limit $\sigma_{0.2}$ is not less than 70 kg / mm^2;
- TCLE in the temperature range +20 + 20017,4 · $10^{-6}grad^{-1}$.

Therefore, an alloy with a temperature-stable modulus of elasticity is characterized by the following properties:

- temperature coefficient of frequency in the temperature range -60 +150 no more than ± 30 · $10^{-6}grad^{-1}$;

- the inflection point is not lower than 350 ° C.

The most important factor in the development of science-intensive metal products production with particularly high service characteristics is the growing demand (for 10-15% per year) of high-tech industries such as rocket production, navigation systems, space vehicles, high-precision instrumentation, nuclear power ("Russian Helicopters", Votkinsk and Kaluga radio engineering equipment plants, Voronezh Mechanical Plant named after M.V.Khrunichev).

According to the author's calculations, the production of science-intensive metal products accounts for about 10% of the innovative metal productscost, which share, according to the Russian Statistical Yearbook, in 2013-2014, accounted for 7.5% of total production.

The production of innovative products is accounted by the Federal State Statistics Service of the Russian Federation through Federal statistical observation (Form No. 1 - Technology).Data on the development and use of advanced manufacturing technologies are fixed by the code of novelty degree: new for Russia - 01, fundamentally new - 02. This form provides information on the use of patented inventions in the development of technologies: used - 03, not used - 04.

Information on the use of advanced production technologies is given by the period of the implementationbeginning: up to one year, from one to three years, from four to five years, six or more years.

As for the size of metal products output with particularly high service characteristics, their share in the total output of innovative products is determined by the author roughly based on the processing of statistical reporting formsfor individual high-tech enterprises.

According to the author, their share in value terms is about 15-20% of the volume of production of innovative products.

The cost of high-tech science-intensive products far exceeds the cost of innovative products, especially those containing rare-earth elements - neodymium, yttrium, samarin, erbium, europium and others.

Examples of innovative metal products produced by industrial enterprises include such types as thermo-hardened rails of 100 m length, thick sheet for the production of large diameter pipes laid in corrosive environments, with working pressure up to 120 atm, individual nanostructured metal products, etc.

3. Conclusion

The author grouped the main types of science-intensive products in the following types: precision alloys - soft magnetic with special physical properties, special electrotechnical alloys, deformable hard magnetic materials, alloys with a specified temperature coefficient of linear expansion, alloys with specified elastic properties, alloys with high electrical resistance; special corrosion-resistant steels and alloys, special heat-resistant and high-temperature alloys.

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EVOLUTION OF RESEARCH AND DEVELOPMENT CENTER FOR REGIONAL DEVELOPMENT: CASE STUDY OF MAKU R&D CENTER

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Abstract: *The role of universities in R&D activities is a subject which needs to be reevaluated and thought over in terms of their contribution to the related industries, their vicinities and research parks. The mere reason of the existence of universities is to push the boundaries of the existing knowledge to achieve better and more reliable results in any given field. Although the ideal is having universities which are able to adapt really quickly to changes, often the reality is not so. The change is mostly slow and not swift enough to keep up with the recent developments in many fields such as the economic changes. These changes in the manner of universities require long periods of time. This is one of the reasons why universities should be quick to respond to regional needs and shifts to help pursue more attainable and resilient ecosystems. The main objective of this article is to analyze the role of research and development unit Mehmet Akif Ersoy University R&D services. It aims to support co-evolution of local municipal and industrial enterprises to increase the competitiveness of the region.*

Keywords: R&D Center,

1. Introduction

The globalizing world and thriving technology has created a great competition in every field. This competition is at the highest level in fields such as industry, agriculture, tourism etc. which are important areas of the economy. Increased competition encourages countries and companies to pursue more research, development and investment activities.

Private sector and state support plays an important role in research and development activities. R & D centers in universities constitute an important part of State support's research and development activities. Researchers who are academically and technically experienced in these centers produce new ideas and products according to the sectors. These emerging products and ideas at the basic level are then developed and presented to the industrial market. At this point, the competitive power of the companies in the market has increasing and it makes a great contribution to the state economy. From this point of view, in this study the contribution of the research and development centers located in Mehmet Akif Ersoy University to the regional economy has been evaluated in general.

2. Burdur and Mehmet Akif Ersoy University

Burdur province is situated in the south Mediterranean regions of Turkey. It has a surface area of 6.887 km^2 and a height of 1000 m. 60.6% of the province's arable land consists of mountains, and the soil. The geographical position of Burdur is given in figure 1.



Fig. 1 *Geographical Position of Burdur*

Burdur economy is based on agriculture, animal husbandry, forest industry and natural stone sector. There are integrated facilities which produce milk and meat at a considerable level in the region, industrial facilities that manufacture agricultural and natural stone processing machinery and also forest processing facilities.

Natural stone and marble production is gaining importance in the region in recent years. Burdur has about 125 factories, 250 active marble quarries; Burdur-based companies have an export capacity of about 131 million dollars and employment capacity of 8500 people [1].

Mehmet Akif Ersoy University has become a world class educational institute in almost every academic field since its foundation in 2006. With 4 institutes, 11 faculties, 6 schools and 13 vocational schools, Mehmet Akif Ersoy pursues excellence in short-cycle, undergraduate and graduate levels. 5 departments running university-wide classes and 18 research centers are continuously doing their important activities in their respective fields. There are also masters programs, associate degrees and certificate programs offered through Mehmet Akif Ersoy University Distance Education and Learning Center.

3. Relationship between R&D Centers and Industrial Sector

As universities become bigger players in R&D and economic development, their relationship with industry, research parks and regions needs to be carefully rethought. The idea that a university is only an educational and research institution should be re-examined. Universities it can be characterized as a multidisciplinary structure, as it integrates many management (strategy, leadership, etc.), engineering (process knowledge, innovation), social (human resources, ethos, etc.), financial (marketing, extroversion, etc.) and other disciplines. Universities should be institutions that respond to changing and developing economic and market conditions in a short and long term [2].

There are many researches related to research centers and development level within the scope of university industry cooperation. Researchers investigating the effects of research centers on themselves and on regional development indicated that centers set up by different universities for the same purpose in the same region increased competition and contributed positively to development [3-5].

4. Burdur and Mehmet Akif Ersoy University Research and Development Center

Burdur economy is based on agriculture, animal husbandry, forest industry and natural stone sector. These five major economic sectors are helping the development of Burdur and contributing to the country's economy. Therefore, it is necessary to carry out research and development studies in these sectors. Mehmet Akif

Ersoy University is the most important institution for research and development studies. The research centers established within the university are the main centers of R&D activities. Mehmet Akif Ersoy University research and development centers are given in Table 1. Since Mehmet Akif Ersoy University is a newly established university, the activities of research centers are at the beginning level.

Table 1: Mehmet Akif Eroy University R&D Centers

Mehmet Akif Ersoy University Research and Development Centers
Physical Education and Sport Sciences Application and Research Center
Scientific and Technology Application and Research Center
Biological Resources Application and Research Center
Burdur Development Center
Child Education Application and Research Center
Lakes Local Archeology Application and Research Center
Application and Research Center for Women Issues
Cosmetics Application and Research Center
Corporate Communication Application and Research Center
'Mehmet Akif Ersoy' Application and Research Center
Marble and Natural Stone Technology Application and Research Center
Music Culture Application and Research Center
Agriculture, Husbandry and Food Research Institute Application and Research Center
Teke Yöresi Folk Culture Application and Research Center
Turkish Folklore Application and Research Center
Distance Education Application and Research Center
Renewable Energy Resources and Technologies Application and Research Center
Turkish Language Practice and Research Center

4.1. Burdur and Mehmet Akif Ersoy University marble and natural stone technologies research and application center

Spain, Turkey, Italy, Pakistan etc. countries are in located Alpine-Himalayan belt. That's why these countries have rich marble deposits. Turkey in terms of diversity and quantity has significant marble deposits potential. It is estimated that this potential is 3,872,000,000m^3[6].

Burdur with 40 million tons of marble potential has an important position in Turkey. The role of research centers plays an important role in the evaluation of marble potential within the scope of university-industry collaboration. Mehmet Akif Ersoy University Marble and Natural Stone Technologies Research and Application Center were founded on 2013. Recommendations for increasing the role of the R & D center in assessing marble potential are given below.

- The research center should support the marble and natural stone industry which is of great importance for the Burdur Provincial Economy.
- By contributing to the efficient evaluation of existing marble and natural stone potential, it is necessary to determine the problems of the sector and develop solution proposals.
- Sector employees should contribute to their training with seminars that will be organized on the topics they need.
- In the field of marble and natural stone technologies, it should follow the innovations in the world and inform the organizations in the sector.
- In order to develop university-industry cooperation, the marble sector, which is the largest economic power of the region, should produce projects that will increase the competitive power needed by the marble sector.

The research and development center should contribute to the strengthening of the scientific and technological infrastructure of the country in the light of the recommendations.

4.2. Burdur and Mehmet Akif Ersoy University Agriculture, Husbandry and Food Research Institute Application and Research Center

Agriculture and husbandry are one of the most important economic areas. There are 1,438,558 decares of agricultural land and 650,196 registered animals in Burdur [7]. Burdur which has a significant potential in this area, food and agriculture industry have developed. Mehmet Akif Ersoy University Agriculture, Husbandry and Food Research Institute Application and Research Center were founded on 2016. Recommendations for increasing the role of the R&D center in assessing agriculture, husbandry and food potential are given below.

- The research center should investigate the environmental conditions of the vegetable and animal production being made in the region, and to develop suitable plant and animal species and to carry out breeding studies and research.
- The research center should develop new products in the center by carrying out research and development studies that will increase production in line with the principles and targets of development plans.
- The result of the research done at the center should present the developed products to the market and the producers.
- Provide guidance services by sharing the developed and applied production models and methods with the regional producers. Training seminars, conferences and training courses should be organized to educate regional producers.
- It should carry out joint studies and projects in the fields of education, research and production within the framework of mutual bilateral cooperation with domestic and foreign universities, institutes, agencies, centers and public institutions.

In Burdur, a total of 182.519 m^3 of industrial wood production has been realized by 2011 and the value of this production is 9.456.744 TL. 94.187 m^3 of industrial production is logged, 762 m^3 is wire pole, 12.213 m^3 is mine pole, 4.475 m^3 is industrial wood, 25.767 m^3 is paper wood, 45.026 m^3 is fiber chip wood, The 89 m^3 section is also a pole bar [8].

Forestry activities are one of the important sources of income for Burdur. Therefore, Mehmet Akif Ersoy University should establish a research center related to forest and forestry activities and work to support forestry activities in the center.

5. Results and Conclusion

In this study, the contribution of the research centers of Mehmet Akif Ersoy University to Burdur province development and economy has been examined in general. It has been found that the Burdur province economy is based on agriculture, animal husbandry, forestry, marble industry and there are determinations about how these sectors will be supported by research centers in universities. University research and development centers should contribute to the development of the region with activities such as projects, education, and seminars. Mehmet Akif Ersoy University Technology, Engineering and Business faculties, should provide academic and technical support to the research and development centers.

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DESIGN METHODOLOGY MANAGEMENT SYSTEMS KNOWLEDGE OF BUSINESS PROCESSES IN MANUFACTURING

Методология проектирования системы менеджмента знаний бизнес-процессов на производстве

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Abstract: It is proved that in the knowledge economy, such assets of the company, like knowledge, are of particular value. New knowledge can increase the individual income of the owners as they apply in business processes and production activities. Defined knowledge management as the process of formation of the intellectual assets of the enterprise. Selected technological, motivational and organizational components of the system of knowledge management. The system methodology of knowledge management are methods to transform individual pieces of information in knowledge relating to a particular sphere of activity. System design of knowledge management of the enterprise is divided into a number of stages, which are discussed in the article. The analysis of world experience of the practical implementation of knowledge management has shown that organizations and businesses take this purpose a variety of techniques and methods. Found out that currently there are three schools of knowledge management. The methodology for the integration of knowledge in the enterprise, which is presented in the form of a diagram. The knowledge creation enterprise is carried out ways: through self-education personnel; by performing duties; tools of knowledge management. Proposed projects for the knowledge management implement in stages and characteristics of each stage. It is proved that the culture of designing the system of knowledge management should include management strategies, planning and provide for close cooperation and distribution of powers. It is concluded that knowledge management helps businesses become more competitive, reduce costs, increase the speed of making management decisions and efficiently identify the needs of consumers. The main purpose of the system of knowledge management of the enterprise is knowledge management an integral part of the work of all employees.
KEYWORDS: KNOWLEDGE MANAGEMENT, INTELLECTUAL ASSETS, MANAGEMENT STRATEGIES, METHODOLOGY FOR THE INTEGRATION OF KNOWLEDGE

1. Introduction

The formation of the knowledge economy means a change in the institutional framework of the functioning of an economic system, since a change in the rules and norms of economic behavior of people, their priorities and values. Activities related to the production and preservation of knowledge, separated from material production, remains subordinate. Institute for conservation of knowledge is important in ensuring the sustainability of society. Knowledge becomes a factor of production through its embodiment in the means of production appear specialized institutions aimed at the reproduction and transfer of new knowledge.

Sustainable competitive advantages of the company are possible as a result of the interaction of a complex resource structure, in which they are acquired, developed and used. The complex structure arises as a result of the interaction of network resources. The first one of the main types of resources of enterprises in the modern economy have identified organizational knowledge Polanyi M. [1], which now referred to the strategic assets of the enterprise, which implies that in order to remain competitive should develop mechanisms to acquire necessary knowledge and its dissemination in a timely manner and in the required format.

However in the knowledge economy may increase individual incomes and promote sustainable development of the country, as new knowledge applied to business processes and production activities, allow [2]:

- increase individual productivity of human labor, which makes it capable of performing the work that has greater social value and thus higher rewards;
- to develop in a person business skills and entrepreneurship, which in turn gives him the ability to make informed decisions;
- to have sensitivity to the perception of new scientific developments, reducing the term of their implementation into production and to stimulate the development of new ideas;
- to develop intelligence and individual talents to generate new technological ideas and rational organization of production in relation to specific conditions.

2. The concept of knowledge management

Swiss scientists T. Krog and M. Kene in his concept of knowledge management, special attention was paid to its important part of knowledge transfer [3], which showed the dependence of profitability from the quality of the process of generating new knowledge and the implementation of its intra-company transfer. This dependence brought the concept of "knowledge capital" P. Strassman [4], who linked the increase in profits generated knowledge capital, and proved that awareness raising and training of employees helps to increase the stock of knowledge, which, in turn, form the net value added.

Focusing on these important components of knowledge management as the process of formation of the intellectual assets of the company, we distinguish technological, motivational and organizational components of this system:

1. The technological subsystem includes the totality of management decisions for the identification, storage, transmission, structuring, processing, transforming and disseminating knowledge.
2. The motivational subsystem includes fostering the accumulation and exchange of knowledge, communities, organizations, contractors, external environment.
3. Organizational subsystem includes a set of methods, activities to promote transformation of individual knowledge in the corporate and the creation of intellectual assets of the organization.

The system methodology of knowledge management are methods to transform individual pieces of information as an organized set of data into knowledge as a set of fixed in the minds and thinking of the facts of reality relevant to a particular area of activity. Therefore, the system design of knowledge management of the enterprise involves a series of steps:

- define the goals and objectives of knowledge management;
- audit and assessment of existing intellectual assets and knowledge of the organization, determining their compliance with the order;

- development of the knowledge management strategy;

- creating changes in organizational culture, organizational structure;

- completion of formation and implementation of the system, the evaluation of its effectiveness.

New knowledge is acquired in the learning process as individuals and units, and training of the whole enterprise. Here, the basic process is the process of turning individual knowledge into organizational knowledge [5]. It is the process of creating organizational knowledge is considered the basis of knowledge management. The most well known model that reflects the processes of creating knowledge is the SECL model, developed by I. Nonaka and H. Takeuchi [6], according to which occurs the transformation of explicit and implicit knowledge:

- socialization – the transition of implicit knowledge to formal (improvement of existing skills);

- externalization – the transfer of informal knowledge in formal (description of skills that are used, clarify the regularities of the practical activities);

- combination – transfer of formalized knowledge formalized (in General terms – the creation of one theory to another);

- internalization – transfer knowledge in formal and informal (receive certain skills).

Strategic institutional aspect of knowledge management involves the creation of such institutions:

- organizational culture that promotes and encourages the development of knowledge, gives knowledge of high value, stimulating exchange of knowledge, provides training to staff and managers on knowledge management;

- infrastructure to support knowledge management processes.

There are two types of learning in organizations: an adaptive and paraguachi. Adaptive learning focuses on changes in response to the development of environment, it is necessary for the survival of the enterprise, and Paraguacu training associated with the development in the organization of the characteristic features or the creation of new opportunities to enhance existing competencies in new competitive areas.

The analysis of world experience of the practical implementation of knowledge management shows that organizations and businesses take this purpose a variety of methods and ways: from the explanation of benefits you receive as a result of the effective use of knowledge to develop knowledge management strategies. Gradually changes occur in the organizational structures for the implementation of knowledge management by creating groups, departments or introduction of the posts of managers in knowledge management. According to the author [7], the most suitable for the implementation of effective knowledge management are network organizational structures that are flat, have a low functional barriers and contribute to the blurring of the boundaries of the enterprise.

Thus, the basis of market valuation of business entities are not material factors, and the ability to use internal resources, capacity for innovation and active work in order to consolidate their competitive positions. The introduction of knowledge management entities is part of their investment and strategic policy and provides for the development and implementation of effective innovative projects.

Knowledge of the enterprise is replenished and updated as a result of training, research, hiring of highly qualified professionals use their years of errors and validation of the activities of various working methods. The collective knowledge of the company, as a rule, are reproduced in documents describing the business processes. However, if the knowledge is not documented, and information about its source and location in the enterprise there, then use a full of these important resources is very difficult, if not impossible.

In a particular application of knowledge management as a function and view management activities include:

- the ability to add value to information by the identification, selection, analysis, synthesis, generalization, storage and dissemination of knowledge;

- creating an interactive community in which employees continuously share what they know and use all the conditions for the assimilation of new knowledge;

- providing knowledge of the kind of practical relevant information that can be used in specific situations.

The need to reduce the deficit of knowledge, which is reflected in the competitiveness and services, and firms as a whole, implies the following tasks:

1. The acquisition of knowledge (fit and use for their needs or those of other knowledge that is already in the world; the development and accumulation of knowledge based on NDDKR and industrial experience of staff).

2. Learning (continuous education and training of employees).

3. The transfer of knowledge (the use of new information technologies, providing access to information resources).

Currently, there are three schools of knowledge management.

The first school believes that knowledge management is primarily a problem of information technology. You need to create a computer network and use the software for work groups (Group Ware). The introduction of computer networks adds communication media, for cooperation in groups, people will be more willing to share information and knowledge [8].

The second school suggests that knowledge management is a problem of organizational culture and teamwork. Strong, positive organizational culture focused on the promotion of training, development, distribution of skills, resources and knowledge [9].

The third school tends to need to develop processes of organizational know-how, which have no need of using information technology [10]. The definition of knowledge management is as follows: "the Identification and use of formal and informal knowledge within processes, people, products, and services" [11].

3. Design methodology of the system of knowledge management in the enterprise

Knowledge management can improve the quality of managerial decision-making, providing managers with the information, reduce costs of operations, increase employee initiative. However, the effectiveness of knowledge management depends on the degree of use of information technologies, since knowledge is considered to be a form of public and individual memory, which is the result of structuring and comprehension of the object in the process of cognition and is stored in computer memory. The methodology of integration of knowledge could be schematically represented as follows (Fig. 1).

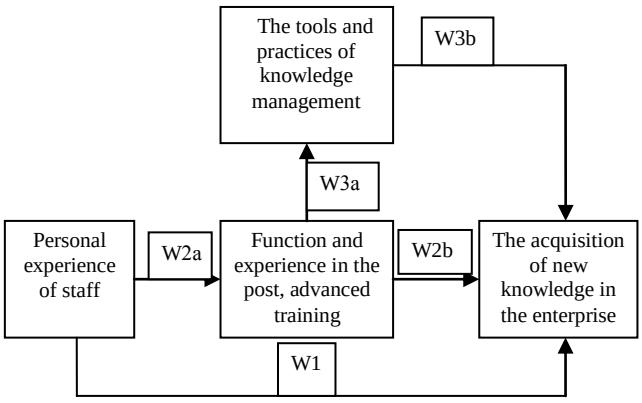


***Fig. 1**. Ways of formation of enterprise knowledge*
W1 – due to the self-education of personnel;
W2 – by performing duties;
W3 – by means of knowledge management

Successful introduction of knowledge management depends on many factors. Therefore, implementing the project management in the enterprise, consider the following:

1. Culture and work environment. A formal knowledge management process easier to implement in companies where there is free exchange of information and knowledge among all employees. However, many companies will have to begin this work in other conditions.

Company in which employees, teams and departments compete with each other and conceal knowledge and information, believing that "information is power" will have to do some preliminary work before you can go directly to the implementation of knowledge management. The emergence in the company atmosphere of mistrust promoted by some business processes, but the need for change regarding culture, and it must be given serious consideration.

2. System performance management and compensation. Depending on the adopted in the company's performance evaluation and compensation or staff members openly share their knowledge with others, or hide them, for fear of low evaluations of their work. If there's indeed a team spirit, recognition and praise can be as effective for a reward.

3. The current practice of management. Knowledge management cannot be regarded as an isolated process or program; it affects the implementation of most management strategies is an integral part of the infrastructure of the company. So if your company applies, for example, a program of total quality management (i.e. responsible for quality each employee), there is a necessity to all employees who participate in the implementation of the project at any stage of this work will be required to adhere to the principles of already existing programs.

4. The position of top managers. Top-managers of their behavior should show that they consider knowledge a valuable asset of the company and share inherent in this project ideas as well as share ideas with other active programs. They will have to devote to this project some money, if you intend to use special technology and the introduction of special posts.

5. The planning of the event. Development of plan of all works on project management knowledge and economic justification.

6. The calculation of the cost of knowledge. During the development study of the project on management of knowledge also need to determine the financial value of enterprise knowledge. Calculating the original amount, can be determined and their future value. Since conventional methods of calculating the value of intellectual resources of the enterprise does not exist, the traditional accounting of our businesses into account such intangible assets is not yet engaged.

Many years of experience in this area has shown that project management knowledge (table. 1) fail, mainly because too much attention to technology and lack of metering at different stages of the project the human factor. Meanwhile, the key to managing knowledge is not a computer network, and people.

Table 1

Stages of system design of knowledge management

Stage	Characteristics of the stage
Planning	Development of plan of all works on project management knowledge and its economic justification
Holding audit knowledge	Determination of the location of knowledge exactly who owns them and who needs them in your organization
Mapping knowledge	The results of the audit are knowledge maps, which give an idea about the structure and location of knowledge in the company
Classification knowledge	The division of all knowledge into categories to further help you find, codification of
Getting knowledge	Finding knowledge, retrieve it (from a document or from another source), receipt (from the person) or create a new one, in case of his absence
The organization storage knowledge	The choice of software solutions for managing data storage systems. Create a database and placed in it the newly acquired knowledge with regard to their classification
Control knowledge	Constant analysis of needs knowledge as well as control over the use and relevance of knowledge

4. The introduction of a system of knowledge management

The first step to implementing the project on management of knowledge is the knowledge audit. It will allow you to get a General idea about the existing knowledge in order to then move on to creating a more accurate "maps of knowledge". In some cases it is advisable to conduct an audit of the total volume of information and knowledge, which is used in the company, or which are needed. The knowledge audit will determine:

- needs in knowledge and what knowledge is missing;
- how knowledge is created, acquired and used;
- how organized the exchange and transfer of knowledge;
- what are intellectual assets.

With this information, you can identify the next step in the process of knowledge management. It can also be used for:

- developing the strategy knowledge management (information);
- making decisions about the content of the Internet;
- verification of the costs of obtaining knowledge (information) from the outside;
- determining the need for specialist management knowledge.

Knowledge is useful only if they are relevant, current and from reliable sources. Technologies such as Push, Intelligent Agents and collective filtering, allows you to select knowledge and to sort them according to established criteria. Intelligent Agents are background programs that operate for the people, initiating any process or starts a specified application. After receiving instructions, the agent operates autonomously as long as did not follow the instructions and will not tell its owner the result, while it scans the websites and the database, guided the collection of information specified in the instructions criteria.

Culture system design of knowledge management should include management strategies, planning and provide for close cooperation and distribution of powers of those who implement research and design. He should consider personnel management in conditions of extreme psychological and cognitive loads [12]. In addition, you need to enter a few special posts for experts in knowledge management who will carry out special duties. It should be remembered that the main goal is to make knowledge management an integral part of all employees of the enterprise (tab. 2).

Table 2

Expertise in knowledge management in the organization

Job title	The purpose and objectives of	Responsibilities
Manager knowledge management	• to identify the knowledge assets and needs in knowledge; • to manage the flow and use of knowledge	• to create a team with representatives from all the divisions of the Department; • to identify individual needs in knowledge and prioritize them; • to ensure that all employees effectively use the knowledge sharing tools; • to prevent a decrease in the efficiency of company databases and to increase; • to organize and conduct seminars; • compliance assistance the Department agreed principles of knowledge management
Coordinator knowledge	• to manage the flow and use of internal knowledge in the corporate knowledge base; • participate in conducting industry research	• to conduct certain internal investigations; • to promote existing in the company information database; • train end users to use different sources of information; • to deal with the paperwork that relates to knowledge management, including the conduct of internal distribution lists and manage your library of "hard copies"
Analyst, an expert on knowledge management	• to provide the teams knowledge management help in the management of information; • conduct analytical research to aid other departments of the company	• to perform the role of a consultant to groups knowledge management; • to develop the architecture, processes and infrastructure to databases and Intranet; • edit content of the home pages of libraries; • analyze and report on the results of research on knowledge management
Administrator knowledge	• manage the acquisition and provision of business information; • find and save links to corporate sources of business information; • to meet the needs of the company in knowledge (information)	• to manage external resources; • distribute logs and reports; • keep a record of; • to organize the storage of documents, books and files; • issue invoices and perform other General office duties; • to liaise with departments.

Manager, knowledge management must have the organization skills and experience in companies or in the financial sector. It is also desirable that it have:

- broad knowledge in the field of information technology including knowledge of: databases, the Internet and software for General use;
- deep understanding of the principles of knowledge management;
- experience of creating teams, lead teams and motivate their members;
- communication skills, interpersonal skills.

5. Conclusion

Knowledge management has a strategic focus, since its development and implementation determine the future of the enterprise, due to the formation of his new organization and information culture, the use of more effective business models, and overall changes to the market conduct of the competition.

In the future competitiveness of corporations will increasingly provide the ability to identify, accumulate, and develop knowledge, to obtain new key competences and using these key success factors in the market, create innovation, and then to turn them into long-term competitive advantage. Thus, the management of knowledge helps businesses to become more competitive, reduce costs, increase the speed of making management decisions and efficiently identify the needs of consumers.

In addition, if the company is suitable for implementation of the project on knowledge management as a way to become a team of people working together to continuously learn something new and improve, it will be much easier to implement this project and the positive effect of the implementation will be much larger.

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STRESS AND STRAIN ANALYSIS OF CONNECTION OF PIPES WITH FLAT ENDS

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Abstract: *This paper investigates stress state in connection of pipes with flat ends used in pressurized pipelines and steam boiler connections. Flat ends are designed according standard EN 12952-3 and later numerically checked using linear elastic material model. These analyses showed areas with increased stress. Therefore, additional analyses were performed using linear elastic-ideally plastic material. The maximal pressure loads are obtained for series of pipes with flat ends and compared to calculated results according EN 12952-3 norm.*

Keywords: PIPES, FLAT END, CONNECTION, STRESS, STRAIN, NUMERICAL ANALYSIS, FINITE ELEMENT METHOD

1. Introduction

A large number of structures in the engineering industry are pressure vessels and pipelines used for different purposes, mainly for transport and storage of liquids, gases and grain matter. They are made of various materials who can operate from low temperatures and pressures to very high pressures and temperatures[1]. There are different perpendicular cross sections of pipes and pressure vessels from rectangular and other non-circular shape to cylindrical ones which are the most commonly used because cylindrical shape provides the maximum strength and can withstand the maximum applied internal pressure for the structure. This is due to the absence of bending stresses in the cylindrical shell wall[2]. Cylindrical cross-section pipes are commonly used in thermoenergetics, hydroenergetics and process technics but due to various thermotechological requirements it is necessary to disrupt the ideal continuity of the cylindrical shape, which can cause an increase in local stresses in that place. Such discontinuities in pipeline geometry are branching of pipeline, connecting pipes of different wall thicknesses, transition of cylindrical to conical shape, placing the connectors on pressure vessels, connecting cylindrical shapes with flat ends and in many other cases[3].

Nowadays, almost all parts of the metal structure are mainly produced partly or completely using welding process. Since pipes or pipe fittings are integral parts of most pressure boilers or boilers, their installation, shape and geometry are prescribed by standards. This paper investigates stress and strain state in connection of pipes with flat ends used in pressurized pipelines and steam boiler connections.

Flat end connection to pipes are commonly used in pressure test of pressure vessels where pressure connections are needed to be closed in order to apply internal pressure inside pressure vessel. Investigated flat ends are designed according standard EN 12952-3[4].

The calculation according to this standard can be divided into two parts: DBF (design by formula) – doing calculation using the formulas that are prescribed in the standard and DBA (design by analysis) – calculations based on analysis, experimental deformation methods or numerical calculation using finite element methods. After designing, flat ends are later numerically checked using linear elastic material model. These analyses showed areas with increased stress. Therefore, additional analyses were performed using linear elastic-ideally plastic material. The maximal pressure loads are obtained for series of connections of pipes with flat ends and compared to calculated results according EN 12952-3 standard. Therefore it was necessary to carry out calculations according to elastic-ideal plastic law referring to EN 13445-3 which describes that at maximum test conditions maximal principal deformation should not exceed 7%[5].

2. Analytical and numerical analysis, results and discussion

EN 12952-3 standard defines when numerical calculations can be used. Numerical calculations apply to components where there were no rules in their construction or where we cannot accurately determine the strength of components according to the equations prescribed by European standards. The methods used for the calculations are: the method of free bodies, the finite difference method and finite element method.

The assessment of the stresses of each component must be carried out in accordance with EN 13445-3. The stresses in this case are checked using strains occurring in the material. For each case of load or combination of loads, the verification must be carried out under the assumptions of linear elastic-ideally plastic material behavior and Tresca's flow condition. The maximum permissible strain value is 5% under normal operating conditions and 7% in test conditions[5].

Three main parameters are selected on multiple levels. The selected parameters are the outer diameter of the pressure vessel connection, the thickness of the pipe wall and the thickness of the flat wall end (cap).

Parameters are selected on multiple levels in order to obtain the wider range of allowable pressure for as many different cases in production. It was chosen that the outer diameter of the connection of the pressure vessel and the thickness of flat end the wall are analyzed on three different levels, and the thickness of the pipe wall on four levels. The selected parameter levels are shown in Tab. 1. According to EN 10029[6] the upper and lower tolerances on the end thickness for thicknesses ≥ 25 and <40, as all selected parameters are within this range, are -0.7 and +1.3. Considering the nominal thickness of the pipe wall in the calculation, tolerances with a negative sign are used in order to obtain less wall thickness and more secure calculations.

Tab1e 1: *Parameter level and design thickness (with lower tolerance values in parenthesis)*

Level	Outside diameter of connection, mm	Wall thickness, mm	Flat end thickness, mm
1	219.1	20 (17.50)	30 (29.30)
2	168.3	22.2 (19.42)	28 (27.30)
3	139.7	25 (21.87)	25 (24.30)
4		28 (24.50)	

The materials used in the manufacturing of connections of pipes with the flat ends are construction steel for pressure equipment. The pipe material is 16Mo3 and the flat end material is P235GH (Tab. 2). For weld material, due to conservativism, a P235GH material

with lower mechanical properties is chosen. Weld is predicted as homogeneous throughout the entire cross section. The following table (Tab. 2) show the main mechanical properties of the materials used at a test temperature of 20 °C.

Table 2: *Mechanical properties of materials P235GH and 16Mo3*

Material	$R_{p0.2}$, MPa	R_m, MPa	A, %	ν	E, GPa
	16 < T ≤ 40 mm				
P235GH	225	360-500	25	0,285	210
16Mo3	270	440-590	24	0,285	210

Numerical analyses are performed using the finite element method in ANSYS 14.5 software[7]. In this investigation, 108 different calculations were performed using three-dimensional models created in SolidWorks 2013[8] and only a quarter of the entire model is modeled in order to reduce the time of the analyses due to the symmetry of the problem. Maximum design pressure and weld dimensions are determined and calculated from EN 12952-3 for each geometry.

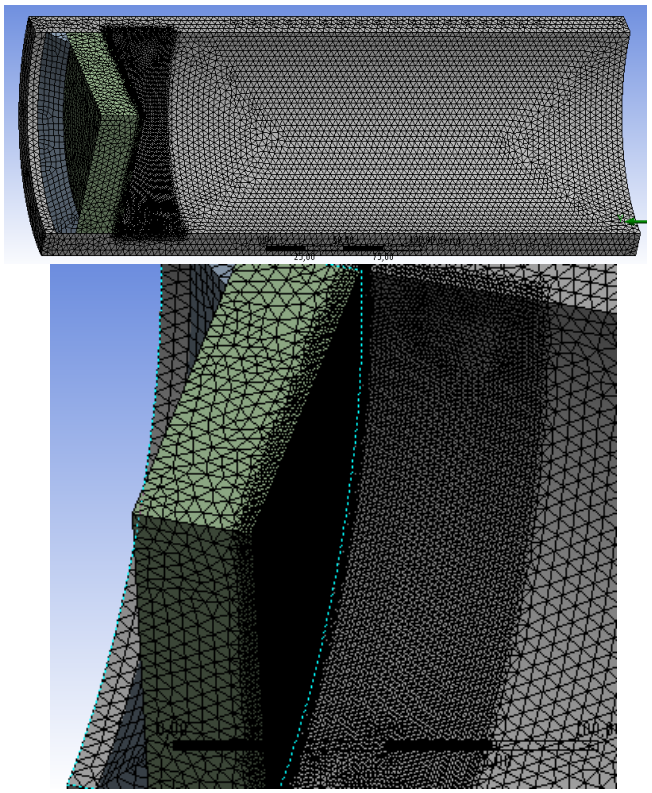


Fig. 1 *Meshed model with second order tetrahedral elements along with detail of finite element mesh refinement in one quarter of pipe with flat end connection*

The numerical analysis are done with second order tetrahedral elements. Because of the geometrical discontinuities around the connection of the pipe with flat end, where the stress concentration is expected, it was necessary to refine the finite element mesh to obtain more accurate stress and strain distribution.

The rest of the model is without discontinuity, so good results can be obtained with meshing with larger elements to reduce the time needed for analysis. The size of a single element in the part where meshing was coarse was 4 mm, while the size of the element on the finer part of the finite element mesh was 1.5 mm. Such level of mesh refinement was obtained using convergence of equivalent stress and strain solutions.

Because of the different dimensions of individual models, the number of elements and nodes varied from model to model. For largest model used in this investigation, the number of elements were 418195 and the number of nodes were 605250.

In finite element analysis the quickest and simplest way to perform analysis is to use linear elastic material behavior. It was the first step in this investigation too, but most of models showed significant stress concentrations i.e. areas where local stress values exceed allowable stress for materials P235GH and 16Mo3. Fig. 2 shows one finite element model where can be seen significant exceeding of allowable stress in the place of welded connection of the flat end with the pipe.

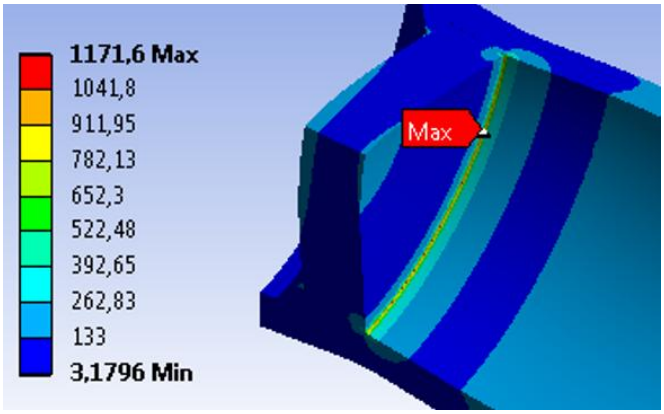


Fig. 2 *Equivalent von Mises stress distribution in finite element model with linear elastic material model, MPa*

In order to determine can this local increases in equivalent von Mises stress value be accepted and considered safe, an additional analyses had to be performed. That was done using different material models. Standard EN 13445-3 suggests using linear elastic-ideally plastic material models and checking principal strain limit. All models are analyzed with this material model and it is shown that models loaded with calculated design pressure give lower values of strain than the 7% permissible by EN 13445-3 standard. Part of these results are shown in Tab. 3 where table contains dimensions of pipe and flat end connection, design pressures according to EN 12952-3 and strains caused by design pressure.

Since all investigated models give lower values compared to allowable strain, another set of analyses are performed to obtain maximal pressure that produce maximal allowed values of principal stress of 7%. Every model had to gradually loaded with small pressure load step in order to precisely determine maximal pressure. Part of results of maximal pressure which gave maximal principal deformation of 7% with pipe diameter of 219.1 mm are also presented in the same Tab. 3.

Table 3: *Design pressure and principal strain for pipe to flat end connection with constant pipe diameter of 219.1 mm*

Connection of pipe with flat end dimensions, mm	Design pressure, MPa	Maximal principal strain for design pressure, %	Maximal pressure with maximal principal strain of 7%, MPa
219.1×17.5×29.3	32.29	1.60	53.42
219.1×17.5×27.3	28.03	0.89	42.42
219.1×17.5×24.3	22.21	0.87	41.59
219.1×19.42×29.3	33.68	1.35	51.21
219.1×19.42×27.3	29.24	0.75	47.67
219.1×19.42×24.3	23.17	0.75	42.83
219.1×21.87×29.3	35.59	1.20	59.43
219.1×21.87×27.3	30.89	0.98	55.09
219.1×21.87×24.3	24.48	0.53	48.79
219.1×24.5×29.3	37.82	0.70	65.28
219.1×24.5×27.3	32.83	0.47	64.13
219,1×24,5×24,3	26,02	0,5	36,98

Since presenting of all results of this investigation in form of tables or in form of diagrams would be impractical, only part of these results, where one geometric parameter (pipe outside diameter) is constant, showing dependence of design pressure and maximal pressure regarding wall and flat end thickness are presented in the following figures. Fig. 3, 4 and 5 show dependence of design pressure regarding end and wall thickness with constant pipe diameters of 219.1, 168.3 and 139.7 mm. It can be noted that thicker wall and thicker flat ends give higher values of design pressure. When comparing all three diagrams it is obvious that situation with same wall thickness but smaller pipe diameter also gives higher values of design pressure.

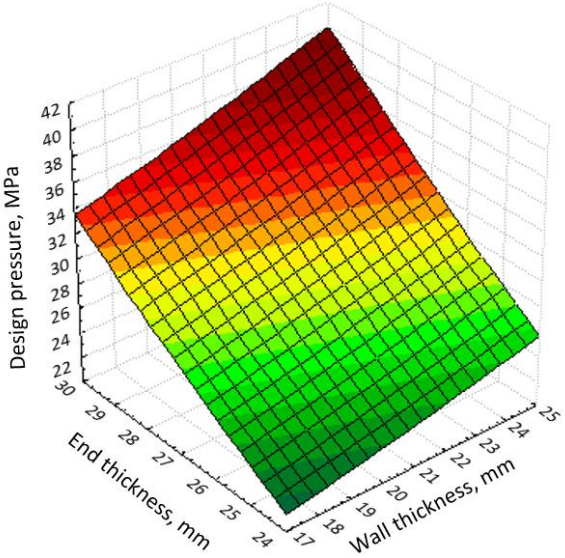


Fig. 3 *Dependence of design pressure on flat end and wall thickness with constant pipe diameter of 219.1 mm*

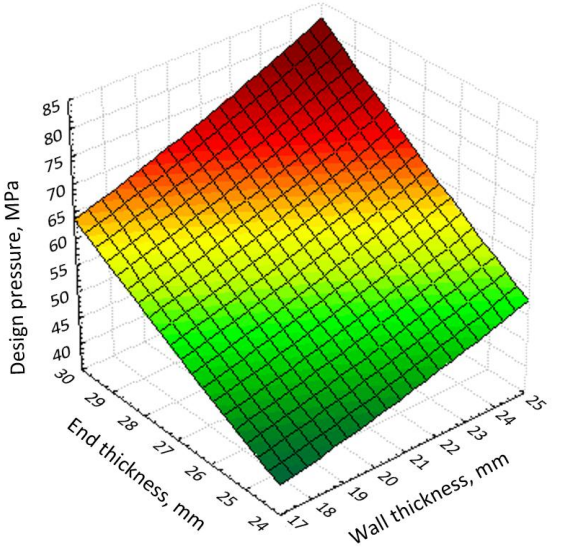


Fig. 4 *Dependence of design pressure on flat end and wall thickness with constant pipe diameter of 168.3 mm*

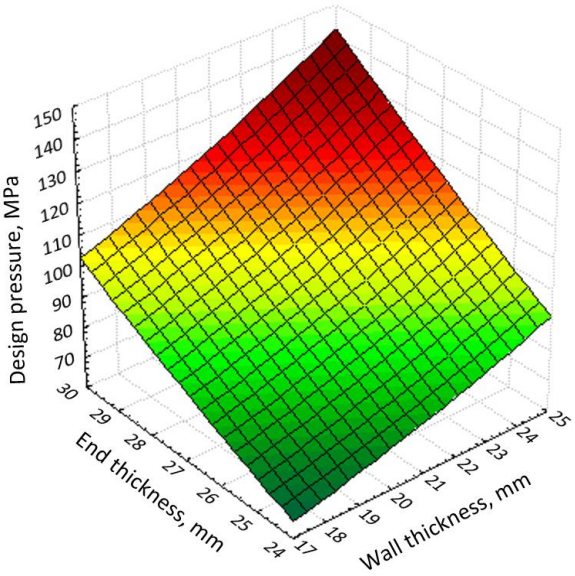


Fig. 5 *Dependence of design pressure on flat end and wall thickness with constant pipe diameter of 139.7 mm*

Fig. 6, 7 and 8 show dependence of maximal pressure causing strain of 7% on flat end and wall thickness with constant pipe diameter of 219.1, 168.3 and 139.7 mm from which it can be concluded that generally and similarly to design pressure, a maximal pressure which gives maximal principal strain of 7% is also increased regarding higher values of wall thickness and thicker flat ends.

When wall thickness and flat ends are kept constant, higher values of pipe diameter give higher values of maximal allowed pressure. All values of maximal pressure causing maximal strain are higher than calculated design pressure. From that it can be concluded that analytical calculation give more conservative values of design pressure compared to maximal allowable pressure obtained considering maximal strains.

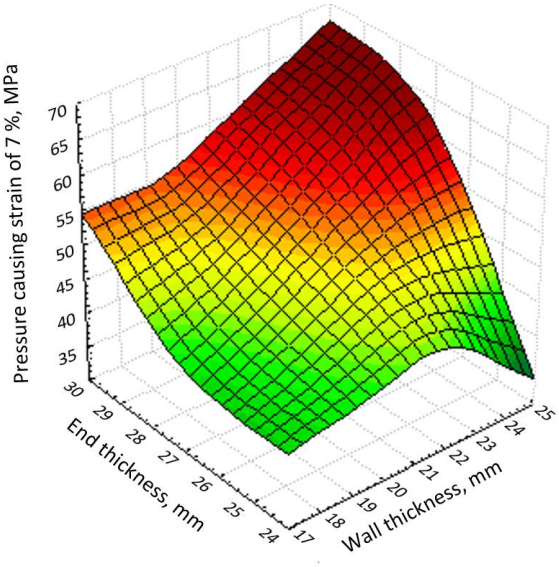


Fig. 6 *Dependence of pressure causing strain of 7% on flat end and wall thickness with constant pipe diameter of 219.1 mm*

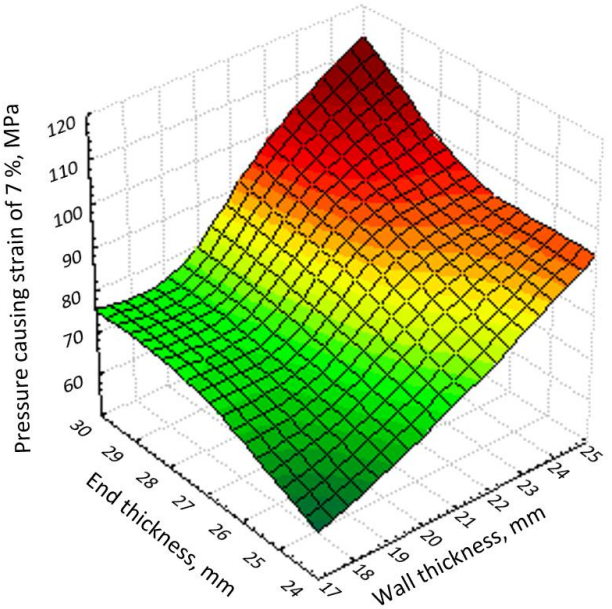


Fig. 7 *Dependence of pressure causing strain of 7% on flat end and wall thickness with constant pipe diameter of 168.3 mm*

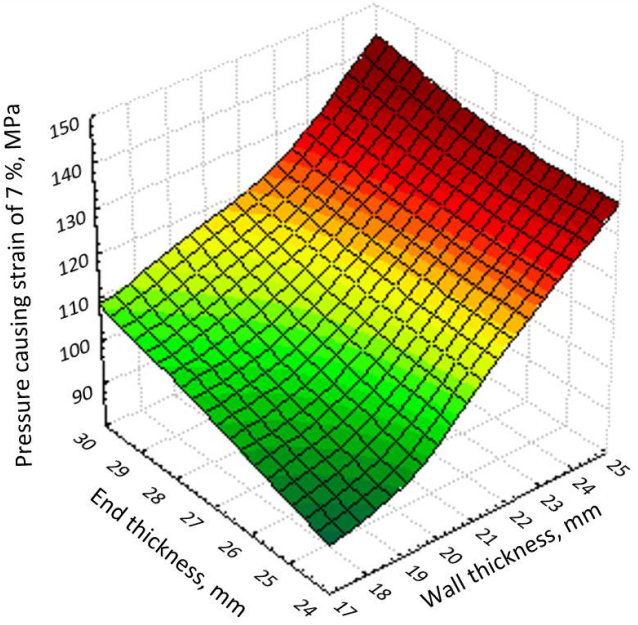


Fig. 8 *Dependence of pressure causing strain of 7% on flat end and wall thickness with constant pipe diameter of 139.7 mm*

3. Conclusion

Flat end connection to pipes are commonly used in pressure test of pressure vessels where pressure connections are needed to be closed in order to apply internal pressure inside pressure vessel. In this investigation flat ends are designed according standard EN 12952-3, and 36 different geometries are modelled regarding different pipe diameter, wall thickness and flat end thickness.

According to the linear-elastic material behavior, a total of 36 analysis were made, while with elastic-ideally plastic material model 72 analyses were performed, giving total of 108 numerical analyses. Linear elastic behavior of materials yielded to occurrence of very large local stresses. The main problem with these calculations was that it was not easy to determine limit of acceptable local stress. Therefore it was necessary to carry out analyses according to elastic-ideally plastic law referring to EN 13445-3 which describes that at the test maximum pressure cannot lead to exceeding maximal principal stress of 7%.

These analyses with linear elastic-ideally plastic material behavior gave lower values of principal strain compared to allowable strain. That can lead to conclusion that analytical calculation gives more conservative values of design pressure compared to maximal allowable pressure obtained considering maximal strains.

Another set of analyses are performed to obtain maximal pressure that produce maximal allowed values of principal stress of 7%, there results also showed conservatism in calculation of design pressure. The results obtained through the numerical calculations should not be taken as final but certainly confirm that the results obtained by the analytical calculations using standard are conservative and what is certainly appropriate because it strives for a more conservative but safer solution.

To estimate how conservative calculations using standard can be, these numerically obtained results, as a further investigation, are also planned to be checked and verified by experiment.

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A LOAD ADAPTIVE CONTROL SYSTEM OF MANIPULATOR ROBOT'S DRIVE

АДАПТИВНАЯ К НАГРУЗКЕ СИСТЕМА УПРАВЛЕНИЯ ПРИВОДОМ МАНИПУЛЯЦИОННОГО РОБОТА

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Abstract: *The control dynamics for the electric drive of manipulation robot (MR) link is considered. Joint-drives in mobility degrees of MR experience the variable loads caused by changes of a spatial configuration of MR in the course of motion, mass and dimensions of the moved payloads, etc. Changes of load can happen over a wide range and cause the essential deterioration in dynamic properties (speed, damping, etc.) of the system of automatic control (SAC) of drive. With the aim to stabilize the desired dynamic properties the algorithm of drive control is proposed which is adaptive to changes of load. The unknown parameters of drive load, necessary to form the adaptive control algorithm, are identified in observing device (OD). The work algorithm of OD to identify the unknown parameters of drive load is proposed. For the proposed control and work of OD algorithms the structural scheme of drive control is construction. The simulation results on computer are proved that in considered SAC of drive the stabilization of desired dynamic properties are ensured.*
KEYWORDS*: MANIPULATOR ROBOT, DRIVE OF JOINT, LOAD ADAPTIVE CONTROL SYSTEM, OBSERVING DEVICE*

1. Introduction

Spatial movements of the end-effector of the multi-joint manipulator robot (MR) are carried out by operations of its joint-drives [1]. Joint-drives of the MR experience the variable mechanical loads caused by changes of a spatial configuration of MR in the course of motion, mass and dimensions of the moved payloads and also technology factors, etc. [2]. Variable load of each drive is characterized by changes of a moment of inertia and an external moment of the mechanical load. The moment of inertia is the parameter (coefficient of the differential equation) and the external moment of load is the external disturbing signal of the system of automatic control (SAC) of the drive [3]. Changes of these variables of load can happen over a wide range and cause the essential deterioration in the dynamic properties (speed, damping, etc.) of the SAC of drive. There is a problem of creation in each joint of MR of a load adaptive SAC of drive which dynamic properties do not depend on changes of load. Therefore, it is necessary to define and use the variable parameters of load of drive for the stabilization of desirable dynamic properties of the SAC of drive. If MR moves unknown payloads, then these variables of load will be not only changing, but also unknown. Both the unknown and changing parameters of load necessary to form a load adaptive control algorithm of SAC it identifies (defines, estimates) by means of the observing devices (OD) [4].

2. Preconditions for resolving the problem

Thus for stabilization of desirable dynamic properties of SAC of joint-drive of MR is to make a load adaptive control system with the OD of identification of unknown parameters of load. The OD of identification of parameters of load it makes for the "mechanical" part of the drive which is described by the equation of the moments on a shaft of the direct current (dc) electric motor [2]:

$$Js\omega_m = M_m - M, \quad (1)$$

where J is the moment of inertia;
M is the external moment of load;
ω_m is the speed of rotation of the shaft of motor;
$s = d/dt$ is the differentiation operator;
M_m is the moment of motor.

The moment of the dc motor is formed according to a formula:

$$M_m = k_m i_a\ , \quad (2)$$

where k_m is the motor's torque constant;
i_a is the armature current.

In [5] based on the main provisions of the theory of observing devices [4] the algorithm of work of OD of identification of unknown value of moment of inertia of load of dc electric motor is proposed in following form:

$$d\left(k_m/\hat{J}\right)/dt = \delta_1 i_a k_s(\omega_m - \hat{\omega}_m), \quad (3)$$
$$d\hat{\omega}_m/dt = \left(k_m/\hat{J}\right)i_a + \lambda_1 k_s(\omega_m - \hat{\omega}_m),$$

where $\hat{J}$ is the estimation of value of moment of inertia J identified in the OD;
$\hat{\omega}_m$ is the estimation of the speed of rotation of the shaft of motor ω_m received in the OD;
k_s is the transfer coefficient of sensor of angular speed of a shaft of the motor;
δ_1, λ_1 are the constant coefficients.

However in this OD described by the equations (3) the influence of the external moment M of load of the motor isn't considered, while it can cause the instability work of OD. Therefore in [6] by analogy with a "mechanical" part (1) of the dc motor the algorithm of work of OD of identification of moment of inertia of load is proposed in following form:

$$d\left(1/\hat{J}\right)/dt = \delta_1(k_m i_a - M)k_s(\omega_m - \hat{\omega}_m), \quad (4)$$
$$d\hat{\omega}_m/dt = \left(1/\hat{J}\right)(k_m i_a - M) + \lambda_1 k_s(\omega_m - \hat{\omega}_m).$$

In expressions (4) it is supposed that the external moment M of load of the motor is measured by the sensor of moment and its value is known. However a measurement of the external moment M is difficult to realize and it isn't always possible, therefore it is required to develop the OD in which both the moment of inertia J and the external moment M of load are identified in common.

3. Resolving the problem

Let's consider the equations of the drive of rotation of a link of MR being the control object (CO) and consisting of the amplifier of power, the dc electric motor and the mechanical transfer (reducer) with the variable mechanical load [3].

The equation for an electric circuit of the dc motor is:

$$u_a = (1 + \tau_a s)R_a i_a + e_m, \quad (5)$$

where u_a is the armature voltage;
τ_a, R_a are the time's constant and the resistance of armature;
e_m is the motor's back-emf.

The equation of the motor's back-emf is given by:

$$e_m = k_\omega \omega_m, \quad (6)$$

where k_ω is the motor's back-emf constant.
The equation of the amplifier of power of the drive is:

(7) $$(1+\tau s)u_a = ku,$$

where k, τ are the coefficient of amplification and the time's constant of the amplifier of power;

u is the input voltage of the amplifier of power of the drive.

We will notice that in the equation (1) in relation to MR link drive the quantities J and M mean the following:

$J = J(\vec{q}, \dot{\vec{\xi}})$ is the moment of inertia of a load of the drive changing in dependence on a $\vec{q}$ vector of generalized coordinates and a $\vec{\xi}$ vector of parameters of MR and its payload (geometrical, weight-inertial parameters, etc.) [2] - it is the unknown parameter of a CO;

$M = M(\vec{q}, \dot{\vec{q}}, \ddot{\vec{\xi}}) = M_e(\vec{q}, \dot{\vec{q}}, \ddot{\vec{\xi}})/i$ is the counted to a shaft of motor the external moment of the drive load which changes are caused by mutual influence of movements on degrees of mobility of MR, moments from the gravity of links and a payload of MR, etc. [2] – it is the external disturbing signal for a CO;

M_e is the external moment of load of the drive;

i is the gear ratio of the coupling from the motor to the MR link.

In expression (1) J and M quantities are variables and characterize the variable mechanical load of the drive of a link of MR.

There are following kinematic ratios of the drive:

(8) $$\omega = \omega_m / i\,,\ \varphi = \varphi_m / i\,,$$

where ω is the angular speed of an output shaft of the drive;

φ_m, φ are respectively the angular positions on a shaft of the motor and an output shaft of the drive.

Solving in common the equations (1), (2), (5)-(8) and neglecting the lag effect of the electric circuit since $\tau = \tau_a = 0$ we will receive the following equation of the drive (of the CO):

(9) $$Js\omega_m + k_m k_\omega R_a^{-1}\omega_m = k_m k R_a^{-1} u - M,$$

where u is the control signal of CO.

The block diagram of the electric drive, i.e. CO, made on the equations (1), (2), (5)-(8) at $\tau = \tau_a = 0$, is submitted in Fig. 1.

In expression (9) the changes of J and M quantities will worsen dynamic properties of the SAC of the drive. Therefore for compensation of influence of variables of load to dynamical properties of the SAC of the drive, we choose a control algorithm of the drive, being adaptive to changes of the moment of inertia J and the external moment M of load of the drive [7]:

(10) $$u = u(\varphi, \omega_m, \hat{J}, \hat{M}) = (k_p k_1(\varphi^* - \varphi) - k_s k_2 \omega_m)\hat{J} + k_s k_3 \omega_m + k_4 \hat{M},$$

where φ^*, φ are respectively the demand and the actual angular positions of an output shaft of the drive;

k_p, k_s are respectively the transfer coefficients of sensors of angular position of a shaft of the drive and angular speed of a shaft of the motor;

$k_3 = k_\omega/(k_s k)$, $k_4 = R_a/(k_m k)$ - the constant parameters;

$\hat{J}$ and $\hat{M}$ are the estimations of J and M quantities of the load received in the OD of identification of these quantities.

In expression (10) the k_1, k_2 constant parameters are selected with the accounting of values of k_m, k_ω, R_a, k, k_p and k_s parameters so, that at $J = J_0 = const$ and $M = 0$, set in models of the drive (9), the desirable transition process of the SAC at $\varphi^*(t) = 1(t)$ will have the set duration T, s and the set overshoot $\sigma = 0$, % [8]:

$$k_1 = 9iR_a/(kk_m k_p T^2), \qquad k_2 = 6R_a/(kk_m k_s T).$$

In our case for clear proof the desirable transition process is chosen aperiodic (monotonous) (Fig. 2, the curve 3). Setting various values of the moment of inertia J and the external moment M of load in model of the drive (9) with the not adaptive to a load control algorithm when in expression (10) $\hat{J} = J_0 = const$ and $\hat{M} = 0$ it is possible to see that to increase in the values of J and M there is a deterioration in characteristics of transitional functions $h(t) = \varphi(t)$ (duration, overshoot and steady-state error increase) - in the Fig. 2, the curves 1 and 2. In this regard there is a problem of stabilization of desirable dynamic properties of the SAC of the drive with the variable mechanical load. The solution of this task is carried out due to development of the self-adjusted control system of the drive, adaptive to changes of the moment of inertia J and the external moment M of load which uncertain values are estimated in the identification OD which also is adaptive to changes of the specified quantities of drive's load.

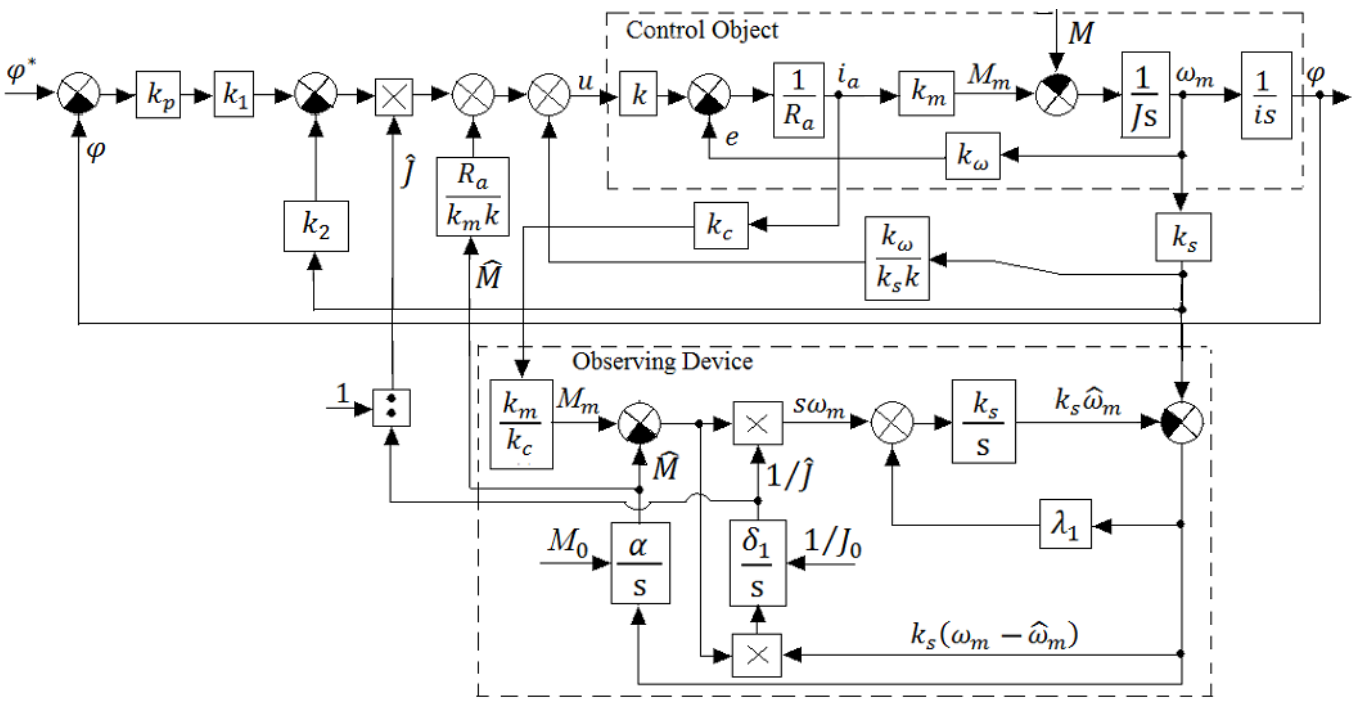


Fig.1 - Block diagram of the load adaptive system of automatic control of drive

For receiving of $\hat{J}$, $\hat{M}$ estimations, the algorithm of operation of the OD of identification of the moment of inertia J and the external moment M of load has the following form [8, 9]:

$$d(1/\hat{J})/dt = \delta_1 (M_m - \hat{M}) k_s(\omega_m - \hat{\omega}_m), \quad (11)$$

$$d\hat{\omega}_m/dt = (1/\hat{J})(M_m - \hat{M}) + \lambda_1 k_s(\omega_m - \hat{\omega}_m),$$

$$d\hat{M}/dt = -\alpha k_s(\omega_m - \hat{\omega}_m)$$

with the initial conditions:

$$\hat{\omega}_m(0) = 0, \ \hat{J}^{-1}(0) = J_0^{-1}, \ \hat{M}(0) = 0,$$

where J_0 is the average value from the possible range of changes of moment of inertia J.

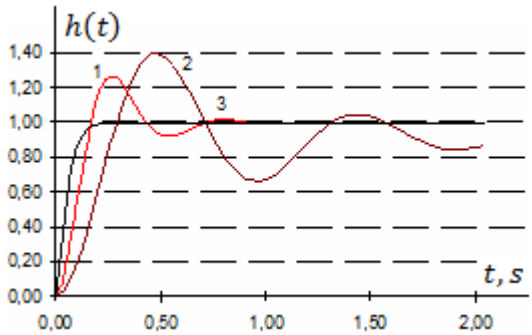


Fig.2 – The graphs of $h(t)$ transition functions
1 – SAC without OD at J =7 kg*m^2 and M =10 N*m;
2 – SAC without OD at J =25 kg*m^2 and M =100 N*m;
3 – SAC with OD at the same values of J and M of load

In expressions (11) for formation of the moment of the motor M_m according to expression (2) the armature current of motor i_a which values are measured by the current sensor with transfer coefficient k_c is used.

The block diagram of the load adaptive SAC of the drive consisting of a CO (9), control algorithm (10), OD of identification of variables of load (11) is shown in Fig. 3.

Let's consider the stability of the adaptive OD of identification of J^{-1} and M variables. Let's use the following designations

$$e = \omega_m - \hat{\omega}_m, \quad \nu = (1/J) - (1/\hat{J}), \quad \mu = M - \hat{M}$$

and take into account that

$$s\omega_m = \dot{\omega}_m = d\omega_m/dt = (1/J)(M_m - M),$$

then the operation algorithm of the identification OD in e, ν and μ coordinates can be described by the equations:

$$de/dt = (1/J)(M_m - M) - \quad (12)$$

$$-(1/\hat{J})(M_m - \hat{M}) - \lambda_1 k_s e,$$

$$d\nu/dt = -\delta_1(M_m - \hat{M})k_s e,$$

$$d\mu/dt = \alpha k_s e.$$

At the same time we will accept initial conditions:

$$e(0) = 0, \quad \nu(0) = J^{-1} - J_0^{-1}, \quad \mu(0) = 0,$$

and on the basis of a hypothesis of quasistationarity [4] we will consider that on the time interval corresponding to transition process in OD the J^{-1} and M variables do not change.

Let's prove that the position of balance of system of the equations (12) is asymptotically steady, i.e.

$$\lim_{t\to\infty} e = 0, \quad \lim_{t\to\infty} \nu = 0, \quad \lim_{t\to\infty} \mu = 0.$$

Let's consider a positive-definite function of Lyapunov of a following form:

$$V = \frac{1}{2}e^2 + \frac{1}{2\delta_1 k_s}\nu^2 + \frac{1}{2\alpha k_s J}\mu^2,$$

where $J = const$ - because it corresponds to a quasistationarity interval.

Considering that

$$\mu = M - \hat{M} = (M_m - \hat{M}) - (M_m - M),$$

let's write down a full derivative of function V with respect to time on the basis of system of the equations (12):

$$dV/dt = -\lambda_1 k_s e^2.$$

Let's show that at $e \equiv 0$ there are also $\nu \equiv 0$ and $\mu \equiv 0$. For this purpose we will consider at $e \equiv 0$ the system of equations (12):

$$0 = (1/J)(M_m - M) - (1/\hat{J})(M_m - \hat{M}),$$

$$d\nu/dt = 0, \quad d\mu/dt = 0.$$

The equality of zero of the first expression means $1/J = 1/\hat{J}$ and $M = \hat{M}$, therefore at $e \equiv 0$ the identical equality to zero the $\nu = (1/J) - (1/\hat{J})$ and $\mu = M - \hat{M}$ parameters is obviously. Therefore the function dV/dt is negative-definite and at construction the OD of identification according to expressions (11) the $1/\hat{J}$ and $\hat{M}$ estimations asymptotically approach to their actual values of the moment of inertia $1/J$ and the external moment M of load of the drive. The convergence of process of estimate depends on λ_1, δ_1 and α coefficients, which can be practically always chosen from a condition that the estimate processes in OD occur quicker than the main transition process in SAC of the drive.

4. Results and Discussion

Simulation of dynamics of control of the drive of rotation of a link of MR is carried out by method of numerical integration of the equations (9) of the drive and writing the program on the computer. For this purpose equation (9) of CO with accounting of the kinematic relations (8) was considered as the following system of differential equations:

$$d\omega_m/dt = (1/J)(-k_m k_\omega R_a^{-1}\omega_m + k_m k R_a^{-1} u - M),$$

$$d\varphi/dt = \omega_m/i.$$

In the program of simulation the different values of the moment of inertia J and the external moment M of load are set in this expression (9), these given values of load are estimated in identification OD on an algorithm (11) and used for formation of a control algorithm (10). Therefore, for simulation are necessary the equations (9)-(11) and the ratios (8).

Results of simulation of dynamics of control of a rotation link drive of MR at variable values of mechanical load are given in Figures 2, 3 and 4. Modeling was carried out at the following parameters of the electric drive with dc motor and OD: k = 10; i = 1; k_p = B/rad; k_s = 3,5 Vs/rad; k_m = 0,7 N*m/A; k_ω = 0,8 V*s/rad; R_a = 3 Ohm; T = 0,03 s; λ_1 = 38; δ_1 = 0,0009; α = 3000; J_0 = 16,5 kg* m^2. So, in SAC without adaptation to load ($\hat{J}$= const = J_0, $\hat{M} = 0$ - isn't used) at working off of an input signal $\varphi^*(t) = 1(t)$ with increase in values of load happens the deterioration in characteristics of the transitional functions $h(t)$ of SAC (duration, overshoot and steady-state error increase) – in the Fig. 2: a curve 1 at J =7 kg*m^2 and M =10 N*m; a curve 2 at J =25 kg*m^2 and M =100 N*m.

While in SAC with OD at these different values of mechanical load corresponding to different configurations of MR and masses of moved payloads, characteristics of transitional functions don't change (the Fig. 2, a curve 3), i.e. independent of changes of load in SAC with OD the set duration and overshoot of desired transition process always take place, and the steady-state error of the SAC is completely eliminated.

In the Fig.3 are shown curves 1 - 4 of transition processes in OD at the identification of unknown values of the moments of inertia J set in the drive model (9) together with the external moments M of load: 1 is the estimate of J =7 kg*m^2 at M =10 N*m; 2 is the estimate of J =10 kg*m^2 at M =40 N*m; 3 is the estimate of

J =20 kg*m^2 at M =70 N*m; 4 is the estimate of J =25 kg*m^2 at M =100 N*m. In the Fig. 4 are shown the corresponding curves 1 – 4 at the identification of unknown values of the external moment of load M set in the drive model (9): 1 is the estimate of M =10 N*m at J =7 kg*m^2; 2 is the estimate of M =40 N*m at J =10 kg*m^2 ; 3 is the estimate of J =20 kg*m^2 at M =70 N*m; 4 is the estimate of M =70 N*m at J =25 kg*m^2 .

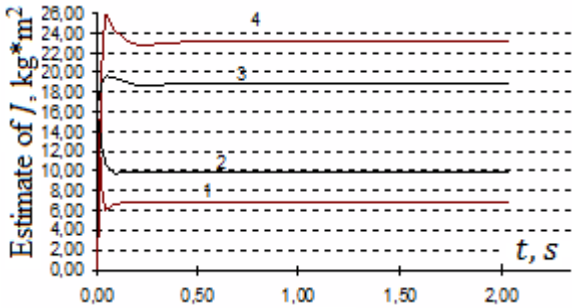


Fig.3 - Transition processes of identification of the moment of inertia of load
1 is the estimate of J =7 kg*m^2 at M =10 N*m;
2 is the estimate of J =10 kg*m^2 at M =40 N*m;
3 is the estimate of J =20 kg*m^2 at M =70 N*m;
4 is the estimate of J =25 kg*m^2 at M =100 N*m.

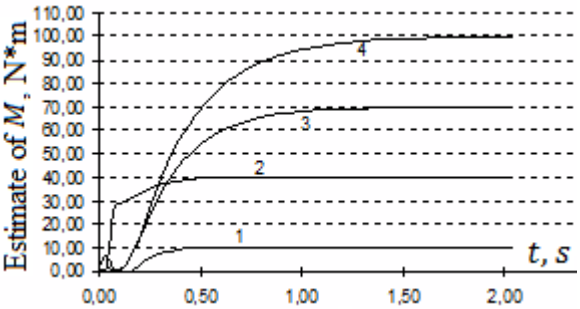


Fig.4 - Transition processes of identification of the external moment of load
1 is the estimate of M =10 N*m at J =7 kg*m^2;
2 is the estimate of M =40 N*m at J =10 kg*m^2 ;
3 is the estimate of J =20 kg*m^2 at M =70 N*m;
4 is the estimate of M =70 N*m at J =25 kg*m^2.

From curves in Figures 2, 3 and 4 it is also visible that process of estimate of unknown variables of the moments of inertia J happens quicker than transition process in the main contour of SAC, that is necessary for the steady work of a load adaptive SAC of the drive, and the estimated values of the unknown external moments M of load eliminate a steady-state error of the drive.

The graphs in Figures 2, 3, 4 of transition processes in OD at the identification of different values of the moment of inertia J and the external moment M of load set in model of the drive (9) have shown that the use of the values J and M estimated in OD to form an adaptive control algorithm (10) provides the invariable characteristics of transitional functions in the control system, i.e. independent of changes of mechanical drive load in SAC with OD the desirable transition process - a curve 3 in the Fig.2 always takes place.

5. Conclusion

Variable mechanical load of joint-drive of MR is characterized by changes of the moment of inertia and the external moment of drive load. The moment of inertia is the parameter and the external moment is the external disturbing signal of the SAC of the drive. Changes of these variables of load cause essential deterioration in dynamic properties (duration, overshoot and steady-state error increase) of the SAC. For the stabilization of desirable dynamic properties of the SAC of drive it is required to use the actual values of the moment of inertia and the external moment of load to forming a control algorithm of the drive. However when the MR is moving unknown payloads the values of these parameters of load will be unknown. For the identification of the unknown parameters and external disturbing signals of the SAC it uses the ODs [4]. So, in [5] the algorithm of work of OD of identification of unknown value of moment of inertia of load of dc electric drive is proposed. However in this OD described by the equations (3) the external moment M of drive load isn't considered, while it can cause the instability work of OD. Therefore in [6] by analogy with a "mechanical" part (1) of the drive the algorithm (4) of OD of identification of moment of inertia of load of drive is proposed in which the external moment M of drive load is considered. As in algorithm (4) the measurement of the external moment M is difficult to realize and it isn't always possible, in this report was proposed the algorithm (11) of the OD in which both the moment of inertia J and the external moment M of load are identified in common.

The proposed algorithm (11) of OD has asymptotically stability of identification of unknown values of the moment of inertia and the external moment of load of the drive during necessary time that allows their use in an algorithm of adaptive control (10) and provides elimination of their disturbing influence on dynamics of control of the drive (9) of a link of MR.

Results of simulation on the computer illustrate that, first, variables of the unknown parameters of load of joint-drive of MR cause inadmissible deterioration in dynamic properties of the SAC of drive, and secondly, use in a load adaptive algorithm (10) of control of the drive (9) instead of unknown values of the moment of inertia J and the external moment M of load of the drive their values $\hat{J}$ and $\hat{M}$ estimated in the OD described by the equations (11) provides stabilization of desirable dynamic properties of the SAC of link drive of MR. The set of a load adaptive drive control systems each of which is in the degree of mobility of MR will provide desirable dynamics of control of movement of end-effector of MR in the course of performance of production tasks.

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EXPLORATION OF THE RADIOECOLOGICAL STATUS OF THE DRINKING AREA OF VELIKO TARNOVO

ИЗСЛЕДВАНЕ НА РАДИОЕКОЛОГИЧНОТО СЪСТОЯНИЕ НА ПИТЕЙНАТА ЗОНА НА ВЕЛИКО ТЪРНОВО

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Abstract: *The article reviews the environment, radiation transformations and how they affect plants, animals and humans. A theoretical overview of the task is done. Results of measurements of the presence of radioactive isotopes in various non-living and living sites in the region of the main source of water in Veliko Tarnovo - "Yovkovtsi" dam lake and some of the obtained spectrograms are presented.*

Keywords: *control monitoring, radiecological control, radiological risk, earth, structura, gamma background*

1. Introduction

The ever-worsening environmental condition on a global scale due to the rapidly growing consumption potential of the human population and the rapid development of technical progress is of great concern because modern civilization puts a serious test on the equilibrium of the biosphere. Therefore, one of the most current problems of the present day is related to the contamination of the biosphere with radioactive substances, its radiation purity and radiation protection.

On this occasion, the French scientist Dorts says, "The man has made a great mistake when he has thought that he can separate himself from nature and not comply with his laws." The rift between man and the surrounding natural environment existed long ago. a "treaty" linking the primitive man to his habitation was violated by a man who felt strong to recognize only the laws he had created in the future. This position must be fully reconsidered and a new pact signed with nature, "giving possibility a man living in complete agreement with it. "

As a result of the large number of experimental studies conducted in different countries and the accumulation of vast information on the migration of radionuclides in ecosystems under different conditions and the action of ionizing radiation on living organisms on Earth.

In addition to theoretical interest, their results are of great practical relevance as they allow the assessment of the consequences of the introduction of artificial radionuclides into the environment and ways and means to reduce human discomfort. Therefore, systematic control of radioactive contamination of air, water, soil, flora and fauna is carried out in all countries. In the case of the smallest exceeding of the permissible standards, the appropriate measures for the protection of the environment and mainly of man are taken.

Radiation monitoring in our country is being constructed as a modern automated information and control system, ensuring the reliability of the collected information by using modern methods of data analysis and evaluation, creation and maintenance of a specific database and solving a certain class of tasks related to conservation the environment and the proper use of natural resources.

According to modern cosmological knowledge, the solar system has been uncovered about 5 million years ago in a cosmic gas-filled and dusty cloud-rich element. Scientists, observing and studying Earth's processes, conclude that a new environment, called the biosphere, within which living matter exists.

The term biosphere (from Greek bios - life and sphaira - globe) appeared accidentally in 1875 in the works of the Austrian geologist Edward Zuis. Later, three interpretations of the notion of biosphere: biological (substrate), geographic (spatial-substrate) and general science (evolutionary - substrate - spatial) [1]. The initial substrate-biological treatment includes the set of all living organisms on Earth. In geographic sciences, this term is traditionally used to mean one of the geospheres of the geographic envelope along with the atmosphere, the lithosphere and the hydrosphere but distinct from the saturation with living organisms. In fact, it is considered as spatially substrate. Modern teachings on the biosphere were created by the Russian scientist Vladimir Vernadsky (1945). In the light of the new geochemical concept of evolution of life, it reveals the geological role of living organisms as a planetary scale factor in creating the gas composition of the atmosphere, water, sedimentary foundation, in the formation of the upper shell of the Earth. According to Vernadsky, not only does life exist in this envelope, but it is, to some extent, altered and shaped by life. This is the third evolutionary substrate - spatial treatment of the concept. According to Vernadsky, "the biosphere is the thin layer of the living substance and the living substance as a body of organisms that, like a gas mass, surround the earth's surface and exert some pressure on the surrounding environment, bypass objects that obstruct their movement or masquerade and obey them" . In fact, the biosphere is a planetary ecosystem in which the flow of substances and the energy flow are mutually interconnected and interconnected globally. The biosphere is an open system consisting of subordinate subsystems and elements that function and develop in a mutually united unity. In its existence the biosphere maintains its equilibrium thanks to its perfect regulatory mechanisms. In recent years, however, the man with his business has created many problems for the functioning of the biosphere.

2.1. Structure and boundaries of the biosphere

The modern biosphere is a multi-component system with complex construction and heterogeneous composition. According to Vernadsky, the biosphere consists of seven elements:

1) a live substance;
2) biogenic substance;
3) Mineral substances;
4) transitional forms between biological substance and mineral substances;
5) radioactive substances;
6) scattered atoms;
(7) substances of cosmic origin.

It is generally assumed that the biosphere consists of three main components: [2]

1) living organisms - this is the living surface of the Earth - plants, animals, microorganisms;
2) mineral substances - substances included in the biological circle;
3) Organic products - substances temporarily excluded from the biological cycle.

The biosphere covers the whole hydrosphere and the entire land. The theoretically living organisms can populate:

1) the atmosphere - within the troposphere and the lower parts of the stratosphere to the height of the nitrogen layer (25 km);
2) lithosphere (depth up to 10 - 15 km). It is virtually not found at a height of 22 km and a depth of 2-3 km.

The components of biosynthesis are:

- Atmosphere. It is the gas shell on Earth. It consists of nitrogen (- 78%), oxygen (- 21%), water vapor and inert gases with a total volume of 1%. Other gases and impurities are considered to be pollutants. The total mass of the atmosphere is 5,16 . 10^{18} kg.

Depending on the change in temperature, the atmosphere is divided into five layers.

1) the troposphere above the poles h = 8-10 km, above the equator h = 16-18km, and above the moderate widths h = 10-12 km. The average thickness of the troposphere is assumed to be <11 km;

2) stratosphere - with a thickness of 10 <h <50 km;

3) mesosphere - with a thickness of 50 <h <90 km;

4) thermosphere - with a thickness of 90 <h <800 km;

5) exosphere - with a thickness h> 800 km;

After this layer, the atmosphere passes into interplanetary gas.

The atmosphere as a whole is a relatively inappropriate environment for the development of the living substance.

Hydrosphere. It is a set of all the waters of the Earth. It forms a continuous water envelope located between the atmosphere and the lithosphere and occupies ~ 70.8% of the surface of the planet. This includes the waters of the oceans, seas, underground and surface waters on land.

The Radiation Situation subsystem of the NASCRGF of the EEA for the MOEW organizes the creation and maintenance of a database for the change of the natural background radiation as a result of anthropogenic factors, assessment of the content of natural and technogenic radionuclides in the atmosphere, soils and water basins. assessment of the radiation situation, formed in individual localities and regions of the country.

The main tasks of NASCRPF can be formulated as:

1) system regime observations of the radiation characteristics of the environmental elements;

2) Processing and analysis of the received data from the system observations, organization of the information base, servicing the units of the Ministry of the Environment and the state bodies with information on the radiation situation;

3) Assessment of the content of technogenic radionuclides in the natural environment and their migration potential in the "Biological Environment - Man" chain [4].

Functionally, control includes:

1) NPP;

(2) Uranium-producing industries;

3) Thermoelectric power plant;

4) Enterprises, institutions and institutions using radioactive substances in their activities;

5) Local and global post-emergency delays;

(6) Non-ferrous metal mining and processing enterprises.

2.2. Types of radioactive transformations and radiation properties.

There are 6 types of radioactive transformations known in nature. Of these, the most likely are: α-conversion, β-conversion and γ-radiation [3]. A-transformation from the kernel takes off a-particle. It is a heavy charged particle made up of 2 protons and 2 neutrons, i. E. it is the nucleus of helium and the particles move at a velocity of ~ 10 m / s. Their air flow reaches up to 10 cm. Fully swallowed from a sheet of paper and organic tissue. Therefore, any substance (barrier) with a thickness greater than the distance therein provides the protection against external irradiation.

In the β-transformation from the core a β-particle takes off and an electronic antineutrino. β-particles are electrons that move at speeds in the order of light velocity (V? ~ 108 m / s). They have an energy of 10 eV to 10 keV. Their air flow reaches a few meters. They are absorbed in aluminum foil with a thickness of 1mm. β- the particles penetrate the human skin and reach a different depth in the tissues. Ordinary clothing weakens the β-flow by ~ 50%.

γ-radiation is electromagnetic radiation with X <10-10 m. Its energy is from 10 keV to 5 MeV. It has a great penetrating ability. Its air flow reaches hundreds of meters.

2.3. Anthropogenic sources

Radioactive contamination of the environment may occur in the following cases: nuclear weapon experiments, nuclear reactor failures, uranium ore extraction, improper storage and transportation of radioactive materials, and nuclear reactor failures. Of these, the radioactive contamination of the biosphere caused by accidents in nuclear reactors is of significant importance. The normal operation of the NPP is associated with a certain degree of environmental contamination with radioactive substances. Pollution is generated from gaseous radioactive waste (radioisotopes of noble gases ^{13l}I, ^{l32}I, ^{3}H, ^{13}C and aerosols of some Cs, Ru, Co and other radionuclides representing the fission products of the nuclear fuel) emitted into the atmosphere.

2.4. Effects of radioactive contamination on plants, animals and humans

2.4.1. Effects on animals

The striking effect of radionuclides on animals is the result of:

1) external radiation - originating from radioactive substances in the air or deposited on the ground;

2) internal irradiation - is generated by radionuclides that have entered the organism.

In internal irradiation, most of the body's respiratory system, skin, or gastrointestinal tract radionuclides selectively accumulate in certain organs where they generate prolonged ionization. For example, 131I accumulates in the thyroid gland, 90Sr - in the hair, 137Cs - in the muscle tissue. This violates the functions of the individual organs. Single and multiple irradiation of adult animals with large equivalent H doses develops radiation sickness.

At H = 1 -2 Sv - radiation disease - mild degree; H = 2-3 Sv - radiation disease - medium degree; H = 3 - 4.5 Sv - radiation disease - severe grade; H> 4.5 Sv - Radiation Disease - Extremely severe. Young animals are more irradiated and birds have less radiation from mammals.

2.4.2. Impact on man

The impact of radionuclides on humans is similar to that of animals, may occur in direct external irradiation or by internal irradiation. The action of ionizing radiation on the human body passes through three stages: physical, chemical and biological.

During the physical stage the radiation ionizes and excites the atoms and molecules of the biological tissue. Radiolysis (dissociation) of water plays a major role in it. Defeat is partially recovered due to the recombination of part of the ions. The duration of the physical stage is ≈ 10^{-13} s.

During the chemical stage, a number of new compounds are formed that are foreign to the healthy tissue. At this stage, molecules break, DNA damage, and amino acid and enzyme alteration. The immune system restores some of the damage. The duration of the chemical stage is ≈ 10^{-3} s.

During the biological stage some of the cells die and the immune system eliminates them. The lesions at the cellular and subcellular levels lead to a number of morphological and functional changes in individual tissues, organs, systems and in the body as a whole. The length of the biological phase can be minutes, hours, days, weeks, and even years. The end result of processes running through the various stages is the generation of radiation effects (injuries) in different tissues and organs. Radiation effects depend on the type and energy of the radiation, the absorbed dose (D) and the equivalent dose (H), their potency, the irradiance of the irradiated objects, etc. Radiation effects are divided into two main groups - somatic and genetic. Somatic (body) radiation effects are injuries in the body that are not passed on to his or her generations by hereditary route. Depending on the time of development, they are divided into early and late. The somatic effects also affect the radiological effects of the embryo and fetus. Early somatic effects occur within a few weeks after irradiation. These include changes in the radiosensitive human organs: haematopoietic organs (red bone

marrow, spleen, thymus, lymph nodes), gastrointestinal mucosa, gonad, respiratory system. The dependence of the effect of the equivalent dose H is as follows:

1) at H <0.25Sv- changes are not observed;

2) at H = 0.25 Sv - temporary changes in blood count were observed. This value is considered a threshold dose;

3) at H = 0.25-1.0 Sv - slight reversible changes are observed;

4) at H> 1.0 Sv - symptoms of radiation sickness are observed. It is divided into four stages;

5) at H = 1.0 - 2.5 Sv - radiation disease - mild degree;

6) at H = 2.5-4.0 Sv - radiation disease - medium degree;

7) at H = 4.0-6.0 SV - severe disease;

8) at H = 6.0 - 10.0 Sv - radiation disease - extreme severity.

Late somatic effects occur after a prolonged lethal period (after years). These include various forms of leucosis and cancer, common functional changes, darkening of the lens, impairment of sexual function, etc. The genetic effect is related to the damage of the gene, where it passes into a new stable form that is reproduced in daughter cells. This process is called a mutation. When the mutation is in a sex cell, its eventual involvement in fertilization would result in the transmission of this mutation to all the cells of the new organism.

Finally, it should be pointed out that minimal losses of plant and animal damage can be achieved by conducting relevant measures, and hence ensuring the protection of human beings in the consumption of plant and animal products.

3. Experimental part

3.1. General Characteristics of the Yovkovtsi Dam

Yovkovtsi dam is part of the national hydropower system of the country. Strategic site of great economic and economic importance. With a volume of 90 million m 3 of water, the dam supplies 6 municipalities. It is built on the right-hand inflow of Yantra River. Around the dam there is a sanitary-guarded zone with posts to control water purity and ecological status in the area. The flora and fauna in the area of Yovkovtsi dam is varied. All plant and animal species typical of the region predominate. The favorable location of the dam also affects the quality of the water, which meets all the sanitary requirements. The control over the Yovkovtsi Dam is managed by NASEM and the performance is carried out by highly qualified personnel working on the dam. Daily qualitative analysis of samples taken from different control posts is performed. One of the most modern wastewater treatment plants is built on the dam, which provides continuous supply of drinking water to the consumers. In conclusion, we should note that Yovkovtsi dam is a modern facility with a high degree of organization, which will continue to develop in the future.

3.2. Brief description of scintillation spectrometer SCC - 256/91

The experimental part was performed with the scintillation gamma spectrometer type SCC - 256/91.

The scintillation spectrometer SCC - 256/91 is designed for the recording of energy spectra of radioactive sources.

Working conditions:

1) air temperature: 10 to 35 ° C;

2) operates at a relative humidity of up to 80% at t = 20 ° C;

3) mains supply 220V ± 15%, 50 Hz ± 1%;

Samples are placed in glass jars, plastic bags, boxes, etc. so that they can not be spilled or scattered during transport and then used for testing.

The bottom deposits are taken with a special instrument. The samples taken are of a mass of 10g.

The material is shredded and dried at 105 ° C and then burnt in a muffle furnace at 400 ° C. The dry residue is weighed and, depending on the quantity, a thin-film or thick-film preparation is made which is subject to radiometry.

Samples of plant material are taken from different parts of the territory subject to control. The stems are cut at a height of 2-3 cm from the surface of the soil. The mass of the sample taken must be 1 kg. Burn in a furnace and measure the resulting sample.

A sample of fish and other animals subject to radiometry shall be not less than 2 kg.

Prior to processing, the fish is washed thoroughly from the mucus and shaved. Larger specimens can be taken separately. Burn in a muffle furnace to obtain a dry residue of at least 20 g.

The harvesting of algae and aquatic plants does not require special fittings. The sample mass must not be less than 0,5 kg.

Soil samples are collected from equal, untreated plots with good grass cover. The sections from which soil samples are taken must be more than 100 m away from the buildings. The area of each sample should be 10x10 cm and a thickness of 7 cm. The plant and animal organisms are removed from the surface layer at a depth of 2 cm. Each sample shall bear a label stating: the date and place of sampling, the mass of the sample and the name and surname of the person who took the sample. The transport pack must be strong and protect the sample from breakage, spillage and contamination.

3.Conclusions:

1. There is ^{137}Cs in the nettle sample taken after the Chernobyl NPP accident. This conclusion is experimental proof that the apparatus used is working normally and can determine qualitatively ^{137}Cs.
2. No samples of radioactive isotopes were found in the measurements carried out on samples taken from the area of Yovkovtsi dam.
3. The deviations observed in some graphs are within the permissible error of the SCC-256/91 spectrometer.
4. Qualitative environmental monitoring of the environment in the area of "Yovkovtsi" dam is carried out by the Regional Inspectorate of Environment and Waters - Veliko Tarnovo.

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CONSTRUCTIVE DESIGN OF A BELT CONVEYOR FOR A COAL MINE

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Abstract: *At the present time, mines, power plants, ports are more complicated and more functional compared to the past therefore raw material processing, production, and amount of transportation material have increased. In this paper it is calculated with using necessary equations with standard charts that a stone cargo construction with 500 t/h in the line which is formed by two conveyors with 500 m straight and 100 m which has 30^o slope.*

Keywords: BELT CONVEYOR, CONSTRUCTIVE DESIGN, TRANSPORTATION,

1. Introduction

Transportation means movement of people or goods from one place to another with consuming minimum energy in shortest way. Belt conveyors are a kind of transportation system that serves for this purpose. Handling with natural conditions is another important property of belt conveyors also. It can be settled down easily through the mountains and over the rivers. While it is so difficult carrying stuff in inclined places with truck or rig, easy with belt conveyors at the same conditions.



Fig 1 *Belt conveyor*[1]

Beside carrying goods in shortest way, belt conveyors also save up time, labor cost and economy. If tons of material will be transported through complex ways, belt conveyors are an exact solution cause of its continuity. In this paper it is aimed to calculate the constructive properties of belt conveyor that has 500 m length straight and 100 m that inclined 30. Weight of the parts, engine power, friction forces and bent forces are some of the calculated constructive properties of the conveyor. After specifying the characteristics of the conveyor, the values of engine power and bent forces are showed on the graphic according to the changing slope of the belt conveyor first, and then same values are showed on the other graphic according to the changing angle between tambours.

2. Inclined Belt Conveyor

At this section calculation will be done for only inclined part of the belt conveyor. The length of the belt conveyor is 100 m and it has 30^o slope. Designing parameter could change according to the heap material mostly cause of the pile angle. The heap material for the conveyor is coal, so some properties of the coal are given in Table 1.

Table 1*: Some mechanical properties of coal*[2]

Pile mater.	Density of coal [t/m^3]	Maximum slope	Pile angle Static	Slope Resistance Coefficient	Particle Size a [mm]
Coal	0,9	15	40	1,85	80

Transportation capacity of the belt conveyor is 500 tons per hour and velocity is 1,75 meter per second and also specific weight of the heap has given 0,9 t/m^3. According to these values from Table 2, bent width can be chosen 2 meters.

Table 2*: Weight of the pile*[2] *[daN/m]*

Bent width [mm]	Specific weight of the pile [t/m^3]		
	0,45-1,20	1,2-2,00	2,00-3,00
1000	15,0	16,0	19,2
1400	22,5	25,5	29,2
1600	27,6	30,3	33,5
1800	30,0	35,0	38,0
2000	33,0	40,0	42,0

Belt conveyor can consist of two parts that are tail pulley and carrying pulley. In order to increase stability tension pulley can be added to the system. As it seen in the Fig. 2.1, the number of tension pulley can be one or two. In this project two tension pulley is used. The angle between tension pulley and ben gives as the deflection angle that mentioned forward again to see the power changing related to the this angle.

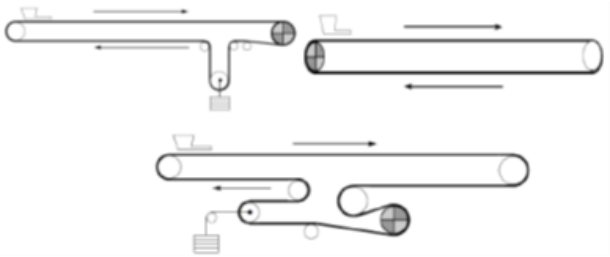


Fig 2 *Belt conveyor with tension pulley*[1]

Bent width is one of the major parameter at design step. The other values are shaped according to bent width. The next step is specifying the distance between tail pulley and carrying roller. After deciding the bent width, the distance can be chosen from Table 3 as 1000 mm and 2500 mm corresponding to L_T and L_D.

Table 3: *Distance between tail pulley and carrying roller*[2]

Bent width [mm]	L_T [mm] Specific weight of the material [t/m^3] 0,5	0,8	1,2	1,6	2,0		Tail Pulley L_D
1000	1400	1400	1200	1000	1000	900	2700
1200	1200	1200	1000	1000	900	900	2700
1400	1200	1200	1000	1000	900	900	2700
1600	1200	1000	1000	900	900	900	2500

2000	1200	1000	1000	900	900	900	2500

Rough sketch is showed up after specifying the distance and bent width of the conveyor. In order to calculate the power specific weights are needed. Specific weight of the movable parts of the belt conveyor can be calculated from the equation (2.1).

$$G_1 = 2G_B + \frac{G_T}{L_T} + \frac{G_D}{L_D} \quad (2.1)$$

The values G_T and G_D are given in Table 4 and the value of G_B can be reached from Table 2.

Table 4: *Tail pulley and dual group*[2]

Bent width B [mm]	Pulley Dia D [mm]	Triad L	Triad G_T	Dual Group L	Dual Group G_T	Tail Pulley L	Tail Pulley G_T
500	89 108	200 200	7,5 9,8	315 315	7,2 9,2	600 600	6,4 7,8
650	108 133	250 250	9,0 11,4	- -	- -	750 750	8,0 9,6
800	108 133	315 315	13,8 18,6	- -	- -	750 950	12,7 12,0
1000	133 133	315 380	18,6 21,6	- -	- -	950 1150	16,0 19,0
1200	133	465	25,4	-	-	1400	23,0
1400	133	530	28,3	-	-	1600	26,0

It has given the length of the inclined conveyor is 100 m. But in calculation it is preferred to use the equivalent length rather than its own length. Equivalent length can be find from the equation 2.2.

$$L_{eş} = L + 45 \quad (2.2)$$

The main dimensional parameters are cleared until now. Next step is determining the engine power. Engine power is total value of the required power for horizontal transport, vertical transport, without pile etc. First, required power for the transporting with no pile will be calculated as is given in equation 2.3. The value of the f_1 can be taken between 0,015 and 0,04, it is taken 0,03 for this situation.

$$P_1 = \frac{f_1 G_1 L_{eş} v}{75} \quad (2.3)$$

Required power to transport horizontally is as given below. The point to be emphasized is that despite calculation are done for horizontal transportation the length of the conveyor is still equivalent length of the conveyor belt.

$$P_2 = \frac{f_1 L_{eş} Q}{270} \quad (2.4)$$

Required power to transport vertically is can be calculated with the equation 2.5.

$$P_3 = \pm \frac{QH}{270} [hp] \quad (2.5)$$

In calculation, flow rate has to be divided to the capacity reducing factor as is shown in Table 5.

Table 5*: Capacity reducing factor related to the slope*[2]

Slope of the conveyor belt φ	k
8°	0,96
12°	0,93
16°	0,87
20°	0,79
24°	0,71
26°	0,66
30°	0,56

Required power for dumper car can be identified by using Table 6 instead of calculating. As it seen below, it should be iterated to determine the value. It has been chosen 9,41 horse power after iterating.

Table 6: *Power for dumper car*[2]

Bent width [mm]	800	1000	1200	1400	1600
Required power [hp]	2,5	3,5	5,0	6,0	8,0

Total power is;

$$P = P_1 + P_2 + P_3 + P_4 + P_5 \ [HP] \quad (2.6)$$

The value of P_5 corresponds to acceleration power but it is neglected generally and so, it has been neglected for this situation also.

Engine power should be over the total power because of that power loss occurs while transferring the engine power to the shaft and also in order to ease first movement of the engine power should be increased in proportion to between 1.1 and 1.4.

$$P_m = (1.1 \div 1.4)\frac{P}{\eta} \quad (2.7)$$

Table 7: *The power of the engine*[2]

	Power [hp]
P_1	10,92
P_2	14,38
P_3	165,34
P_4	9,41
P_5	-
Total power	200,6
Engine power	287,004

After determining the powers, friction forces of the tail pulley and jockey pulley will be calculated. First, friction force of the tail pulley is calculated as is given below.

$$T_D = \mu_1 \left(G_B + \frac{G_D}{L_D} \right) L_{eş} [N] \quad (2.8)$$

We can choose μ_1 as 0,025[3] and then the tension pulley

$$T_T = \mu_2\left(G_B + \frac{G_T}{L_T} + \frac{Q}{3.6\,V}\right) L_{eş}[N] \quad (2.9)$$

After obtaining the friction force values of the tension pulley and tail pulley the belt forces are can be calculated with the given equations.

$$P = \frac{T_E\, v}{75} \quad (2.10)$$

The deflection angle can be taken[4] between 260-270^0, in this problem it has taken 265^0 and the value of μ has taken as 0,3.

$$\frac{T_1}{T_2} = e^{\mu\alpha} \quad (2.11)$$

T_E corresponds to the difference between T_1 and T_2. From equation (2.12) tensed bent force can be found. The relationship between the bent forces T_1 and T_2 can be found from equation (2.11).

$$T_1 = \left(\frac{75Pe^{\mu\alpha}}{v(e^{\mu\alpha} - 1)}\right) \quad (2.12)$$

***Table 8**: The bent forces*

	Bent Forces [daN]
T_1	16390
T_2	4090

3. Conclusion

The result of these calculated values are for only 30^o which is the slope of the bent conveyor. If we want to see the results for the angles between 0^o and 30^o it can be shown graphically.

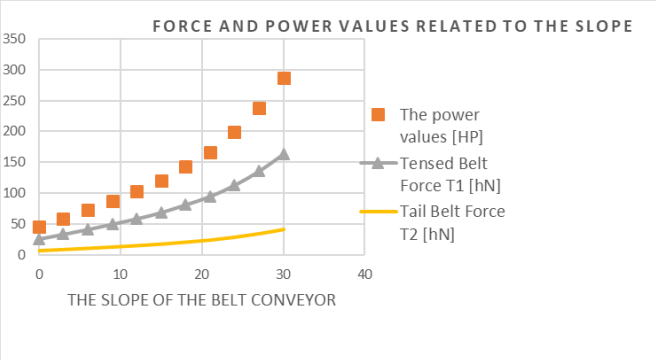


***Fig 3** Force and power values related to the slope*

The horizontal line on the axis shows the slope of the belt conveyor and the vertical one is the the value of the forces and power of the conveyor. First, it can be seen that increasing value of the slope leads to the increasing power and the belt forces and also it can be claimed that required power and the belt forces increasing exponantially. In order to avoid high costs and catastrophic failures the slope of the belt conveyor should be kept lower.

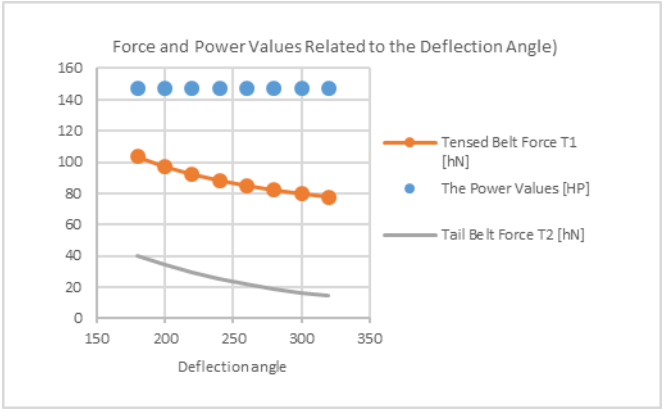


***Fig 4** Force and power values related to the deflection angle*

In figure 3.2 it is shown that the relationship between results and deflection angle. As it is seen, deflection angle has no effect on the power but the forces on the belt decrease. Increasing value of the deflection angle has positive effect because stress value decreases as the force decreases on the belt.

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FRESHWATER SUPPLY FOR SHIPS DESALINATED BY METHOD OF ELECTRODIALYSIS

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Abstract: *For the purpose of freshwater supply for ships, we have explored the desalination process of sea water by electrodialysis. From the analysis of the obtained results, the desalination process of the Black Sea water by electrodialysis has been explored. The average salt content of the Black Sea water is 15-16 g/l, and the global ocean water - 35 g/l, while the salt content in water from the Baltic Sea is 5.77 g/l. The Black Sea water was diluted with fresh water up to a concentration of 5.77 g/l.*

Electrodalysis is the most effective method for desalination of natural waters with low salinity. So, we have taken water equivalent to salt water content of the Baltic Sea water. Desalination of this water is effective and requires little energy. To reduce salt content of sea water, the separation was carried out on reverse osmosis membranes with a selectivity of 70%, and then the penetrant was separated by electrodialysis. Every 5 minutes, the solution loses 55.8% of salt. During the treatment (45 min), water is desalinated up to a concentration of 51.2 mg/l, and it can be used for industrial (technical) or household purposes. Calculation have shown that the selectivity of membranes during desalination was 99.11%.

As a result, on the basis of theoretical and experimental studies of seawater desalination by electrodialysis, there have been developed the principal circuits of the system of environmental safety of ballast water and water treatment facilities in the port, for environmental safety of ballast water and for obtaining industrial water.

KEYWORDS: *DESALINATION, ELECTRODIALYSIS, CONCENTRATION POLARIZATION.*

1.Introduction

The problem of fresh water supply for ships have been existed over the course of a history of the maritime fleet. The water on ships has always been limited. This was due to a deterioration of water quality during a long-term storage, as well as due to the limitation of fresh water tank volumes on ships. Provision of water through its obtaining from the shore cannot be considered to be economically justified, and this is carried out in exceptional cases, since its cost at the coastal provision stations increases sharply (coastal water is 5-15 times more expensive than desalinated water), and when refueling in foreign ports requires large currency spending (the cost of 1 ton of fresh water now amounts on average 10-15 USD). Therefore, the feasibility of desalination of sea water on ships is obvious and is beyond questions. It has been established that the freshwater supplies on ships depend on their type and the cruising radius and make up 2-8% of deadweight.

In recent years, both in domestic and in foreign practices, a significant number of freshwater generators have appeared, the principle of operation and methods of obtaining water in which differ significantly from the earlier design solutions. The ship power plants are more and more equipping with the reverse osmosis freshwater generators, characterized by high ecological quality. The electrodialysis type installations, especially intended for small vessels of the fishing fleet also attract attention.

We have studied the process of sea water desalination by electrodialysis and the problem of freshwater supply for ships.

Just like in any other liquid phase process, in this case, concentration polarization plays an important role as well. In presence of concentration polarization, there occurs an increase in gradient of the concentration potential on the ion-exchange membrane. At this time, diffusive ion leakage is growing in membrane. Thus, purely ionic transfer for a given electric potential is several times decreased. During such concentration polarization there is considerably increasing in the diluted solution the difference of the ohmic potential as well, since as a rule, the ohmic resistance of the electrolyte solution is inversely to its ionic concentration. Since the dissolved electrolytes flow, which is intended for separation, is approximately proportional to current density, the electric power consumed for separation of the solute's volume unit goes up proportionally to current density. On the other hand, the fixed cost of the electro-membrane module for the given quantity of solution intended for separation is often reducing with the increase in current density. In consequence of above stated, there is always existed the optimal current density, when the total cost of power inputs and capital expenditures is minimal. At the same time, this optimal value often exceeds the highest possible value, which in practice is obtaining for diluted solution during motion at high-velocity in narrow channel. **[1,4].** Thus, and so, in the first place the working current density is limited by concentration polarization, but not due to process efficiency. Proceeding from this, it is reasonable to intensify the process through the reduction of adverse effect of concentration polarization that is possible to achieve by action of pulsed pressure in the channel between membranes [2]**.**

2. Preconditions and means for resolving the problem

The assigned task requires conduction of theoretical and experimental investigations for calculation and designing the high-performance electro-membrane devices that is of high topicality and represents scientific novelty.

A mathematical model of non-steady and non-isothermal electro-membrane process we've developed, with account for simultaneous action of gravitational and forced convections, when meeting the electrical neutrality condition, under the influence of pulsed pressure, allows for implementing electrodialysis processes on the rationally designed electro-membrane devices, with optimal regime parameters [3].

An experimental study of electrodialysis was carried out on a laboratory installation (Pic. 1) for the purpose of studying the processes of desalination, concentrating solutions, synthesis of new substances, pH correction, obtaining highly demineralized water, amino acid separation, acid and alkali extraction from solutions of the corresponding salts, removal of inorganic compounds from organic solutions.

The installation is manufactured in the form of a wall-mounted bench (1) on which there are mounted: the unit of mechanical filtration of solutions (2), electromembrane device (3), pump unit (4) with the electrical power supply sources (5), hydraulic panel with rotameters (6), manometers (7), control valves (8), sampling equipment valves (9) and an electrical power supply source for the device (10). The working tanks are (11) are with the outlet valves. In the upper part of the working tanks, it is necessary to provide the inlet holes for filling working solutions with a funnel. The device is installed on a worktable by analogy with the example of placement shown in Figure 1.

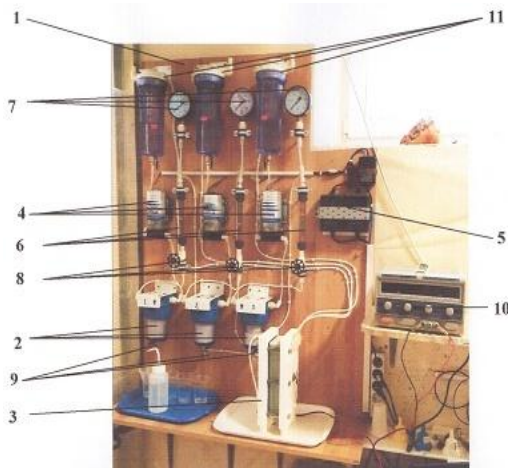


Fig.1. *A laboratory installation of electrodialysis .*

For the purpose of seawater desalination by membrane technology, the paper dwells on studying the electrodialysis processes of 20,10 and 1% sodium chlorine solutions. As the model solutions, we used NaCl solutions of different concentrations; the direct current source is a rectifier HY3005C, which allowed for obtaining the current density of 15 mA/cm^2.

The analysis of the test results shows that when the initial concentration of NaCl salt is 20.85 g/l. The NaCl solution loses 20% of NaCl during the first 15 minutes, within 20 minutes, the solution begins to clear faster, losing 70% of NaCl. In the last 5 minutes, desalination slows down again. The solution loses only 5% of salt. Current almost constantly, but suddenly starts to reduce. This is because the low-concentration electrolyte is poorer than the high-concentration electrolyte. Finally, the salt content of the concentrate is 31.0 g/l, which is close to the limit of NaCl salt dissolution. This means that the process occurs without dilution of the concentrate, and crystalline may appear in the salt solution, and it is possible to obtain two products: NaCl salt and water.

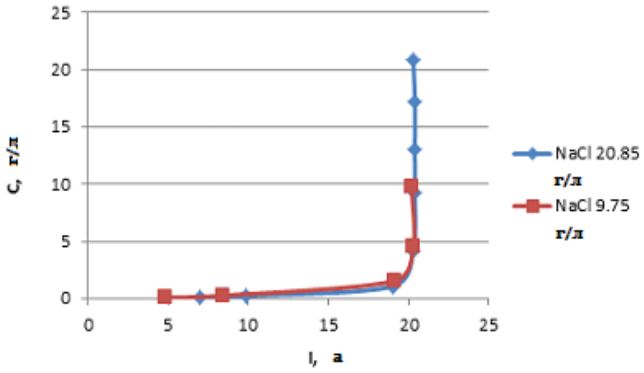


Fig.2. *NaCl concentration depending upon a current intensity*

When the concentration of NNaCl was 9.75 g/l, for the first and last 5 minutes, the concentration was reduced to 50%, for the test from 10 to 15 minutes, the concentration was decreased by 80%. Entirely in the process of electrodialysis, the concentration of the solution was decreased from 9.75 g/l to 0.091 g/l. In addition, it can be noted that a high degree of purification is observed when the concentration is 1 g/l.

Figure 2 illustrates the dependence of the NaCl concentration on the a current intesity, from which it can be seen that the curves are practically identical. This can be explained by the fact that the chemical compositions of liquids that need to be analyzed are the same, that is. they conduct electric current in the same way.

At significantly lower concentration of the solution, the salt content in the solution is 1.09 g/l and decreases by 50% on average every 5 minutes. Based on the results, we can say that if a salt solution with NaCl concentration is 1 g/l, in order to speed up this process, it is necessary to use less selective membranes, increase the voltage or take another new technological solution.

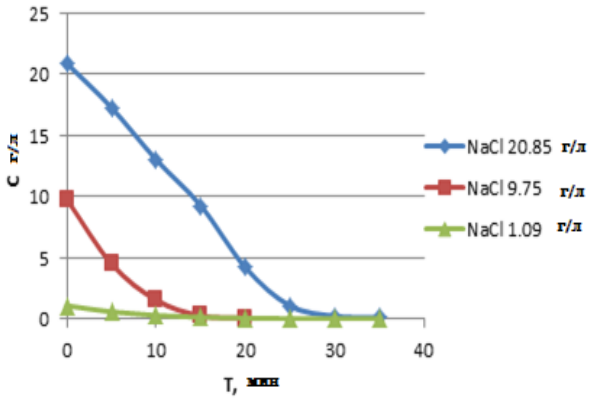


Fig.3. *The rate of electrodialysis of NaCl*

Figure 3 illustrates the rate of electrodialysis of a NaCl solution of various concentrations. We can see that when the initial concentration is 9.75 g/l, the solution is cleared. At this time, the first test (initial concentration - 20 g /l) of NaCl concentration in the solution reaches 10 g/l. Thus, it can be concluded that membrane is more effective, when the NaCl concentration varies from 10 g/l to 1 g/l.

Comparison of the curves presented in Figure 3 demonstrates that the experimental results are not only in a qualitative, but also in a very good quantitative coincidence with the data of theoretical calculations. This means that the mathematical models we are using, adequately describe the nonstationary isothermal processes occurring in the chambers of electromembrane systems.

3. Conclusion

Based on the analysis of the results obtained, we have studied desalination of the Black Sea water by electrodialysis. The average salt content of the Black Sea water is 15-16 g/l, in the global ocean -35 g/l, while waters of the Baltic Sea – 5,77 g/l. Water of the Black Sea was diluted with freshwater to a concentration of 5,77 g/l. The results of the desalination process of the Black Sea water by electrodialysis are presented in Table 1.

Electrodialysis is most effective in desalination of natural waters with low salinity. Thus, we took water with salt water content equivalent to the Baltic Sea water, and desalination of this water is effective and does not require much energy. To reduce salt content of sea water, the separation was carried out on reverse-osmosis membranes with selectivity of 70%, and then the penetrant was separated by electrodialysis. Every 5 minutes, the solution loses 55,8% of salt. During the treatment (45 min), water is desalinated to 51.2 mg/l concentration and can be used for the industrial (technical) purposes or domestic consumption. Calculations have shown that during desalination, selectivity of membranes was 99,11%.

The water testing results (diluted to 5,7 g/l).

On the basis of theoretical and experimental studies of seawater desalination with electrodialysis, we have developed the flow diagrams of a system environmental safety of ballast waters and water treatment facilities in the port, for obtaining industrial water and freshwater supply for ships.

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EXPEDIENCY OF USING MULTIFUNCTIONAL GAS DISTRIBUTION STATIONS IN TRANSPORT INFRASTRUCTURE

ЦЕЛЕСООБРАЗНОСТЬ ИСПОЛЬЗОВАНИЯ МНОГОФУНКЦИОНАЛЬНЫХ ГАЗОРАСПРЕДЕЛИТЕЛЬНЫХ СТАНЦИЙ В ТРАНСПОРТНОЙ ИНФРАСТРУКТУРЕ

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Abstract: *The article is discussing the possible options for the implementation of potential energy, which is contained in the gas pipeline in the form of pressure, which is actually lost when the gas is reduced at the GDS. Improving energy efficiency is a major challenge for Bulgaria's economic development. The extensive development of Bulgaria's gas pipeline network and the increase in the level of gasification also increases the energy that is actually released into the atmosphere. Are considered various options for the implementation of overpressure for the purpose of increasing energy efficiency, the realization of which will not only improve the efficiency of the construction of the distribution network of gas pipelines, but also will partially solve the problem of the widespread introduction of road transport on electricity and liquefied gas.*
KEYWORDS: *GAS DISTRIBUTION STATION, ENERGY EFFICIENCY, TURBO EXPANDERS, SMALL SCALE LNG, GASIFICATION OF BULGARIA*

1. Introduction

Bulgaria is implementing a project to develop its gas transmission network, including the possibilities offered by projects of interconnection with neighbouring countries through the construction of Interconnector gas pipelines. Works on them are in different degree of readiness. The construction of the gas intersystem connection between Bulgaria and Romania was completed in the autumn of 2016, until the end of 2020 it is planned to be put into operation interconnectors Greece-Bulgaria and a similar gas pipeline with Serbia. In perspective is considered the increase in the volume of gas supplies to Bulgaria when would be implemented the projects "Southern gas corridor" and "Turkish stream".

Today, the consumption of natural gas in Bulgaria is about 3 billion m3 per year, of which about 10% is natural gas extracted in Bulgaria, and 90% is imported gas. The structure of consumption of primary energy resources in Bulgaria today is dominated by coal-37% and nuclear energy — 22%, as well as oil — 21%. Natural gas pertains about 12%, while the territory of Bulgaria is gasified by about 3% [1]. As the costs of using coal resources increases, Bulgaria's need for natural gas will increase significantly.

2. Results of discussion

The concept of the implementation of promising projects for the development of the Bulgarian gas industry, including the implementation of the gas hub project, should be based on the most effective solutions at all stages of the creation of the gas transportation infrastructure. Gas in the main gas pipelines contains a significant amount of potential energy of the excess pressure of the gas flow, which is irretrievably lost when reducing gas at gas distribution stations to pressures in distribution networks.

At present time the technologies of complex use of energy of gas on GDS for power generation are known.

On GDS is made a pressure drop of the transported natural gas from 7.5 to 1.2 MPa. For use of physical energy of gas received at the expense of decrease in pressure of gas on GDS, instead of using traditional throttle devices it is supposed to use expander-generator aggregates (EGA), the schematic diagram of work is specified in figure 1.

The use of EGA provides not only a reduction in pressure, but also the generation of electricity, which is produced by an electric generator installed behind the expander. The potential for energy production due to excess pressure is directly proportional to the energy potential of the gas, which is determined by the technical work of adiabatic expansion.

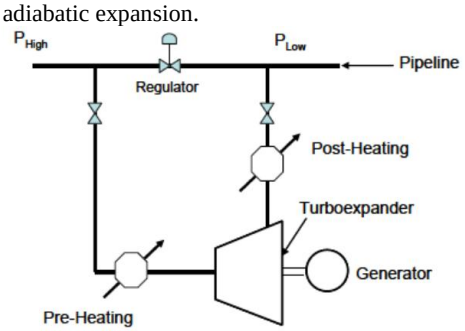


Fig 1. *Schematic diagram of EGA*

From the point of view of energy saving in the gas transportation system is promising the utilization of this potential energy. EGA are produced by many manufacturers, for example, ABB and Atlas Copco, Corporation "Rotoflow", the RMG company, JSC "Turbogaz", LLC "Kriokor", STC "MTT".

The first experiments on the installation of turbo expanders in Europe began in the mid-70s of the 20th century in Germany, the Netherlands and France. For the first time, a EGA was set in commercial operation in the USA in 1983 (table 1).

Table 1*. The first implementation projects of EGA in the industry [3]*

Location	Application	Size, Hp, (kW)	Design Flow and Pressure Drop	Year Installed
San Diego, CA (SDG&E)	City Gate	365 (260)	11 MMCF/D (810 – 390 psia)	1983
Memphis, TN (Memphic Light)	Chemical Plant	600 (450)	15 MMCF/D (450 – 87 psia)	1983
Stockbridge, GA (Transco Pipeline)	Compressor Station	400 (300)	7 MMCF/D (555 – 85 psia)	1984
Hamilton, NJ (Starmark Energy)	City Gate	3,862 (2,800)	36 MMCF/D (635 – 70 psia)	1987

In 2010 was launched in London an ambitious project to equip the main gas pipelines around the city with a mini-EGA network, the total installed capacity of the network is expected to be 20 MW [4].

Are also known technologies of complex use of gas energy from GDS for filling of vehicles equipped with engines on compressed and liquefied gas.

At low-tonnage LNG production, gas liquefaction is generated at local installations (capacity - no more than 10 t/ h) located near gas pipelines, for example: gas distribution stations (GDS), automobile gas-filling compressor stations (AGFCS), gas compression stations (GCS), - with delivery to consumers (within a radius of 200 km) for use as gas motor fuel for transport or replacement of diesel fuel or fuel oil at enterprises with energy-intensive technology.

If liquefied gas is used, the natural gas with the main line pressure is supplied to the drying unit, compressed in a turbocharger located on one shaft with the turbo expander up to 41 kgf/cm^2, cooled in a natural gas cooler and divided into liquefied (13.5%) and expanded (86.5%) flows. The liquefied stream comes through the cleaning unit, and, further, both streams pass through the advanced and basic heat exchangers. As a result of expansion in the turbine expander gas temperature is reduced to -50 ° C. Since this decrease in temperature is not enough to liquefy the gas, further throttling is performed, as a result of which the temperature of the gas decreases to -140 ° C. The gas-liquid mixture enters the separator to separate the liquid from the vapor phase; the steam phase passes through the heat exchangers, and the liquid enters the storage and distribution unit. The schematic diagram of the installation for liquefied natural gas with a throttle-expander cycle is shown in figure 2, the specified scheme was implemented at GDS-4 in Yekaterinburg [5].

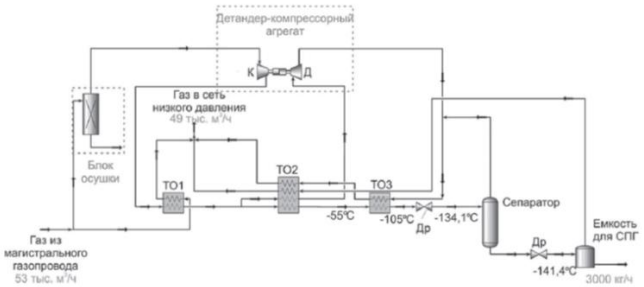


Fig 2. *Schematic diagram of LNG production plant with throttle-expander cycle*

In case of using compressed gas, natural gas purified from impurities and moisture comes from external networks (gas distribution substations GDSS) to the compressor inlet under pressure 0,3 – 0,6 MPa. In the compressor, the gas is compressed in series with a moisture separation. During the compressor operation, the pressure and temperature of the compressed gas are controlled by stages. After cooling, the gas is sent to the separator, where it is removed from the condensate and oil trapped in it during compression and cooling. Gas compressed to 25 MPa fills the inner cylinders (pressure compensators) in the volume of about 1120 liters. Compressed natural gas from the pressure compensator is fed to the filter connector located in the transfer column and then through the ball valve and solenoid valve, filter and enters the flow meter. After that, the gas flows through the pipeline to the filling connection and further — into the cylinders of the refueled car. The cost of production of CNG is much lower than the cost of production of fuel from crude oil: to prepare natural gas for use as a motor fuel, it does not require pre-processing, the gas is transported through pipelines directly to the gas station. According to the international natural gas vehicles association (NGVA), currently programs for the development of the gas motor fuel market are being implemented in 86 countries.

Work on liquefaction and compression of natural gas may also be executed partially or fully due to the transformation of energy of excessive pressure of main gas flow.

In principle, it is possible to implement the scheme of multifunctional gas distribution stations combined with gas filling and electric charging stations.

The use of electricity generated from autonomous sources is always faced with the problems of synchronization of these sources with existing electricity networks. In addition, in order to run a charging station on the gas station and start trading with electricity, it must enter into contractual relations with electricity supply organizations. These problems are sometimes intractable due to the expensive hardware for synchronization or unwillingness of the suppliers of electricity to prevent interference in the operation modes of their own networks. Therefore, when generating electricity by autonomous sources, it is desirable to have the same autonomous consumers. These consumers can be vehicles equipped with electric motors and the GDS itself. In this case the project of creation of the multipurpose gas-distributing stations providing not only reduction, but also complex use of energy of gas on GDS for generating the electric power for own consumption and gas station of vehicles, and also production of the liquefied and compressed gas as gas-engine fuel can be realized that will allow to utilize potential of pressure which is now bleached from main gas pipelines in the atmosphere and to provide direct additional profit. A special advantage in this case have GDS, located in close proximity to industrial enterprises and large settlements, thanks to the presence of potential consumers.

Conclusions: The new construction of a network of natural gas main and distribution pipelines in Bulgaria creates unique opportunities for the implementation of promising ideas, one of which is the idea of energy saving and increasing the efficiency of primary energy resources consumption. Electric drive and natural gas used as motor fuel, reduce the consumption of liquid fuels, provide energy saving, increase the life of motor vehicles, reduce environmental pollution.

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CHOOSING APPROPRIATE MACHINERY FOR REDUCED TILLAGE

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Abstract: *The paper discusses the gradual transition from conventional tillage through reduced tillage to no-tillage while creating favourable conditions for increase of organic matter. The paper suggests crop and tillage method rotation for a period of five years in order to facilitate this transition. It also reviews tests of soil physical properties which can help farmers determine how their soils are changing and what effect the change of tillage method has on them.*

Keywords: NO-TILLAGE TRANSITION, CROP ROTATION, RESIDUE RETENTION, TESTING SOIL PHYSICAL PROPERTIES

1. Увод

Reducing the number of soil treatments (tillage) is a key pillar in soil protection agriculture. Two main criteria should be observed – increasing the amount of plant residues, left on the field surface and the degree of mechanical impact on the soil. It has been proved that for effective soil conservation at least 70% of the plant residues should be left on the surface after a certain type of soil treatment [5]. What determines the degree of mechanical impact on the soil aggregate structure is the baseline state of the field, including momentum of the soil, crop rotation applied, and stage of application of soil protection measures.

Obtaining the desired effect of soil conserving activities is a process, which cannot be achieved through direct transition from layer reversal tillage to no till. The technology for conserving and/or recovering soil structure requires gradual transition to reduced tillage while at the same time the organic matter content is increased. It has been determined that soils directly subjected to no till require a long period for recovery of the active carbon, lost during the classical tillage [5]. Thus, sandy loam soil requires about three years of no till for each year of intensive tilling, in order to recover the lost levels of active carbon [10]. The organic matter, particularly carbon in soil, recovers faster that the soil structure. The more degraded the soil is, the bigger the difference.

Reducing this difference is achievable through correct application of a reduced number of soil treatments. [6]. In soil conserving agriculture, there are no singularly determined evaluation criteria for the mechanical impact on soil, but it is important for this impact to correspond to soil formation processes. [1,2,3,4,7,8,9]

In this sense, based on experience, the following types of tillage can be accepted as soil conserving:

- Creating and maintaining a permanent mulching layer on the field surface;
- Periodical (every 4 to 5 years) deep loosening, followed by surface loosening, in order to avoid the formation of plow pan and to improve soil structure;
- If necessary, layer reversal tillage can be done any time, but the right approach is to do it once every 4 to 5 years until the optimal values for continuous application of no till technologies have been achieved;
- The share of surface treatment within the sowing depth should prevail.

2. Choosing the machinery for reduced tillage

Keeping in mind the idea of reducing the number of soil treatments, from a design aspect it would be good for these machines to be of the combined type. At the same time, their performance characteristics should meet the requirements of the technology for growing the crop selected and the type of soil.

One example of machines, selected for minimum soil treatment is based on cereals crop rotation and the types of soil treatment (see Fig. 1).

The first year of crop rotation is the initial stage of implementing soil protection agriculture. The crop rotation in a given field pre-determines the type of soil treatment to be held (surface – ST; deep – StrT). The surface treatment can be held by chisel (stubble) cultivator (see Fig.2, Fig. 3 and Fig.4), and the deep treatment (StrT) – by a strip tiller (see Fig.5 and Fig.6).

Crop		Year									
		I		II		III		IV		V	
Wheat		Wheat - ST		Sunflower - StrT		Barley - ST		Rapeseed - ST		Corn - StrT	
Barley		Corn - StrT		Wheat - ST		Sunflower - StrT		Barley - ST		Rapeseed - ST	
Rapeseed		Rapeseed - ST		Corn - StrT		Wheat - ST		Sunflower - StrT		Barley - ST	
Corn		Barley - ST		Rapeseed - ST		Corn - StrT		Wheat - ST		Sunflower - StrT	
Sunflower		Sunflower - StrT		Barley - ST		Rapeseed - ST		Corn - StrT		Wheat - ST	
Field		ST	StrT	ST	StrT	ST	StrT	ST	StrT	ST	StrT
		Soil treatment									
Transition to no till treatments											
Legend: ST- surface treatment of soil; StrT–strip tilling with in-depth introduction of mineral fertilisers											

Fig. 1. *Crop rotation and tillage methods*

Taking into consideration the crop rotation given, for each of the five fields there are three surface and two deep treatments. During year one, for field one a surface treatment is conducted preferably with the chisel cultivator shown on fig. 3. During year two, this field is to be subjected to deep strip tilling for disrupting the plow, but no more than 30 cm deep. During years three and four, a surface treatment is held again. During year five, deep strip till should be done in the strips from year two with increased depth to 60 cm if needed. The other four fields are treated in the same way, but the treatments are displaced over the years, according to the crop rotation scheme applied.

With spring-loaded loosening tools, the surface soil layer (10÷12 cm) is well-loosened. The cutting section aligns the plant cover when there is high stubble and green vegetation. A considerable part of the plant vegetation (about 70%) is buried together with the scattered fertilisers.



Fig.2. *Chisel cultivator with rotor type cutting section*

With rigid loosening tools, it is possible to apply deeper tillage (up to 25 – 30 cm), but it results in a lower degree of soil crushing. Thus, combining them with heavy rollers becomes appropriate. Mixing the soil is not so intensive, so most of the plant cover and fertilisers remain on the surface.

The combined type of soil loosening tools allows introduction of fertilisers simultaneously with the tillage. With an appropriate suspension, the working tools can introduce the fertilisers where the predominant part of the root system of the crop grown is.



Fig.3. *Chisel cultivator with disk- type cutting section*

The deep soil loosening tools cause considerable deformation both in the surface and the subsoil layer, fig.3. When the field is strip tilled at 70 cm strips, about 70% of the area remains under plant residue. In combination with fertiliser introduction, the fertilisers are introduced deeply, which is favourable for crops with strong central root. The presence of appropriate pushing wheels guarantees good soil structure on the surface of the treated strip.



Fig.4. *Chisel cultivator with introduction of fertilisers*

Both individual and central dosing result in appropriate fertiliser distribution, but with the latter, the strip tiller is saved from the fertiliser mass in the fertiliser boxes.



Fig.5. *Strip tiller with individual fertiliser dosage*

To achieve better results from the types of tillage presented here, the rule of carrying out these treatments only in the conditions of the so called “mature soil” (with humidity 50÷70% of Maximum Soil Humidity) should be applied. Gradually increasing the depth of strip tilling is recommendable with compacted soils. In this way, a better structure of the soil layer is achieved and an increase of power is not needed.



Fig.6. *Strip tiller with central dosage*

Well-structured soil is a pre-requisite for favourable indexes of its physical properties (see Fig.7). To track the direction of change in the physical properties of soil, it is important to watch its bulk density, which is considered to be a crucial factor for fertility.



Fig. 8. *Handbook with guidelines for good practices in tillage*

The handbook with guidelines for good practices in tillage, shown on Fig. 8, is designed for farmers to use it directly in the field and is a practical tool for determining soil density.

The handbook contains a disk for reading the soil density and a table with recommended tilling procedures. It can be used before and/or after tilling, and it is recommended in both cases the soil to be "matured". Reading before tillage helps to choose an appropriate way of its application, while reading after it can be used for making an irrigation schedule.

Using the handbook requires the availability of two measuring instruments: moisture meter and soil hardness meter. They can be analog or digital type, but the former is recommended for the practice (see Fig.9).



a) - digital ***b) - analog***

Fig.9. *Soil hardness meters*

Inside the Handbook are the Disk and the Table with recommended tillage (see Fig. 10). The Disk consists of rotating and stationary part. The latter is divided into semi-circles, each with 9 sectors, containing a colour scale. The rotating part has two open sectors, opposite each other, and belts, which represent soil layers.

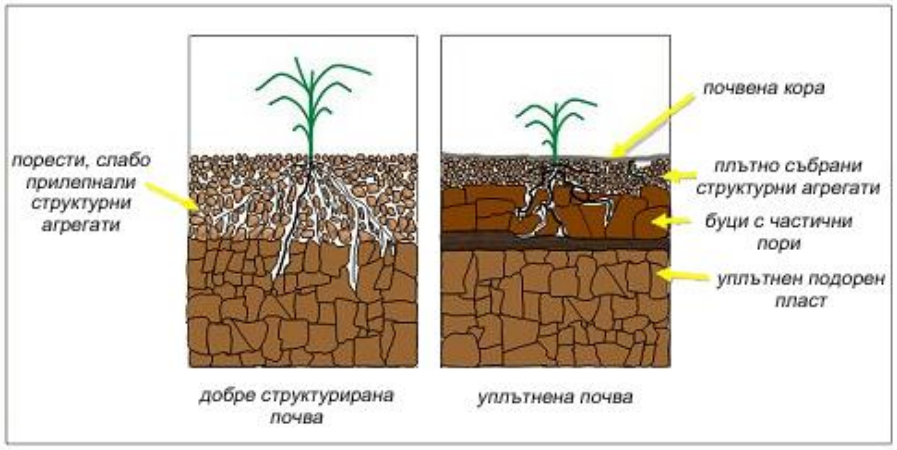
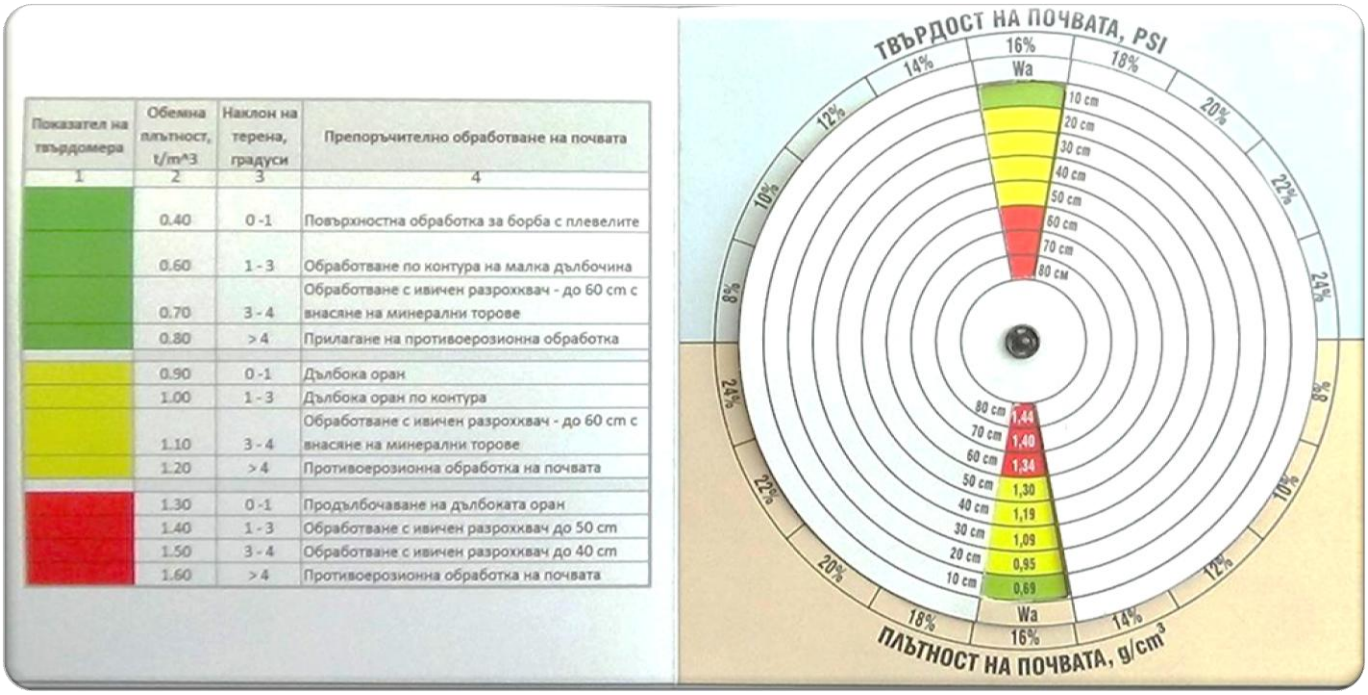






Fig. 7. *Well-structured and compacted soil*



Показател на твърдомера	Обемна плътност, t/m^3	Наклон на терена, градуси	Препоръчително обработване на почвата
1	2	3	4
	0.40	0 -1	Повърхностна обработка за борба с плевелите
	0.60	1 - 3	Обработване по контура на малка дълбочина
	0.70	3 - 4	Обработване с ивичен разрохквач - до 60 cm с внасяне на минерални торове
	0.80	> 4	Прилагане на противоерозионна обработка
	0.90	0 -1	Дълбока оран
	1.00	1 - 3	Дълбока оран по контура
	1.10	3 - 4	Обработване с ивичен разрохквач - до 60 cm с внасяне на минерални торове
	1.20	> 4	Противоерозионна обработка на почвата
	1.30	0 -1	Продълбочаване на дълбоката оран
	1.40	1 - 3	Обработване с ивичен разрохквач до 50 cm
	1.50	3 - 4	Обработване с ивичен разрохквач до 40 cm
	1.60	> 4	Противоерозионна обработка на почвата

Fig. 10. *Inside of the Handbook with instructions for good practices in tillage*

3. Working with the Handbook before tillage is in four subsequent steps.

The first step is to measure the absolute humidity of the soil, which is one of the indicators on the Disk. Using the moisture meter (see Fig. 11), the reading is done directly in the field and the value obtained is used when adjusting the Disk for work.



Fig. 11. *Analog soil moisture meter*

The second step is related to measuring the soil hardness in depth. With the instruments presented, a depth of up to 80- cm can be reached. The analog hardness meter has colour scale, divided into three sectors – green, yellow and red (see Fig.12). The scale in the upper part of the Disk where the soil hardness is shown as another indicator, has the same colours. The interpretation of the scale readings is as follows: green sector – good condition of soil density; yellow – satisfactory; red – poor



Fig. 12. *Soil hardness meter scales*

During the third step, soil compaction is measured. First, the Disk indicators should be set according to the data from the instruments. The adjustment is done in the upper part of the Disk, related to the soil hardness.

There is a blue indicator of absolute soil humidity on the outer belt of the rotating part, which should stand against the sector, showing the humidity measured by the moisture meter. In this way, the colour scale for soil hardness is open, where the colour indication from the soil hardness meter at the respective depth of its penetration (see Fig.13). Thus, from the scale in the lower semi-circular part of the Disk, we read the soil density at the specific depth of penetration. Here, besides the colour indication, the scale shows a numerical one, with the colours interpreted in the same way as in the upper scale and the numbers seen are the mean value of soil density in the specific layer.

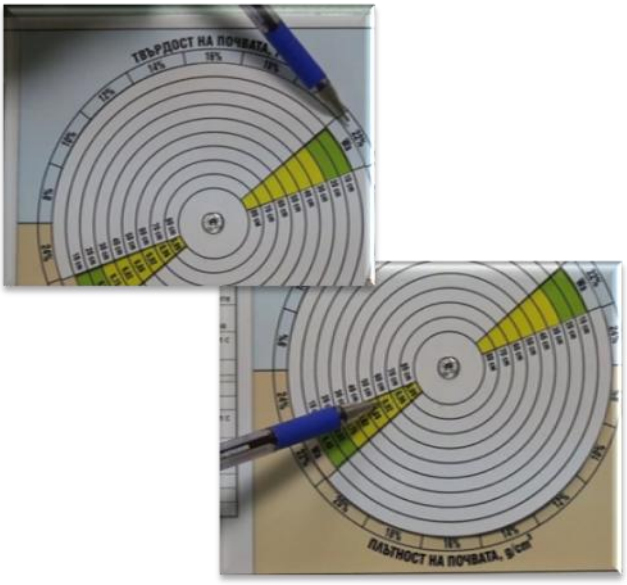


Fig 13. *Disk indicators*

Based on the result obtained, recommendations are offered for the most appropriate mode of tillage. The treatments suggested are also in line with the terrain. Thus, the choice of machinery is in compliance both with the physical properties of the soil and with its erosion resistance.

4. Conclusion

The choice of machinery is correct if the soil treatment performed by it corresponds simultaneously to the physical soil properties, the needs of the crops and the soil conservation procedures planned. Reducing the number of treatments allows the degraded soils not only to accumulate active carbon, but also to improve their structure. For heavily degraded soils, this type of treatment should continue until the soil is ready for no till treatment. Thus, a smooth transition from classical to no till mode of treatment is achieved, which generally characterises the soil conserving agriculture.

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STUDY THE EFFECTS OF IRRIGATION REGIMES OF STRAWBERRIES ON THE YIELD UNDER DRIP IRRIGATION

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Introduction

The geographical location of our country predetermines a tendency towards warming and drought. This requires research into the response of agricultural crops to water scarcity, optimization of the parameters of irrigation regimes, and the search for resources for the efficient use of irrigated water.

The shortage of water for irrigation of agricultural crops necessitates a reduction in irrigation regulations or a complete dropout of irrigation to eliminate the deficit.

In Bulgaria there are extremely favorable conditions for the cultivation of different berry crops, incl. of strawberries that are of great economic importance, mainly due to its high productivity and production efficiency. They are characterized by poor dryness, with growth and fruiting largely dependent on the presence of sufficient moisture in the soil during the growing season. Therefore, the optimization of the water regime in the soil is of the utmost importance for the management of the processes of yield formation and the achievement of sustainable results and production of high quality from this crop. The application so far of the surface drip irrigation of this culture shows the expedience and the economic benefit of applying this way to the conditions in our country. This method fully meets the requirements for sustainable agriculture and organic production of fruit, incl. provides high yields, reduces undesirable side effects [2].

Studies carried out so far on irrigation of strawberries show that this culture responds very well to microwaving both in terms of production size and in terms of quality [3]. Studies in Bulgaria and abroad in this regard show that a prudent regulation of soil moisture during flowering and ripening can increase yields from 20% to 50% [5], while pollutant water savings are from 20 to 40% [4].

Favorable climatic conditions for efficient strawberries are available throughout the country up to 1200-1300 m above sea level [1].

The aim of the study is to study the parameters of the irrigation regime of strawberries at optimal and insufficient water supply in drip irrigation

Material and method

The surveys for the establishment of the pollack regime of "Polka" strawberry strains in surface drip irrigation were carried out during the period 2015 - 2016 in the experimental field of the Pushkarov Institute - Chelopechene, Sofia.

The following options were tested:

Precipitate humidity - 85% of WHP (water holding capacity)

- 100% realization of the water application rate (variant 1);
- 80% realization of the water application rate (variant 2);
- 60% realization of the water application rate (variant 3).

Irrigation norms are calculated using the formula:

$$m = [10.H\alpha.(\delta_T ot\ ППВ - \delta_T\ пр.вл.)].K.K_1,$$

Where: m is the size of water application rate in mm;

α – soil density in gr / cm3;

H – depth of the active soil layer in m (in test H = 0.5 m);

δт - of WHC - marginal Polish moisture in% relative to absolute dry weight of soil;

δт - presumptive soil moisture in% relative to the absolute dry weight of the soil;

K – the irrigation rate reduction factor taking into account the area occupied by the plants in 1 dka. In the experiment K = 0.52.5, ie. 52.5% of the area is irrigated.

Drop irrigation does not apply the entire irrigation rate as with other watering methods. A reduction is required at the expense of the unwatered area. For this purpose, the Ferckman, Grazoli [6] formula was used, taking into account the planting scheme. After calculating the irrigation rate for option 1, the norms of the other options are also set against its size.

Result and discussion

Phenological development.

The growing season of strawberries is divided into two sub-periods during which soil humidity is required for plant growth. The first sub-period of irrigation (spring) is the formation and growth of new leaves and blooms, fruiting. The second sub-period of irrigation is after harvesting the fruit, which creates normal conditions for the development of the crop. During this period, new leaves and runners are formed and fruit buds are planted, leaves are not dried.

The start of the vegetation of strawberries (2015) began in the third ten-day period of March, beginning of the buttoning is the second decade of April, and the beginning of the flowering began in the third ten-day period of April. After the massive blooms, which ended in the third ten-day period of May, strawberry harvesting began. The first harvest was made on 7 June and the last one was 30.06 (Table 1). The second period of irrigation is after harvesting the fruit. It started on July 1st and ended on 16 October.

The start of vegetation for strawberries in 2016 began in the second ten-day period of March, with the beginning of buttonisation being the third ten-day period of April and the beginning of the flowering in the first ten days of May. After the mass flowering, which ended in the second ten-day period of May, strawberry harvesting began. The first harvest was made on June 2 and the last on June 14 (tab.1). The second period of straining of strawberries begins after fruit harvesting ends from July to October.

Table 1:*Phenological development of strawberries*

year	Start of vegetation	Start of buttonization	Blooming			fruit development		
			start	mass	end	start	Mass	end
2015	20,03	14,04	24,04	07,05	23,05	2,06	07,06	30,06
2016	14,03	22,04	20,04	02,05	18,05	28,05	02,06	22,06

Tracking the rainfall and temperature regimes, especially during the summer months of July and August, showed that rainfall in the country is far from sufficient to satisfy the plants' soil moisture needs, and the ten-day temperatures over the entire growing season considerably exceeded the relevant norms. In practice, this confirms the thesis that drought in the country is not an episodic phenomenon, but climatological normality.

Table 2: *Rainfall during raspberry vegetation period*

Periods	Total rainfall, mm		
	2015	2016	Precipitation provision %
м. IV - IX	321	234	62,4
average multi-annual	293	120	92,2
м. V -VI	167	137	-
average multi-annual	152	54	-

In the years of study, the provision of rainfall in the 60-year series characterized 2015 as dry with a guarantee of 62.4% and 2016 as very dry with a provision of 92.2% for the period April-September / . The fallen rainfall during the vegetation of the crops is unevenly distributed, which necessitated the realization of watering. The months of April, May and June during the different ten-days periods are dry, with daily rainfall ranging from 1.0 to 26.0 mm. During this period, the most active phase of the culture development and the soil moisture in the active soil layer is below the required for biological growth (Table 2).

Table 4: Monthly sums of average daily air temperatures in ^{o}C

years	Monthly sums						Total for the period april-september		
	April	May	June	July	August	September	Total for the period IV – IX	Deviation from the average for the period 1957-2016 г.	
								total	%
2015	257,8	509,3	533,8	734,0	683,8	559,5	3278,2	+ 193,86	6,28
2016	412	431,8	621,3	672	645,3	514,7	3297,1	+ 212,76	6,90
Average for 1957-2016 г.							3085,15		

With regard to air temperature, the years under review are characterized as very warm with provision of 7.72% (2016g) and 12.75% (2015). The temperature values for the period April-September tend to increase compared to the average for the 60-year series with deviations of + 6,90% (2016) and + 6,28% (2015), (Table 3).

Table 5.1: *Irrigation regime for drip irrigation for the region of Sofia First irrigation period (April - June)*

variant	2015			2016			Average for the period 2015-2016 г.		
	Irrigations, number	water application rate m^3/da	Irrigation rate m^3/da	Irrigations, number	water application rate m^3/da	Irrigation rate m^3/da	Irrigations, number	water application rate m^3/da	Irrigation rate m^3/da
With 100% water application rate	7	17,8	124,6	8	17,7	141,6	8	17,7	133,2
with 80% water application rate	7	14,2	99,7	8	14,2	113,6	8	14,2	106,6
with 60% water application rate	7	10,7	74,7	8	10,6	84,8	8	10,7	80,7

Table 5.2: *irrigation regime for drip irrigation for the Sofia region Second irrigation period (July-October)*

variant	2015			2016			Average for the period 2014-2016 г.		
	Irrigations, number	water application rate m^3/da	Irrigation rate m^3/da	Irrigations, number	water application rate m^3/da	Irrigation rate m^3/da	Irrigations, number	water application rate m^3/da	Irrigation rate m^3/da
With 100% water application rate	11	16,9	185,9	12	17,7	212,0	11	17,3	199,0
with 80% water application rate	11	13,5	148,7	12	14,0	168,0	11	13,6	158,0
with 60% water application rate	11	10,1	115,0	12	11,0	134,0	11	10,4	124,0

Irrigation and irrigation regulations

The size and timing of watering irrigation of crops depends on the amount and distribution of rainfall during the growing season. They depend on the water-physical properties of the soil, the needs of water culture and the dynamics of meteorological factors. The realized number of irrigations as well as the watering and irrigation norms in the two experimental years do not differ significantly due to the almost uniform weather conditions in the field experiments. Years of field experiments on the amount of precipitation during the

growing season of culture (April to September) are characterized as dry.

The lunar period for the active vegetation of strawberries in the Sofia region covers the time from the second ten days of April, when the development of the culture begins - formation and growth of new leaves and blooms, formation and ripening of the fruit till the end of the harvest period - 30 June. The greatest number of irrigations were realized in the phases of flowering and fruiting of the crop. The second subperiod of watering for strawberries in the Sofia area came after July 1 and ended September 24. This period is one of the driest periods of the development of the culture and a higher number of waterings have been realized.

The results from the triennial experimental years show that during the first period of irrigation of the strawberry on average for the three years the number of the pollinators was 8 with the average water application rate - 17,2 mm and the irrigation rate - 133,0 mm, and during the second period of irrigation - 11 pcs. waterings with average irrigation rate - 17.3 mm and irrigation rate - 199 mm. The total irrigation rate for the two irrigation periods is 332 mm. (Table 5)

The irrigated regimes in the outdoor strawberries, in the case of surface drip irrigation, have had a significant impact on the formation of yields.

The data from Table 6 show that the highest yields in the soil-meteorological conditions for the Sofia field, on average, for two years were obtained with the variant, irrigated with 100% implementation of the irrigation norm. The yield is 1060 kg / dka, followed by the 20% reduction in the irrigation rate of 781 kg / dka. The lowest yields were obtained with the 40% reduction of the norm - 665 kg / dka. Lowering the irrigation rate by 20% resulted in a 28% reduction in yields compared to the 100% irrigation-irrigated option. This irrigation regime can be used in the event of a water shortage. The decrease of the irrigation rate by 40% resulted in a more drastic reduction of the yield - 38%, which is due to the very dry and hot year of the field experimentation (Table 6).

Table 6: *Yields strawberry variety "Polka" by years and average for the period*

variant	2015		2016		average 2015 – 2016	
	yield kg/dka	differences ±	yield kg/dka	differences ±	yield kg/dka	differences ±
1. 100%	970	St	1150	St	1060	St
2. 80%	757	-219	805	-345	781	-279
3. 60%	628	-341	701	-449	665	-395

CONCLUSIONS

On the basis of the field experiments we can draw the following conclusions:

1. For the period of active vegetation of the crop (April-June), 8 irrigations with with an average water application rate of 17.7 mm and a total irrigation rate for the period -133.0 mm were needed and respectively realized and for the autumn period (July September) - 11 irrigations with average water application rate- 17.3 mm and irrigation rate -199.0 mm. The total irrigation rate for the two irrigation periods is 332 mm

2. The realized irrigation regimes in individual years have had an impact on the yields obtained, with the highest yields being obtained for the variants irrigated with a 100% water application rate. The yield is 1060 kg / dka, followed by the 20% reduction in the water application rate of 781 kg / dka. In the event of a water shortage, it is recommended to apply irrigation regime with up to 20% reduction of the water application rate.

3. The analysis of meteorological factors shows that the rainfall in the country is insufficient to satisfy the requirements of the plants from soil moisture and the ten-day temperature values over the whole vegetation period considerably exceed the respective norms, which requires the use of drip irrigation for successful fruit production in the case of water shortages and relatively high temperatures, as well as the application of water-saving irrigation technologies.

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