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J21410-001

Zakharzhevskii O.A., Afonin V.V.

**AMENDMENTS IN CLARKE'S AND PARK'S TRANSFORMATIONS
ACCORDING TO THE LAOUT OF THREE-PHASE STATOR
WINDINGS**

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The amendments to the Park and Clarke transformations take into account structure of three-phase stator windings. They reflect the shape of the distribution of magnetic induction in the air gap of the machine. The amendments proposed by the authors.

Keywords: The amendments to the Park's and Clark's transformations, the layout of the windings, the distribution of magnetic induction in the air gap.

The various options Clarke's and Park's transformations use as the basis of the vectors transformation in three-phase machines [1-4].

Clarke's transformation (CT) original expression in modern notation:

$$\text{direct transformation} \quad \begin{cases} i_{\alpha} = \frac{2}{3}(i_A - \frac{i_B + i_C}{2}); \\ i_{\beta} = \frac{1}{\sqrt{3}}(i_B - i_C); \\ i_0 = \frac{1}{3}(i_A + i_B + i_C). \end{cases} \quad (1)$$

$$\text{reverse transformation} - \begin{cases} i_A = i_{\alpha} + i_0; \\ i_B = -\frac{1}{2}i_{\alpha} + \frac{\sqrt{3}}{2}i_{\beta} + i_0; \\ i_C = -\frac{1}{2}i_{\alpha} - \frac{\sqrt{3}}{2}i_{\beta} + i_0. \end{cases} \quad (2)$$

Original expression Park's transformation (PT) in modern notation:

$$\text{direct transformation} - \begin{cases} i_d = i_{\alpha} \cos \theta + i_{\beta} \sin \theta; \\ i_q = -i_{\alpha} \sin \theta + i_{\beta} \cos \theta. \end{cases} \quad (3)$$

$$\text{reverse transformation} - \begin{cases} i_{\alpha} = i_d \cos \theta - i_q \sin \theta; \\ i_{\beta} = i_d \sin \theta + i_q \cos \theta. \end{cases} \quad (4)$$

Transformation CT connects real currents of the three phases of the stator - i_A , i_B , i_C and fictitious currents orthogonal system i_{α} , i_{β} , i_0 , fixed relative to the stator. If we assume the additional condition $i_A + i_B + i_C = 0$, we obtain the CT variant, often used for vector control of three-phase machines. This transformation typically used to convert from the three-phase machine to "equivalent biphasic" machine. Equivalence is understood with respect to electromechanical conversion, what carried out in an electric machine. Ease of analysis in an orthogonal coordinate system in comparison with the analysis of three-phase system eliminates the question of substantial differences in the processes of these machines.

Transformation PT is used to transfer vectors of an orthogonal coordinate system fixed stator (α, β) in the orthogonal coordinate system fixed to the rotor (d, q), and it is used else to convert a coordinate system rotating with an arbitrary velocity.

Generalized vector of the stator current can be written in different coordinate systems $\vec{i}_s = [i_{ABC}] = [i_{\alpha\beta 0}]$ or in an abridged version - $\vec{i}_s = [i_{\alpha\beta}] = [i_{dq}]$.

To analyze processes in three-phase electric machines typically use equations for current and voltage laws Kirchhoff for the instantaneous values of currents, voltages and magnetic fluxes. Moreover functions between the magnetic flux phase electrical machine described by the equations in matrix form [2-4] –

$$\begin{bmatrix} \Psi_A \\ \Psi_B \\ \Psi_C \\ \Psi_a \\ \Psi_b \\ \Psi_c \end{bmatrix} = \begin{bmatrix} L_s & M_{AB} & M_{AC} & L_{Aa} & L_{Ab} & L_{Ac} \\ M_{BA} & L_s & M_{BC} & L_{Ba} & L_{Bb} & L_{Bc} \\ M_{CA} & M_{CB} & L_s & L_{Ca} & L_{Cb} & L_{Cc} \\ L_{aA} & L_{aB} & L_{aC} & L_r & M_{ab} & M_{ac} \\ L_{bA} & L_{bB} & L_{bC} & M_{ba} & L_r & M_{bc} \\ L_{cA} & L_{cB} & L_{cC} & M_{ca} & M_{cb} & L_r \end{bmatrix} \times \begin{bmatrix} i_A \\ i_B \\ i_C \\ i_a \\ i_b \\ i_c \end{bmatrix}, \quad (5)$$

where the inductance of the stator windings L_s - and rotor windings L_r - and M_{AB}, \dots, M_{cb} - the mutual inductance between the windings stator, rotor and L_{Aa}, \dots, L_{cC} - the mutual inductance between the windings stator and rotor as functions of angle rotation θ of rotor relative to stator.

Given the angle of rotation θ , these equations have the form [4] –

$$\begin{bmatrix} \Psi_A \\ \Psi_B \\ \Psi_C \\ \Psi_a \\ \Psi_b \\ \Psi_c \end{bmatrix} = \begin{bmatrix} L_s & M_{AB} & M_{AC} & M_{Aa} \cos(\vartheta) & M_{Aa} \cos(\vartheta + \frac{2\pi}{3}) & M_{Aa} \cos(\vartheta - \frac{2\pi}{3}) \\ M_{BA} & L_s & M_{BC} & M_{Aa} \cos(\vartheta - \frac{2\pi}{3}) & M_{Aa} \cos(\vartheta) & M_{Aa} \cos(\vartheta + \frac{2\pi}{3}) \\ M_{CA} & M_{CB} & L_s & M_{Aa} \cos(\vartheta + \frac{2\pi}{3}) & M_{Aa} \cos(\vartheta - \frac{2\pi}{3}) & M_{Aa} \cos(\vartheta) \\ M_{Aa} \cos(\vartheta) & M_{Aa} \cos(\vartheta + \frac{2\pi}{3}) & M_{Aa} \cos(\vartheta - \frac{2\pi}{3}) & L_r & M_{ab} & M_{ac} \\ M_{Aa} \cos(\vartheta) & M_{Aa} \cos(\vartheta + \frac{2\pi}{3}) & M_{Aa} \cos(\vartheta - \frac{2\pi}{3}) & M_{ba} & L_r & M_{bc} \\ M_{Aa} \cos(\vartheta) & M_{Aa} \cos(\vartheta + \frac{2\pi}{3}) & M_{Aa} \cos(\vartheta - \frac{2\pi}{3}) & M_{ca} & M_{cb} & L_r \end{bmatrix} \times \begin{bmatrix} i_A \\ i_B \\ i_C \\ i_a \\ i_b \\ i_c \end{bmatrix} \quad (6)$$

The equations are not visible depending on construction the machine windings.

Vector control systems of three-phase machine are used concept of generalized vectors of current, voltage, and magnetic flux. Such a representation it is convenient to display the interaction of currents and magnetic flux in an electric machine in the form of conditional vectors of these variables with transformations of vectors in the complex plane. It is possible under certain assumptions: sinusoidal magnetic induction distribution in the air gap machines produced when current flows through one of the windings, symmetry of the windings construction, linearity of the magnetic system. These assumptions mean that always used in fact only one and the same model for all machines - a model of an idealized machine, and the influence of

structure machine windings is ignored. Mainly structure of stator windings generates a distribution of magnetic induction in the air gap induction machine and determines the properties of electromechanical energy conversion. The report [2] was carried out in the harmonic analysis of distribution magnetic induction, but not found the influence to model machine.

The authors proposed the correction functions and the correction factors to the elements of vectors transformation and to formulas vector transformations [3,4] to obtain compliance with the distribution of the magnetic induction in the gap real machine.

Now (1) will have the form ZA-Clarke's transformation –

$$\begin{cases} i_{\alpha} = \frac{2}{3} (KAa(0) \cdot i_A - KAa(\pi/3) \cdot \frac{i_B + i_C}{2}); \\ i_{\beta} = \frac{1}{\sqrt{3}} KAa(\pi/6) \cdot (i_B - i_C); \end{cases}, \quad (7)$$

where $KAa(\theta)$ - correction function reflects the deviation of the magnetic fluxes mutual inductance of stator windings from the function $\cos(\theta)$. The function $\cos(\theta)$ corresponds to an idealized model of the machine [4]. Similar correction factors was applied to clarify some of the other elements of the transformation matrices vectors [3,4].

Transformation PT binds the coordinates windings fixed relative stator, with the coordinates fixed to the rotor.

Is now available a modified from (3) the ZA-Park's transformation where the correction functions $KAa(\theta)$ is used -

$$\begin{bmatrix} i_{dq} \end{bmatrix} = \begin{bmatrix} i_d \\ i_q \end{bmatrix} = P_{ZA} \cdot \begin{bmatrix} i_{\alpha\beta} \end{bmatrix} = \begin{bmatrix} KAa(\theta) \cdot \cos \theta & KAa(\theta - \pi/2) \cdot \sin \theta \\ -KAa(\theta + \pi/2) \cdot \sin \theta & KAa(\theta) \cdot \cos \theta \end{bmatrix} \cdot \begin{bmatrix} i_{\alpha} \\ i_{\beta} \end{bmatrix} \quad (8)$$

Correction function $KAa(\theta)$ takes into account the mutual inductive coupling between the stator windings and any secondary windings depending on the angle rotation rotor θ and taking into account deviations from the sinusoidal distribution of magnetic induction in the gap machine [3,4].

When using the correction function in matrixes (5,6) need to be considered as rotation angle of the rotor and well as the angular position of inductively coupled coils.

Formally correction of elements is equivalent to their replacement with new elements. But the correction functions themselves serve as an indicator of approximation of idealized model of a three-phase model machine to real machine, they serve as a kind of characteristics the structure of the windings.

Correction factors to expressions what equivalent to the matrixes of vectors transformation are computed from the correction function of the matrix of mutual inductance between the stator and rotor windings $KAa(\theta)$, if as an argument put the angle between the corresponding vectors.

Conclusion

The authors propose a modified method of vectors transformation in the complex plane - M-TCP [3,4], which differs from the basic method for transforming

vectors in the complex plane – TCP. Unlike TCP the method M-TCP is taken into account the structure of three-phase windings of the machine. Unlike traditional harmonic analysis of the distribution of the magnetic induction along the air gap machine, the method M-TCP used the correction functions and correction factors to the elements matrices transformation magnetic fluxes for an idealized machines [3,4].

The same method was used in this article to the Clarke's and Park's transformations vectors of three-phase machine, that gives ZA-Clarke's and ZA-Park's transformations. One of the advantages of M-TCP is that the structure all the previous systems of vector control of three-phase machines is preserved and the all transformations of vectors in control systems have preserved. This is possible because used the correction to elements of matrixes of vectors transformation, and not a replacement of these elements by new elements. The method M-TCP, ZA-Clarke's and ZA-Park's transformations will more accurately perform vector control of three-phase machines and their processes simulation.

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Zakharzhevskii O.A., Afonin V.V.

IMPROVEMENT OF MODEL SOLAR CELLS

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Proposed improvement model of the solar cell, which simplifies the modeling modes the selection of maximum power from the solar battery with account for the difference in illumination solar cells.

Keywords: model solar cells, difference in illumination solar cells.

Steeply dipping voltage-ampere characteristic (V-A characteristic - VAC) have solar photovoltaic cells (Solar Battery - SB), fuel cells. An important task of use of these sources is to obtain maximum power from them.

Obtaining a maximum power from such sources with variable voltage to a stable voltage requires circuit automated design (CAD), which is based on the model itself SB. Model SB is reflected in its VAC and it is usually constructed from the physical representations of the p-n junction photodiode [1-5].

The study is mainly used schematic model (fig. 1). Its essence lies in the fact that the ideal current source J_L (photocurrent of photocell) is connected to antiparallel him semiconductor diode VD1. VAC diode VD1 is described by Shockley

$$I_D = I_0 \{ \exp[(qV_j)/(nkT)] - 1 \} \quad (1)$$

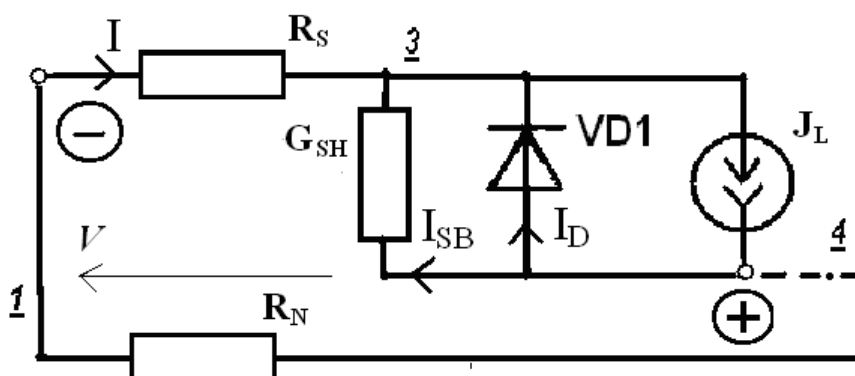


Fig.1. Scheme used of solar cells.

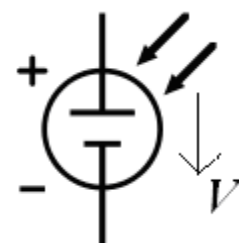


Fig.2. Model EMF.

Here V_j - voltage across the diode; V - the voltage at the output terminals (on the diode and on series resistance R_S); I - output current, load current; R_S - series resistance; I_D - diode current (current of the p-n junction); $R_{SH} = 1/G_{SH}$ - resistance parallel to diode; I_{SH} - leakage current through R_{SH} ; I_0 - reverse saturation current of the p-n junction; n - factor of type diode ($n = 1$ for an ideal diode); q - electron charge; k - Boltzmann constant; T - the absolute temperature; R_N - load resistance;

for 25°C $kT/q \approx 0,0259$ [B]. The circuit model (fig.1) serves as a similarity of source photovoltage V (fig. 2), it is assumed that the photo-EMF for any value of the photodiode current is determined by potential barrier photodiode and photo-EMF has for any value of current SB. However, the circuit model (fig.1), as amended by the Shockley equation (1) and (2) does not have this property -

$$I = I_L - I_0 \{ \exp[qV_j/(nkT)] - 1 \} - V_j / R_{SH} \quad (2)$$

Physical processes to overcome the potential barrier for output electrons from photodiode occur at any value of current (for output even a single electron). This assertion is reflected in the experimental VAC photodiode modules SB on fig.3.

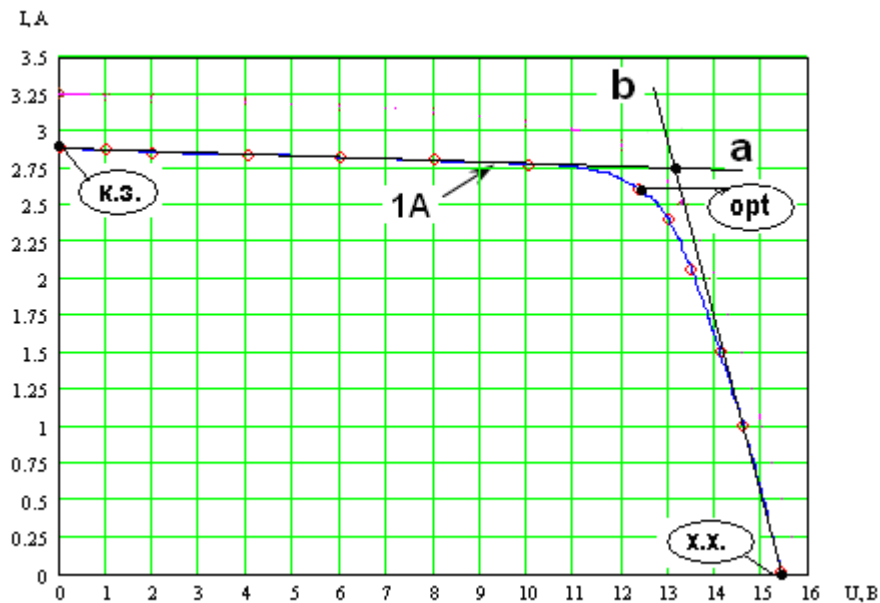


Figure 3. Experimental VAC of modules the solar cells of flint.

In the physical and technical studies used more complex expressions to describe VAC photodiode [2,3]. Quite complex equations described in VAC module Sat PSIM software package [4].

Usually a problem CAD for SB associated with conversion an unstable voltage of SB in the stable voltage of secondary source. For this task, more important is the simplicity of the model and accounting special properties of SB, such as those associated with the uneven illumination photodiodes connected in series, with the inequality photo-EMF groups photodiodes connected in parallel, with heterogeneity of heating and cooling of individual elements SB etc technical tasks.

Authors suggests a simpler model SB (fig.4), consisting of standard circuit elements CAD whose parameters can be easily determined from experimental data VAC of SB or with help an identification of the model parameters in the time work.

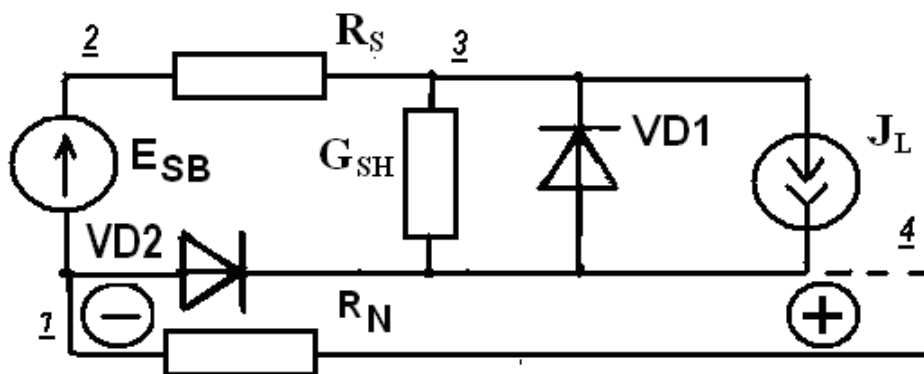


Fig.4. The proposed scheme of model of solar cells.

Linear approximation for the module number 1 contains the EMF source E_{SB} with internal resistance R_S , the current source (J_L) is enabled in series with EMF

source in the same polarity: **a** - for real source of EMF in model SB, **b** - for the real current source in model SB. Parallel to current source J_L included ideal diode VD1, what shunt the source current on diode forward branch. Diode VD1 has included parallel to the leakage conductance G_{SH} . SB model outputs (points 1-4 in scheme) associated with an equivalent load resistance SB R_N . The load SB may be a voltage pulse converter. Zero load resistance $R_N = 0$ corresponds to a short circuit (sc = к.з.) SB and resistance $R_N = \infty$ corresponds to the idle (idle = x.x.). Both modes - idle and short-circuit - corresponds to zero power in the load. Fig.3 also shows the linear approximation VAC SB, where the point of optimum load power is at the intersection of two lines **a** and **b** at coordinates $u_{ab} = 13,2$ В and $i_{ab} = 2,75$ А. Fig.3 shows both the optimum point (on an experimental VAC №1 and the point of intersection of lines **a** and **b**) are quite similar values for the maximum load power:

$$P_{Nopt} = u_{Nopt} * i_{Nopt} = 12,4 * 2,6 = 32,24 \text{ [Вт]} \approx u_{ab} * i_{ab} = 13,2 * 2,75 = 36,3 \text{ [Вт]}$$

Ideally, the model fig.4 if the load current $i_N = I$ do not exceed the current value of the current source J_L , then the voltage drop across the current source is equal to the voltage drop on the line of the VAC ideal diode VD1, i.e. remains zero, and the load applied equals voltage source of EMF - E_{SB} . If the load current exceeds the current source photocurrent - J_L , then the diode VD1 goes to the back of the VAC diode. The load current is thus necessarily passes through the current source and by the definition will be equal to the current J_L regardless of load resistance.

With taking into account to the resistances model fig.4, if the load current

$i_N = I$ do not exceed the current source current J_L , then the diode VD1 is still open, and the voltage across the diode VD1 remains zero, and the load voltage is applied EMF minus voltage across the series resistor R_S

$$u_N = u_{14} = u_{13} = E_{SB} - R_S * I. \quad (3)$$

In particular, in the mode $i_N=0$

$$u_{Nxx} = E_{SB} - R_S * 0 = E_{SB} \quad (4)$$

If the load current i_N exceeds the current of source J_L , then the diode VD1 is locked, and the load current will include leakage current I_{SH} .

Have a relation to the Kirchhoff voltage law

$$u_N = E_{SB} - R_S * I - (I - J_L) * R_{SH}. \quad (5)$$

In the short-circuit

$$u_N = 0 = E_{SB} - R_S * I_{кз} - (I_{кз} - J_L) * R_{SH}. \quad (6)$$

Together, the four equations (3) - (6) allow us to determine all four parameters of linearized model in Figure 4.

Accounting for nonuniform illumination of individual photodiodes SB requires the introduction of an additional diode VD2 [3], in parallel with each of the photodiodes connected in series SB (fig. 4). Diode VD2 makes the work of each photodiode of a chain of serially connected photodiodes work independent of other photodiodes SB, allows leaking of the photocurrent on the other photodiodes of the same chain of photodiodes. Model SB for fig.4 allows you to create complex shapes VAC (with breaks) to account for some modes of the shading photodiodes.

. It is possible accounting illumination via a current source J_L and accounting the material properties of photodiodes and environmental conditions through the value of EMF E_{SB} . It allows you to simulate and parallel connection of several chains of

photodiodes with arbitrary illumination individual photodiodes. This is possible because the models of each of the photodiodes are very simple, contain typical circuit design elements.

As a current source and EMF can be used dependent current sources and dependent voltage sources, simplifying accounting depending the operating mode SB, the inhomogeneity of illumination, the variability of temperature, as well as consideration of other dependencies SB.

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J21410-003**S.V. Tyulevin, M.N. Piganov, G.P. Shopin****FITTING THICK-FILM MICROASSEMBLY'S ELEMENTS***FSUE SRPSRC "TsSKB – Progress"**Samara State Aerospace University named after academician S.P. Korolyov
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The device for fitting thick-film resistors to rated value is described by method of torch discharge. The skeleton diagram of the device is provided. The principle of its operation is considered. The device allows to increase accuracy and to expend the functional capabilities of process of adjustment.

Key words: fitting, thick-film resistor, device for fitting, composition, the principle of operation, accuracy, functionality.

Introduction

Accuracy of the microassembly's output capacities depends on accuracy of film passive elements (resistors, capacitors). Electrical specifications of thick- and thin-film elements are affected by dispersability of the blend's dust, heat treatment conditions, film morphology [1,2], etc.

Typical process of thin-film microassembly's PCBs manufacturing doesn't provide high accuracy of thin-film resistors. Usually, variation of resistance at PCB is above 10%. Fitting thick-film resistors to nominal value is used for providing required precision of thick-film resistors resistance. Devices for fitting thick-film resistors by single-electrode discharge method are reviewed in [3, 5].

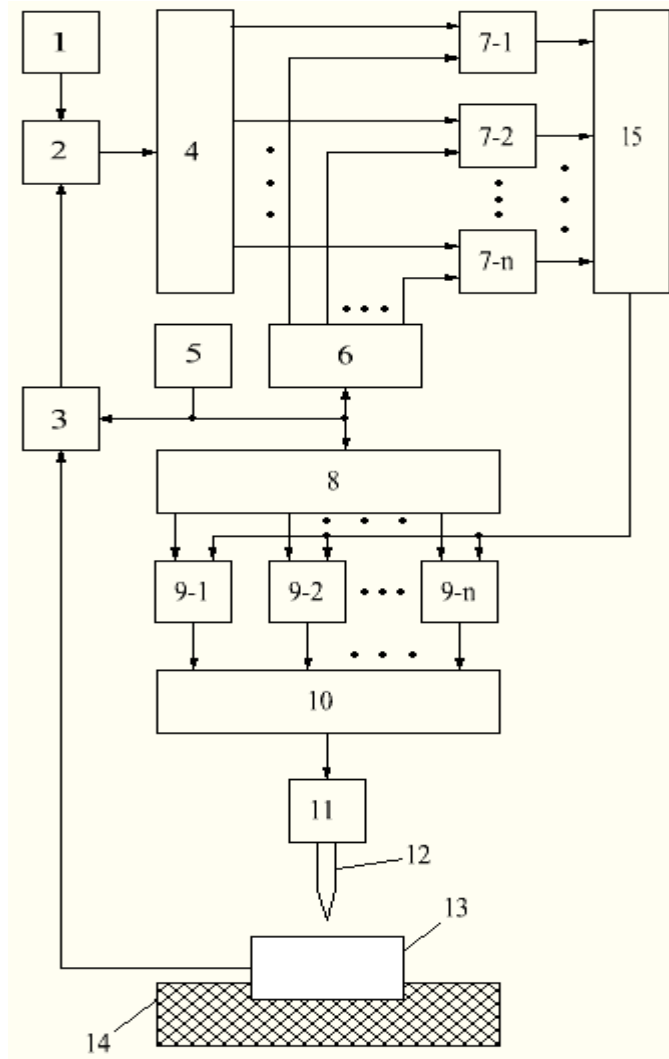
The disadvantages of these devices are low precision and low stability of fitting process, associated with need to use group of working electrodes, each of its must have individual installation clearance between top of the emitting cone and surface of resistor.

Objective – increasing precision and stability of fitting film resistors by torch discharge method and different power discharges, using one working electrode.

Fitting device's working principle

Device consist of reference potential source 1, compare device 2, resistance measurer 3, analog to digital converter (ADC) 4, one-shot vibrator 5, shift register 6, first group of AND elements 7-1 ... 7-n, data storage unit 8, second group of AND elements 9-1 ... 9-n, digital-analogue converter (DAC) 10, [torch discharge](#) generator 11, working electrode 12, fitting resistor 13, substrate holder 14, OR element 15.

Fitting resistor 13, resistance measurer 3, compare device 2 and ADC 4 are wired in series; DAC 10 and torch discharge generator 11 are wired in series too. Torch discharge generator 11 has working electrode 12, which set up between top of the emitting cone and resistor's surface 13, which is attached at substrate holder 14. Reference potential source's 1 output connected with first input of compare device 2. First input of each AND elements of first group 7-1...7-n connected to the same-named output of ADC 4. Shift register's 6 input and control input of resistance measurer 3 combined and connected to the one-shot vibrator's 5 output. Each of shift register's 6 output wired with second input same-named first group AND element 7-1...7-n.



Pic. 1. Schematic diagram of the device for fitting thick-film resistors

Data storage unit 8, OR element and second group of AND elements 9-1...9-n are additionally added in the device. Data storage unit's 8 input also connected to the one-shot vibrator's 5 output, and each of its outputs connected with input of the same-name second group AND element 9-1...9-n. Second inputs of second groups AND elements 9-1...9-n combined and wired to the OR element's output 15, each of OR element's inputs connected to the output of same-name first group AND element 7-1...7-n. Each of outputs of second group AND elements 9-1...9-n wired with same-named input of DAC 10.

Device works by push-pull circuit this way.

During the first period fitting resistor's resistance 13 is measured by resistance measurer 3. In this case resistance measurer 3 is forming fixed voltage, which is proportional to this resistance. Fixed voltage is direct during two periods. One-shot vibrator 5 gives fitting resistor's value measure command and command of supporting of permanent collected level of resistor measure's 3 output voltage. Vibrator's output signals have rectangular waveform. Fitting resistor's 13 resistance measurement and measurer's proportional to resistor output voltage formation are

taking place at the device during “zero” level of impulses (first period). Both these processes take a little part of first period, the result is that most of first period and all second period (almost two periods) formed fixed voltage is maintained at the resistance measurer’s 3 output. Resistance measurer 3 can be realized with full bridge circuit or with completed digital resistance measurer.

Compare device 2 is based on the voltage subtracter. Difference between resistance measurer’s output voltages 3 and reference potential source 1 is calculate by compare device. Reference potential source 1 is proportional to limit of the fitting resistor’s resistance 13. ADC 4 forms digital code that proportional to ADC’s input voltage (difference signal at output of compare device 2). ADC 4 has n – charges, “weight” of each next charge, starting second, two times less than previous.

At the first work period of device for resistor fitting, at the first output of shift register 5 logic “1” is formed. Then “1” goes to the second input of first group AND element 7-1 and allows signal on the output of the AND element 7-1, contained at the first output of ADC 4.

Simultaneously with the process described above, by the one-shot vibrator’s 5 command, digital code is forming at the outputs of data storage unit 8. This code has information about power of first (most powerful) torch discharge. Signal from the each of data storage unit’s 8 outputs goes to the first input of the same-named second group AND element 9-1...9- n .

If output signal of AND element 7-1 is logic “1”, (it goes to the first input of OR element 15), then during the second period logic “1” is maintained at OR element’s output 15. Logic “1” goes to second inputs of second group AND element 9-1...9- n , thereby passing signal to the output of elements, contained at the same-named output of the data storage unit 8.

Output signal of each second group AND elements 9-1...9- n goes to the same-named DAC’s 10 output. During the second period fixed voltage is maintained at the DAC’s 10 output, voltage is proportional to the energy of first torch discharge. Voltage goes to the input of torch discharge generator 11. Between emitting cone point of working electrode 12 and fitting resistor 13 torch discharge appears, this leads to resistor’s material evaporation and to enlarging of its resistance.

If output signal of AND element 7-1 is logic “0”, (it goes to the first input of OR element 15), then during the second period logic “0” is maintained at OR element’s output 15. Logic “0” goes to second inputs of second group AND element 9-1...9- n , forming logic “0” at its outputs. Zero voltage is formed at the DAC’s 10 output. With such turning on the generator 11, torch discharge isn’t produced.

During the second period of fitting, by the one-shot vibrator’s 5 command logic “1” forms at the output of shift register 6. Logic “1” goes to the second input of first group AND element 7-2, thereby passing signal to the output of AND element 7-2, contained at the second output of the ADC 4.

Simultaneously, also by the one-shot vibrator’s 5 command, digital code forms at the outputs of data storage unit 8. Digital code has information about power of second torch discharge.

Generally, the work of device during the second period is going as described above.

If second decade of ADC 4 has logic “1”, then torch discharge of second period leads to resistance increment two times smaller, than in the first period of fitting.

In future fitting resistor's 13 control cycle and burning a part of resistor's layer repeats, every time compared to previous cycle, incremental resistance will be two times less, if matched address bit of ADC 4 has logical “1”.

Conclusion:

Improved accuracy and stability of torch film resistors fitting are benefits of the device. This is achieved by including of data storage unit 8, second group of AND elements 9-1...9-n and OR element, and using one working electrode 12 for all cycles of fitting. High accuracy of setting the big amount of clearance between tops of working electrode's emitting cone and resistor's surface. Codes for each cycle of fitting, which allow using one working electrode, are stored in data storage unit 8 and forms automatically at unit's outputs by the command from the one-shot vibrator 5.

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J21410-004

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CONCEPT OF QUALITY MANAGEMENT SPACE RADIO ELECTRONIC MEANS

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The article discusses a conception and structural model of quality management (QM) space radio-electronic means (REM). The model identified six circuits (QM) and ten lifecycle REM.. The concept is based on 17 principles QM

Concept, quality management, electronic warfare, space equipment, structural model, control loops, lifecycle, marketing system

Introduction

The exit of the industry from crisis at open market economy is almost impossible without a solution of a problem of improvement of quality and competitiveness of released products. In general, it is a problem of technical and economic, not just management. Technically, it can be solved in the design, manufacture, testing, operation and maintenance. Economically - through product price that reflects the quality of its consumer [1].

Quality products - a set of its properties, provides the possibility of its application and meet certain requirements of the consumer. Engineering approach to the determination of the quality of the product involves analyzing technical patterns in the manifestation of various properties of the product of the same functionality. From this perspective, the quality is studied in terms of comparing the properties of the product together with a set of properties of a similar product that is accepted as the standard of comparison.

Product quality is determined by several factors. The quality level is laid in the early stages of development. One of the main places here that takes scientific and technical advance that has the product and the developer that he can use in the analysis of options and choice of design strategy. Product quality depends on what scientific ideas get their material embodiment in the technical documentation. Implemented product quality in the manufacturing process, and confirmed the operational phase. According to the academician Subetto A.I. [2] quality - "core" of national idea of Russia on strategic horizon of its future. Quality is observed by it as geopolitical strategy of recovery and development of economy and a country civilization.

The problem of improvement the quality is acute primarily in science intensive sectors the high technology branches of technics which include electronics. It acquires special importance in the design and manufacture of space equipment.

The purpose of this article – develop a new concept and a structural model of quality management space REM.

Structural model of quality management

In all developed countries is paid a lot of attention to quality management. Formed a definite strategy in quality management it is characterized by the following moments: the formation of quality is not understood as a technical function, which

can be realized by a single unit, but as a systematic process that covering the whole organizational structure of the company; organizational structure of the enterprise should conform new concept of quality; quality issues are relevant not only in the production cycle, but also in the process of development, construction, marketing, service; quality should be focused on conform the requirements of the consumer, not the manufacturer; improving product quality requires the use of new production technologies, automation, from design to automatic change in the quality control process; comprehensive quality improvement is achieved only interested participation of all employees.

Approaches and quality model developed by the ISO 9004 series, as well as in [1] does not take a count the specifics of rocket and space technology (RST), in particular ensure the quality of cosmic radio-electronic means.

We have developed a new structural model of quality management space radio-electronic means. Model shown in Figure 1. At this stage the RST company can evolve only by introducing a system of quality control. Quality management should occur through modern certified system of quality management. We can say about presence of such system only if all the indicators of quality products, all factors of quality process systematically carried out and a systematic approach to formation of quality (establishment, support, maintenance, forecasting and quality assurance) products. Quality management as a set of actions carried out through 6 contours. The system should ensure the formation of a given level of quality on ten major stages of the life cycle products: marketing, forecasting, research, design, pre-production, production, testing, use, operation, disputes. They make up a loop (chain) of quality.

Quality management system – it set of control units and objects of management interacting via logistical and information tools by the management of product quality.

The most important element of products quality management system is subsystem of control technological processes (TP). Manage of TP shall conform the conditions of optimality. Optimal control of processes of formation and structurization, installation and assembly, sealing, inspection and testing involves a two-step solution of the problem: problem of external optimization of appointment of conditions technological process and modes of formation of products, providing the required functionality and quality parameters, and internal optimization problems - adaptive process management application, processing, stabilizing properties of products to compensate for the instability processes caused by wear and deformation of the technological snap and hardware, control elements degradation and other factors.

The main element in this effort is the development and use of new technologies. Most effective technology to improve the quality of products should be marketing that involves the use of fundamentally new technologies in all major stages of the life cycle of products. Marketing provides structural and functional construction of system of quality, oriented on management flexibility, the precise interaction of the structural units, the functional orientation to the adaptation of the technical and technological processes to economically optimal satisfaction of social and forecast market requirements.

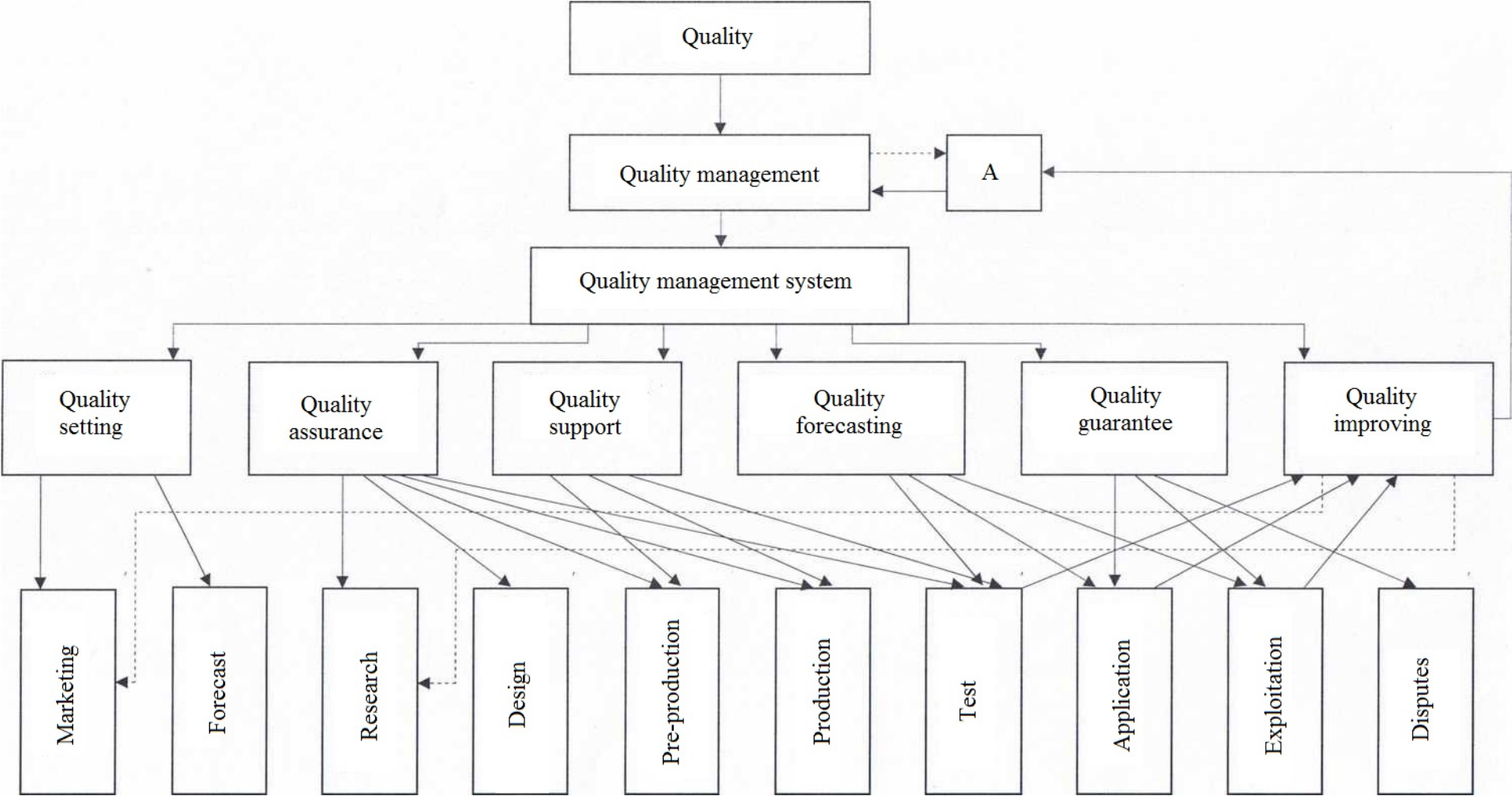


Fig. 1. Structural model of microassemblages quality management.

Technical solutions must combine the latest advances in scientific and organizational terms with economically proved levels of safety, reliability, compatibility and mentality criteria. Necessary to use technological solutions, which combine novelty of processes with economically optimal choice materials and equipment [1].

Concept of quality management

We have proposed a new concept of quality management of radioelectronic means for space purposes. The main conceptual management principles in the transition from general to private methodology are as follows:

1. Allocating of following quality management levels: international; state; industry; coordinating; regional; enterprise. Combining these levels in a vertically integrated system.

2. Organization of quality management system elements in the company by features of vertical and horizontal integration. Priority of horizontal links over vertical.

3. Across-all-areas quality management. Allocating of the following contours of forming quality: quality setting; quality assurance; quality support; quality forecasting; quality guarantee; quality improvement.

4. An integrated approach to quality. Accounting for all of the parties forming quality (technical, informational, methodological, organizational, staffing, resource, economic, social, law and other).

5. Combining the interests of suppliers of electro radio products (ERP), materials and other components with the interests of manufacturers, customers and users of microelectronic devices on the basis of mutually beneficial or compromise.

6. Use the rule: "the quality management system does not provide a quality in itself, but its use creates the conditions for quality assurance.

7. The combination of administrative and market approaches in determining the goals and objectives of the design, production, certification.

8. Use the rule: in the forming of quality space REM is no universal schemes, models, methods and techniques which are effective for different structural and technological options (STO); each scheme, model, methods and techniques have an area of optimal or sustainable use; when analyzing the options are not rejected any, even the non-obvious solutions and opinions.

9. The presence of inverse information links in all contours and stages of the life cycle of a product; use adjustments, correcting links and expert systems.

10. Presence of duplicate projects (or fragments), including alternative steps of development new STO.

11. Partial or complete parallel processes of research, design and manufacture of electronic components.

12. Accounting "technological heredity" in the selection and quality assessment, informative parameters and properties of the product.

13. Varying the "density" of control depending on the liability of REM or microassemblages and risk measures if they refuse.

14. Strengthening the role of electro-physics-diagnosis in control process between operations of TP in manufacturing REM and incoming inspection of

components, materials and ERP.

15. Accounting limiting possibilities of operating TP, measurement and control tools.

16. Introduction of redundancy in important but not so informative stages of production and control.

17. Clear division of labor, duties and responsibilities among participants at all stages and processes.

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MODELS FOR REPRESENTING THE VARYING OBJECTS

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Abstract. This paper considers the applicative type computational model which is parameterized for representing the variable objects/domains and their interaction. The possibilities of the establishing and maintaining the relationships of object states, data objects, and metadata objects are discussed.

Key words: computational model, variable objects, metadata objects

1. Introduction

The problems under consideration are related to the design and construction methods, computational models, tools and information technology aimed to analysis and building dynamic information systems (IS) and corresponding transition processes when processing Big Data. Under these conditions, the known methods of checking the correctness properties of systems and structures, of possibly interacting (information) objects proves unsuitable or over restrictive [1-4].

The latest trend at the model level, associated with the evolving understanding of objects as representations of information processes, regardless of whether they are natural or artificially engineered processes aimed to transformation of information that leads to the development of notion of a variable object.

In this paper we discuss the use of the basic model means of semantics of variable objects evolving along $f+g$ - dimension, where , in particular, for information systems (IS) and information technology (IT) f are “stages” , and g are “properties”. This is a basis for proposal to develop information modeling prototype system using software models of the evolution of systems of objects. The class of simulated problem domains is characterized by the need to take into account for different forms of interaction between objects, and a good example would be the information tasks of law enforcement.

2. Structure of a problem domain

Assume that the problem domain is modeled in accordance with understanding of objects as presentations of information processes, regardless of whether they are natural or artificially engineered processes aimed at the transformation of information that leads to the development of ideas about the variable object.

Since the data objects (DO) base is a formalized image of the problem domain (PO), assigned with the specific character of the applied information system (AIS), the DO base itself is in a permanent “evolution”. Evolution of DO base is associated with the development of a suitable notion of its state and the process of transition from the old state to the new one.

On this basis, the representation of DO base evolution means that the process of studying the problem domain permanently interacts with the actual environment of the AIS, ensuring adequate representation of the problem domain.

Assuming that the assignment adjusts AIS for a application-specific mode, users develop their own ideas about the problem domain.

Consideration of a family of various representations leads to the subdivision of all possible PD states into relatively persistent subsets, which are self-contained (i.e. the “worlds” corresponding to users or user applications).

3. Main constructs for problem domain representation

The PD representation constructs are used to capture the dynamics of data objects base taking into account their interactions within the information system.

3.1 Properties and attributes. Operations with individuals and properties lead to the formation of special properties, called *laws*. At its core, the law reflects the restrictions imposed on the properties of the individual/object.

Recall that in the applications -- applied research, -- namely the observer assigns *attributes* to the objects (to a contrast with properties they are not inherent for objects). Recall that both a logical formula $\Phi(x)$ and λ -expression $\lambda x. \Phi(x)$ define the property, but an immediate and direct attribution of properties $\Phi(\bullet)$ for the individual x is determined by the description:

$$\iota x. \Phi(x),$$

having a meaning of “the only x , which $\Phi(x)$ ” (compare with expression $\lambda x. \Phi(x)$, having the meaning of “those x , that $\Phi(x)$ ”).

There is a clear difference between the observer and his language, i.e. of the linguistic reality, on the one hand, and the individuals from problem domain D of on the other hand. The connection between them is established by *evaluation map*:

$$\| \bullet \| : \{ \text{the descriptions, } \lambda\text{-expressions} \} \times \text{assignments} \rightarrow \text{individuals}.$$

In this case: the assignment is temporarily considered as an index ranging over families. The tied up corresponding concepts are exactly *attribute* a and *property* $\Phi(\bullet)$ (by the description):

$$a = \|\iota x. \Phi(x)\| i \text{ для } i \in I. \quad (Attr)$$

Thus specified attribute identifies the set of individuals with the property $\Phi(\bullet)$. In conventional terms, a *functional representation of the attribute* is established (attribute is a mapping from the set of individuals and “observation points” into a set of values). Note that the ‘individual’ is determined by “the description”.

In the above context, the following principle is used:

attribute is determined by (Attr).

Adding uniqueness requirement

$$\{a\} = \{d \in D \mid \|\Phi(d')\| i = \text{true}\} \quad (Singleton)$$

leads to a necessary and sufficient condition:

$$\|\iota x. \Phi(x)\| i = a \Leftrightarrow \{a\} = \{d \in D \mid \|\Phi(d')\| i = \text{true}\}. \quad (Unique)$$

In other words, having $i \in I$ and intending to determine $\|\Phi(d')\| i$ relative every $d \in D$, the observer must make sure that the formula is true for a *single* d . Once this is achieved, then the individual is denoted by a and is seen as a *value* to the description *relative* i .

Thus, the observer is forced to do the following work: for a fixed family $i \in I$ and evaluation $\|\Phi(d')\|i$ relative any $d \in D$, it checks the uniqueness of d .

Following the adoption of this requirement, the more rigorous is to write the following:

$$\|\cdot\| \cdot : \{\text{the descriptions, } \lambda\text{-expressions}\} \times \text{assignments} \rightarrow [\text{individuals}].$$

where '[individuals]' means *power-set*.

3.2 Functional schema. A general and direct solution for attributes requires the use of multiple attribute functions (*Attr*), which are called a *functional schema*. To achieve such an objective the equality (*Attr*) have to be revised as follows:

$$\begin{array}{ll} \text{ix. } \Phi(x) &= h' \text{ in a language of observer,} \\ \|\|h'\| &= h \text{ is the individual concept in a domain,} \\ h(i) &= a \text{ is the individual in a domain } (= \|\|h'\|i). \end{array}$$

You can choose any explanatory system. Someone may choose to think in terms of 'concept-individual'. If necessary, the observer can use reasoning and in terms of 'individual-state'. In this case, the individual h is fixed, whereas a is considered as its state reached under the influence of the *forcing* i .

Generalized individuals (or: concepts) are in accordance with the schematic diagram:

$$h : I \rightarrow C, \quad h(i) = c,$$

where h is a mapping from 'viewpoints' I , or forcing conditions, into (a subset of) the attribute C , perceived, for example, as a set of all possible states c of the individual h , and $C \subseteq D$. The latter, undoubtedly, is a *determined* set of individuals. There is a clear reason to consider h as a *concept*. Thus, the concept is, in fact, the functional schema.

3.3 Metadata objects. (Individual) functional schemata can be gathered into a bigger set:

$$H_C(I) = \{h \mid h : I \rightarrow C\}. \quad (V \text{ Dom})$$

Of course, $H_C(I)$ is an idealized object. It is important that $H_C(I)$ is a representation and, more specifically, a distinguishing feature of the *variable object* becomes characterized by the structure with two *parameters* I and C .

The features and advantages of the variable object construction appear in the dynamics.

4. Transition effects

Arguing the objects a *state* is considered as the function value, taken from the functional schema, at a given point -- one of the many 'viewpoints'. This is in a full harmony with the general model and computational environment.

4.1 State transitions. From a computational point of view a set of individuals is generated, e.g., from C by:

$$H_C(\{i\}) \subseteq C \text{ for } i \in I.$$

This state is a state of variable object $H_C(I)$, where C is a local universe of possible individuals. The pointer i marks a family of individuals, which are 'observed' from i . The states $s1, s2, \dots$ of a functional scheme are represented by the *stages* of a variable object:

$$s1 : H_C(\{i\}) = \{h(i)\} \subseteq C$$

$$s2 : H_E(\{i\}) = \{h(i)\} \subseteq E$$

$$\dots : \dots \quad \dots$$

Transitions, or transformations $g : s1 \rightarrow s2$ are the components of *events* (they are triples):

$$\langle s1, s2; g \rangle.$$

The idea of a variable object provides a natural representation of the *transition effects* in the case of dynamics of computations with objects. Moreover, it provides a convenient metatheoretical context. All the sorts of effects are expressed by adding the *natural transformations* $H_g : H_C \rightarrow H_E$ for mapping

$$g : C \rightarrow E.$$

Analysis by elements for $i \in I$ gives the following:

$$H_g(I) : H_C(I) \ni h \quad \mapsto \quad g \circ h \in H_E(I),$$

$$H_g(\{i\}) : C \supseteq \{h(i)\} \quad \mapsto \quad \{(g \circ h)(i)\} \subseteq E.$$

This means that the set of transformations imposes the *laws of individuals*, i.e. the laws that objects/individuals must satisfy in the case of reasoning with objects/individuals.

As an immediate and direct result, it is obtained a clear understanding of the interaction of objects -- through a *state variable*, which is shared by the interacting objects. Thus, the set of natural transformations is a representation of laws. And the short diagram below determines what the specific laws in question are:

$$\{h(i)\} \subseteq C,$$

$$x1 \in \{h(i)\}; x2 \in \{h(i)\}; z \in C,$$

$$\dots \Phi(x1) \& \Psi(x2) \& x1 = z \& x2 = z \dots,$$

where z is a common variable (joint state variable).

5. Conclusion

An applicative type computational model is presented and parameterized to use the variable objects and their interactions. The model is equipped with a scheme of its application to the analysis the problem domain of "Big Data". Analytical expressions for laws are obtained allowing for the problem domain to establish and maintain communication states of objects, data objects and metadata objects.

1. The varying objects are represented as constructions with two parameters. In applications, the first of them is assumed to be an assignment. This gives connections with an environment for computational model. Second parameter normally represents a type. Type system in use can be varying depending on a particular application.

2. On the other hand an assignment can be used as state of computation. Then state transitions can simulate a computational dynamic.

3. Types can be determined using the logical expressions. Thus their truth value in a general case depends on the state of computation.

4. Types are generalized using the type transitions. Studying the type dynamic in the proposed computational model leads to homotopy type theory which can be used to further extensions of the results obtained in this research.

This research is a generalization of the results which are related to establishing the conceptual computational model and obtained in different time conducting the research projects granted in part by the RFBR 14-07-00119-a, 12-07-00661-a, 14-07-

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**COMPUTATIONAL MODEL OF APPLICATIVE OBJECT
INTERACTION**

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Abstract. This paper is aimed to modeling the object interaction using the applicative computational technology. In this case, starting with a few of generic objects it is possible to study the computational behavior of all the variety of derived objects. It is shown that the computational properties of generic objects when interacting with environment stay unchangeable. This gives rise to a system of free and natural computations based on the ideas of object interaction. The approach in use is significant for data analysis, object recognition and logical forms of determining the object properties in critical information technologies.

Key words: applicative technology, object interaction, Big Data

1. Introduction

Computing and its development puts a lot of questions, on the most part from which answers either are incomplete, or unknown. At present an exhaustive explanation of the properties of interacting objects as information processes is not yet reached. Direct transfer of the existing in science models of interaction from the field of physics to the area of information objects is impossible. Implementation barriers are largely due to the mathematical apparatus used, which is familiar to physicists, but it is unusual in computer science, not to mention programmers. In this regard, significant result may be the development of a kind of “mathematical adapter” between the two areas.

In this paper the information technology for natural computations was introduced and studied with the limitation to the applicative computational system. Case study for the assumptions of object with object and object with environment interaction was evaluated. The first case gives rise to computations in applicative prestructure while second case leading to computations in applicative structure. The established evaluation map helps to verify and discover the computational invariants.

This is important in an area of Big Data lacking the direct methods and technologies for the purposes of data analysis, object recognition and logical forms of determining the object properties in critical information technologies.

2. Objects and environment

2.1 Fixing the object. Attempts to fix object, assume it as something “ordinary” (and what is meant by “ordinary”, it remains quite unclear and non-augmenting) did not bring the expected result. And it is not negligence of researchers -- they exhibit complete thoroughness and accuracy, and technologists made software, which itself is sound.

To understand the phenomenology of the object the explorer needs more perfect “instrument base”, and in this case, faced with constraints of “ordinary” meta-mathematics, which rather awkwardly reflects real object in its notations.

Object also demonstrates its natural diversity: it is both prescription, and the result at the same time. As well can we cope with this?

2.2 Object-as-process. If we try to imagine object vividly, it turns out that we cannot say definitely -- quite determined, -- what is it. At best we can talk about its *possible presentations*. These possible presentations can be computationally observed, and their relationship forms the framework characterized by special mathematical properties.

Importantly, the object can show itself in an infinite many ways: it has a variety of forms.

“Computational distance” between the individual forms can be described in terms of “redex-contract” (“redex” means “reducible expression”; contract is understood as a limitation, convolution). On the way to the result a reduction of the object is done in the direction from the redex to contract.

During the implementation of the reduction the object interacts with the environment, “captures” disposed therein other objects that are in its sphere of reach, and these objects are recombined in applicative structure:

$$\| \bar{c} \| env = c$$

In contrast, the way from the result, an object expansion occurs in the direction from object contract to its redex. During the expansion, the object is synthesized as a *combinator*, releasing previously captured objects which are returned to the environment, while remaining within its reach and scope.

Thus, the object is in a state of transition as redex-contract and is a process.

3. Way of thinking the objects

3.1 Traditional way of thinking. Entrenched way of thinking is to transfer the abstract and general mathematical theory on some given specific problem domain. Tacitly assumed that all mathematical concepts and the way they interact are well comprehended, and all explanatory system has great expressive power. So large that the chances are good for embedding substantive applied theory into pure theory, to obtain new results. All this led to artificial systems of explanation.

3.2 Artificial explanation. In developing *object theories* in computer science, which is performed by such a way, the researchers stalked a trap. In fact, the objects once thought of as abstract entities, and strongly linked to the models and explanatory systems prevailing in the discipline of *data structures*.

This resulted in that the artificial computing began to be explained even with more abstraction and artificiality. Trap for the researchers was that the theory of objects were appearing, but were not productive because these theories overgrown cumbersome notations and a lot of complications preventing the perception of details, hence they have not received the development and application, but for these reasons become *intuitively rejected*.

Interest in artificial computing quickly became lost, and the attractiveness of natural computing, by contrast, started to grow rapidly. Return to the “natural”

explanatory systems replaces the culture of formalisms and logical forms of reasoning.

3.3 Natural explanation. An idea to explain the objects and their behavior *naturally* requires the adoption of certain principles. Then, based on these principles, the *explanatory system* is developing. We have to select the central beliefs that will fully characterize the range of the effects, in this case they are computational ones. So, there is one entity -- object, -- and another entity -- environment.

Object interacts with the environment so that the result of evaluation is *placed* in the environment. On the other hand an object in the interaction with the environment receives from environment the values and/or parameters.

4. Computational environment

4.1 Environment representation. The construction of environment should cause quite comfortable feeling: this is the place where the values of the objects are stored.

Hypothetically, the environment is a universe where there are both “deep” and “peripheral” parts. The details of the deep part are timely unknown, but its structure can help generation of a reasonable assumption. Peripheral part, on the contrary, is good “seen” and is known for not only its structure, but also for all of its components. Talking about from where the environment was taken, it could be argued that “at first it was nothing”, but intuition suggests ideas as to imagine this idea of nothing.

The empty environment usually is denoted as a pair of parentheses: ().

4.2 Interaction of an object and environment.

4.2.1 Environment. A thesis, that interaction of objects needs the intermediary -- *environment*, is perceived as obviously. At least, currently it does not attract doubts. More rigorously, to initialize an interaction of objects, the structure is needed where they are localized.

Opposite case -- when some “wandering” objects “meet” other wandering objects, -- is interesting, but this discussion will be postponed for a while. The area of programming gives a case when objects, by some way or otherwise, are already packed by in the environment. Thus a central concept under development is namely the environment which is understood as an environment for computations. Environment is equipped with the programming system, but not vice versa.

Other circumstance is that an object interacts not with all environment at once, but with its partition -- that which will appear “in an area of action” of the object.

4.2.2 Prestructure. An applicative prestructure is used for packing objects. Two aspects of an object -- *redex* (reducible expression) and the *contract*, -- reveal in it. In other words, the prestructure gives a representation of computation both in terms of a reduction -- transition from *redex* to the *contract*, -- and in terms of expansion -- transition from the *contract* to *redex*.

The principle of interaction gives some *non-symmetry*: there is an object-initiator of action and there is an object-recipient of action. Influence of one object on another is stepwise: it is carried out, if and only if objects are located immediately *beside*. The arrangement happens of two kinds: *beside* and not *beside* (distant), and in the second case the objects do not interact. In case of an arrangement *beside*, the objects immediately enter in interaction. The new object, as a result of interaction,

arises and begins its existence -- result of acting, or applying of the first object to the second. Now, if there will be an object located beside thus newly born object, the new act of interaction begins where are two distinct cases.

In the first of them newly generated object captures the existing one, which has appeared beside and acts on it.

In the second case newly generated object is captured by the existing one which affects this object.

In any of these cases the new object arises and begins its existence and this object is considered as a result of such non-symmetrical interaction of two objects-parents. It settles in prestructure on the equal rights with other objects. In particular, this means the following: as soon as the new object-result is generated, it is possible to speak about the new act of interaction.

Thus, the inhabitants of prestructure participate in interaction which evolves by a principle of a dominoe. The following circumstance is important: either there are *initial* atomic objects, or there are *derived* non-atomic objects, each having exactly two ancestors-parents. A question still open: where are the initial objects from, but this discussion will be postponed for a while.

5. Analysis of interaction

The object can be revealed in interaction with other objects if it participates in application. In this case it can show arity, equal to 0 (constant object) or distinct of zero. For simplicity we shall consider a case when the object shows arity, equal to 1 (unary function).

As interaction is carried out through the intermediary -- environment, -- then some metaoperators will be required. For a while, we shall be limited by two metaoperators: Λ -- currying and $\parallel \bullet \parallel$ -- evaluation map.

For any object M we shall check up, whether it can show arity 1 in the environment i . To obtain this we write down

$$\parallel M \parallel i \ d0,$$

which represents a value of object M in the environment i . If value of object M shows arity 1 then there is a construction of value of object in the environment

$$\Lambda \parallel M' \parallel i \ d0,$$

where M' is the same as object M everywhere, except for a variable to which we should assign the value $d0$: instead of this variable, the number of de Bruijn 0 is written as a prototype of a pointer to $d0$ in environment i' . Environment i' is the same as environment i everywhere, except for an image of this substitutional variable, which is now assigned $d0$:

$$\parallel M' \parallel [i, d0].$$

Actually, it was necessary to create a compound metaoperator

$$\Lambda \parallel \bullet \parallel \bullet : \text{object} \times \text{environment} \rightarrow \text{value},$$

which is object generating, setting up the function of arity 1. Really,

$$\Lambda \parallel M' \parallel i \ d0 = \parallel M' \parallel [i, d0],$$

where $[i, d0] \equiv i'$.

For example, if M is an identity transformation \mathbf{I} with the characteristic $\mathbf{I} d0 = d0$ then it is sufficient to assume, that M' is a substitutional variable which is assigned the value $d0$ in environment i :

$$\begin{aligned} \parallel \mathbf{I} \parallel i & \quad \Lambda \parallel \mathbf{0} \parallel i d0 \\ d0 & \\ \parallel \mathbf{0} \parallel [i, d0], & \text{ where } [i, \\ d0] \equiv i' & \\ \text{Snd } [i, d0] = d0, & \end{aligned}$$

as was expected. Here $\Lambda \parallel \mathbf{0} \parallel i$ is an image of object \mathbf{I} , obtained as a result of its interaction with environment. This should be simply a pointer Snd to $d0$, located in the modified environment.

Other example. If M is a cancellator \mathbf{K} with the characteristic $\mathbf{K} d1 d0 = d1$ then it is sufficient to assume, that M' is a substitutional variable which is assigned the value $d1$ in environment i :

$$\begin{aligned} \parallel \mathbf{K} \parallel i & \quad \Lambda (\Lambda \parallel \mathbf{1} \parallel) i d1 d0 \\ d1 d0 & \\ \Lambda \parallel \mathbf{1} \parallel [i, d1] d0, & \text{ where } [i, d1] \equiv i' \\ \parallel \mathbf{1} \parallel [[i, d1], d0], & \text{ where } [[i, d1], d0] \\ \equiv i'' & \\ (\text{Snd} \circ \text{Fst}) i'' & \\ \text{Snd } i' = d1, & \end{aligned}$$

as corresponds to the characteristic.

And one more example. If M is the allocator \mathbf{S} with the characteristic $\mathbf{S} d2 d1 d0 = d2 d0 (d1 d0)$,

then

$$\begin{aligned} \parallel \mathbf{S} \parallel i d2 & \quad \Lambda (\Lambda (\Lambda \parallel \mathbf{2} \mathbf{0} (\mathbf{1} \mathbf{0}) \parallel)) i d2 d1 d0 \\ d1 d0 & \\ \Lambda (\Lambda \parallel \mathbf{2} \mathbf{0} (\mathbf{1} \mathbf{0}) \parallel) [i, d2] \} & d1 d0, \text{ where } [i, d2] \equiv i' \\ \Lambda \parallel \mathbf{2} \mathbf{0} (\mathbf{1} \mathbf{0}) [[i, d2], d1] & d0, \text{ where } [[i, d2], d1] \equiv i'' \\ \parallel \mathbf{2} \mathbf{0} (\mathbf{1} \mathbf{0}) \parallel [[[i, d2], d1], & d0], \text{ where } [[[i, d2], d1], d0] \\ \equiv i''' & \\ \parallel \mathbf{2} \parallel i''' (\parallel \mathbf{0} \parallel i''') & (\mathbf{1} \parallel i''' (\parallel \mathbf{0} \parallel i''')) \\ \text{Snd} \circ \text{Fst} \circ \text{Fst } i''' & (\text{Snd } i''') (\text{Snd} \circ \text{Fst } i''' (\text{Snd } i''')) \\ \text{Snd} \circ \text{Fst } i'' d0 & (\text{Snd } i'' d0) \\ \text{Snd } i' d0 (d1 d0) & = d2 d0 (d1 d0), \end{aligned}$$

as was expected.

6. Related works

An idea to drop down the computations into self-contained blocks with “nameless dummies” instead of variable was formulated by N. de Bruijn [1, 2] in 1970s. This early formalism appeared rather fruitful to solve distinct and complicated text representation tasks. This approach is known for researchers in theoretical computer science but is not used in modern information technologies (IT). Nevertheless, the related but much earlier ideas of M. Schoenfinkel [3] which were rediscovered by H. Curry [4] are successfully used in many branches of computer

science and programming. This approach is known as a *combinatory logic* giving rise to applicative computational systems. But the “natural manner” of computations with *combinators* using then as “wandering” objects was, in fact, not used in modern IT. The natural computations using applicative computational systems were used at the basis of “computational invariants”, formulated by V. Wolfengagen [5]. Earlier the idea to use combinators for composing Web-services was used by L. Cardelli et. al [6] but not became widely used in Web science and its applications. The new challenges of using computations with objects were analyzed by H. Barendregt et. al [7], G. Bell et. al [8] and others [9,10] but in relation with applicative computations.

The proposal here is based on the direct use of de Bruijn formalism in connection with combinatory logic to study the main computational effects which are promising in applying the models of natural computations [11, 12]. First, this is a study of object interaction and, second, the study of interaction of object with environment. The generality is in assumption that the environment can be assumed as an object as well. This assumption is distinctive from assumptions in use in area of programming language semantics.

A kind of natural computations was used by B. J. MacLennan [13] in conjunction with the information tasks of a molecular synthesis. At last, the general direction to assume computing as a natural science was argued by P. Denning [14].

7. Conclusion and future work

A computational model of natural computations is proposed. It is analyzed from a standpoint of object interaction.

1. A layered structure of computational environment is proposed describing the computational activity of the objects. The simplified assumptions as can be shown lead to a standard semantic model for programming languages. Less standard standpoint is argued to subdivide the environment into “deep” and “peripheral” parts. This gives rise to the natural computations model.

2. Studying the properties of this model shows that it can be represented in a step by step manner which can serve to developing a computational framework for object evaluation.

3. The proposed computational model can be used to discover and verify the various “computational invariants”. As was shown the invariants are relative to the computational environment which has a layered structure.

This model can be embedded into host computational model based on applicative pre-structure. The simplicity, flexibility and generality of this model are believed to be useful for semantic and computational analysis of Big Data discovering and using the computational invariants. The basic invariants can be chosen the same as the combinatory basis. The practically sound invariants can be derived using the applicative prestructure at the first stage and applicative structure at the stage of validation.

This work is a generalization of the results, which are associated with the construction of conceptual and computational model obtained at different times during the projects, partially supported by RBRF grants 14-07-00119-a, 12-07-00661-a, 14-07-00072-a, 12 -07-00646-a, 13-07-00716-a, 12-07-00554-a, 14-07-00054-a. This research is partially supported by RScF grant 14-11-00816.

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**CALCULATION AND CONSTRUCTION OF DESCRIPTIONS OF
HALF-TONE FOR SQUARE ELEMENT***Ukrainian academy of printing
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Abstract. Certainly and family of descriptions of halftones, given by the relative area of raster element is built, depending on the change of him geometrical sizes for the element of square form and their properties are analysed.

Key words: MATLAB Program, halftone, tone value, dot shape.

RIP - the process of converting tonal images in a discrete two-dimensional array of screen elements given shape, such as square, round, rhombic, etc. Such spatial sampling used in printing to convert pictorial information into a form suitable for reproduction its way to print of avtotypiya. In screening image is similar to the theory of signal is called amplitude- or frequency- modulated, information about the nuances of the original tone is set by the relative area of the screen elements [2,5]. To form a raster patterns used tools and techniques are based on information technology [1,5,6]. When the amplitude- modulated screening printing and blank items within the unit cell concentrated in certain areas, and in the frequency- modulated - they are split into relatively small elements of equal size, placed randomly with a certain frequency, which depends on the key areas of the image. Later appeared various hybrid combination of amplitude-frequency grid. The bright colors and shades are similar to the frequency raster, and the secondary colors - to the amplitude [3,5,7].

Initially, experts believed that the frequency screens become widespread application in color printing, because they have no moire phenomenon and outlets. However, it turned out that because when copying and printing dot gain screen elements in a raster frequency is too large and that the worst is uncontrollable, the quality of reproduction is lower compared with the traditional grid. In addition, the frequency screening is even different specific defects that were not in the traditional raster [2], which also leads to a limitation of their application. In the literature of prepress processes mainly analyzes the physical properties of the screening process and the results of experimental studies. Only in some publications presented a simplified mathematical model of screening on stage of preparing images for printing and making halftone printing plates [1, 5, 8]. There is a significant gap in the level of mathematical description of the process of screening in the printing industry, compared with the theory of digital image processing, which are used in computer graphics because most mathematical models, methods and algorithms for here is discrete-continuous rather than no analogy in nature. The relevance of this study is justified by the fact that the printing industry for research tone reproduction mainly

used experimental methods, which are based on the basis of various tests [1,7], which are not designed to find the optimal characteristics of the screening program and its implementation or physical. Conducted in the theoretical study of family characteristics make it possible to establish screening performance during graduation dependence of the main parameters of the process and make the necessary practical conclusions. Purpose - to build a mathematical model of screening for parameter set square screen elements on which to analyze the characteristics of family screening, filed dependence of the relative surface area of the square unit cell (the result obtained) from the geometric size of screen elements (control action).

To construct a mathematical model of screening adopt the following assumptions:

- raster element has the shape of a square, whose centre coincides with the centre of the unit cell;
- control action (input variable) is provided by changing the geometric size of the bitmap element;
- output variable - relative coverage area of the unit cell;
- relative variables - technological impacts of various actions.

Scheme geometry screening is shown in (Fig.1)

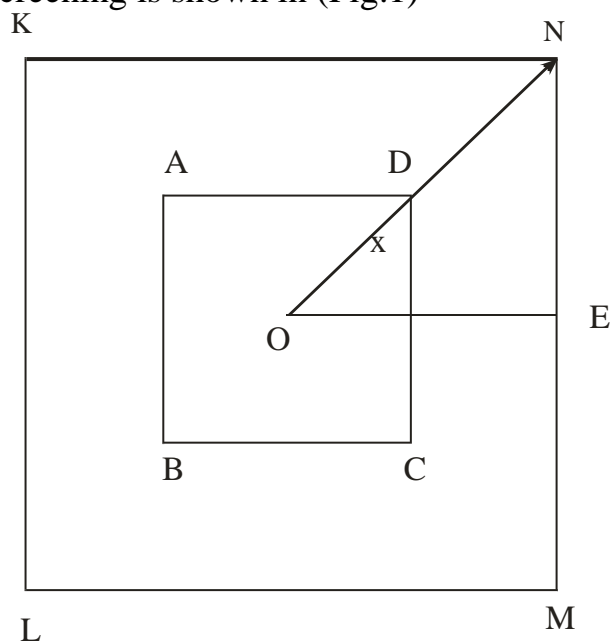


Fig. 1. Scheme geometry screening

In Fig. 1: Square KLMN - raster unit cell whose dimensions are determined by its screens; square ABCD - raster element whose center is located in the center of the unit cell of the raster (point A). The control input or independent variable screening describes the geometric size of screen elements x , for ease of comparison with other types of payments bitmap, expressed in terms of half the diagonal of a square raster element. By increasing the density of the lightest to the darkest parts of the original screening this parameter increases from zero to ON and is the size of the whole square unit cell of the raster. Under the scheme of Figure 1 square area of the screen elements depending on its size is expressed by the formula

$$S_a = 2x^2 \quad \text{for } 0 \leq x \leq \frac{\sqrt{2}a}{2}, \quad (1)$$

where x - input variable, a - side of the square unit cell of the raster (segment KN), is:

$$KN = a = \frac{1}{L}, \quad (2)$$

where L - screen frequency.

Relative area coverage raster cell is determined by the ratio of the absolute area of screen elements to the area of the unit cell

$$S = \frac{S_a}{S_k}. \quad (3)$$

Substituting the values of S_a formula (1) and given that

$$S_k = \frac{1}{L^2}, \quad (4)$$

we obtain an expression of mathematical model of screening for square screen elements:

$$S = 2x^2 L^2 \quad (5)$$

In Formulas relative area of the square raster element in terms of the screen frequency and the geometric dimensions of the raster element, which is the independent variable, namely the control action.

If the expression (5) change linearly independent spatial variable x in the given range, then this is just to calculate and construct the characteristic screening. To simplify the construction characteristics of screening used object-oriented programming in the popular package Simulink [4]. In accordance with the principles of modeling, based on results from the above formulas developed block diagram of the simulation model of the process of screening a library of functional blocks Simulink, which is shown in Figure 2.

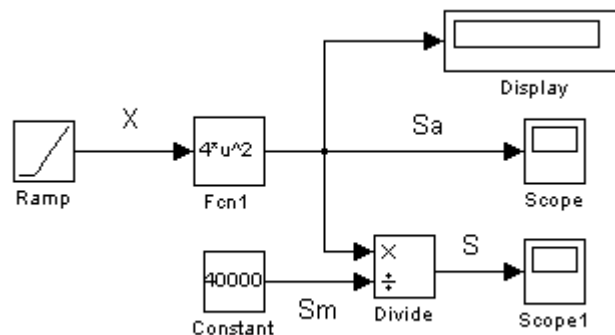


Fig.2. Block diagram of the simulation model an object-oriented programming in a package in Simulink

Basically, the base unit of mathematical functions Fcn, particularly in its dialog box, write the expression (5) to calculate the relative area of the screen elements. Managing the impact creates a block Ramp, which generates a linearly growing geometric dimensions within specified limits, for example, $[0 - \frac{L\sqrt{2}}{2}]$ and presents

them to the output unit Fcn. The results of calculations are visualized and block Skope Display in graphs screening performance.

The main goal was to build a simulation modeling characteristics screening and analysis of its properties. For example, have adopted the screen frequency $L = 50$ lines / cm. Determined necessary geometry and established model. The results of simulation modeling in a graph features screening in relative unit area square screen elements are shown in Figure 3.

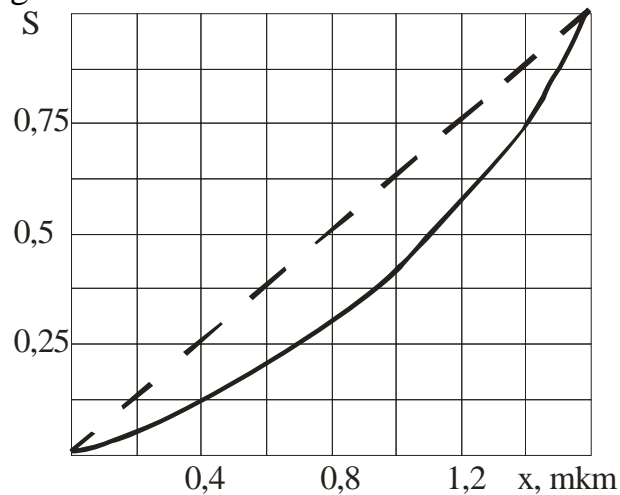


Fig.3. Characteristics of the screening process to screen elements square

For comparison, the figure given dotted linear characteristic screening. Characteristics of screening increases by a quadratic dependence and at a rate $l_0 = 141.4$ microns is the relative area of basic scanning square $S_m = 1$ v.o. The maximum deviation from linear is at $l_0 = 70$ microns and is - 25%.

The results of the next series of simulation modeling characteristics screening in relative units for screens 30, 50, 80 and 100 lines / cm are shown in Fig. 4.

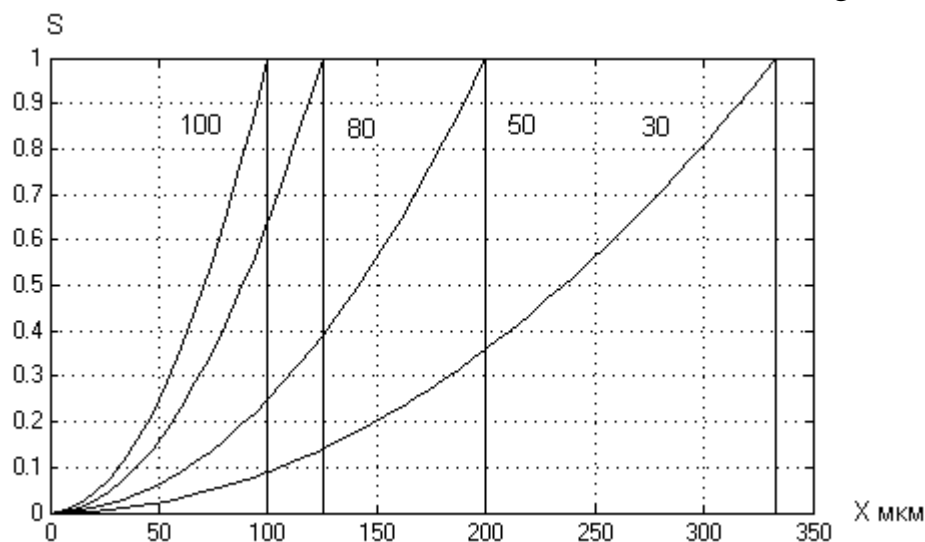


Fig.4. Characteristics of screening process to screen elements with square screens 30, 50, 80 and 100 lines / cm

As can be seen from the figure, the reduction screens results in displacement and tensile properties for the spatial variable. For example, if lineature 100 lines / cm is

placed in the spatial characteristics of the interval [0 - 70.7] mkm, and at lineature 30 lines / cm characteristic expands, becomes less steep and is located in the spatial interval [0 - 235.7] mkm.

Comparing the characteristics of screening conclude that an increase in screens characterization becomes more rapid, therefore sensitivity screening process to different influences and disturbances, such as illumination. Based on the simulation results conclude: the process of screening using the square element is nonlinear, so that screening leads to illumination halftone prints on medium tones penumbra and therefore requires correction, increasing the screens leads to increased sensitivity of the screening process to different influences and actions affects the quality of prints.

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COMPUTER MODELING OF THE LIGHT DEVICES

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Abstract: In this paper we described the problems of light device calculation and design, the principles of the developed software for the light devices automated modeling and design.

Key words: modeling, program, system, light devices, reflector, design.

INTRODUCTION

The research of the problems of light device calculation and design and develop the programs for automated modeling is very important and needed.

Now there are many kinds of light devices (fig.1).



Fig. 1 Kinds of light devices

Light device consists of such elements as light source, optical system, start regulative equipment, constructive nodes (fig.2). Its parameters greatly depend on light device design feature and noticeably influence upon its features as a whole.



Fig. 2 Light device

The problem of light device calculation is to determine a geometric form of optical system elements in order to get a required light distribution. Lighting materials used for optical system element fabrication, and its work conditions must be taken into account. Mirror reflector must provide the required form of light power curve.

MAIN PART

Mathematical modeling of the propagation of radiation based on the probabilistic interpretation of the photometric values.

Problem reduces to finding probability. The mathematical experiment conducted. All radiation emitted by the light source appears finite set of light rays. The trajectory of its motion traced for each ray. The rays are grouped into conical bundles (fig.3).

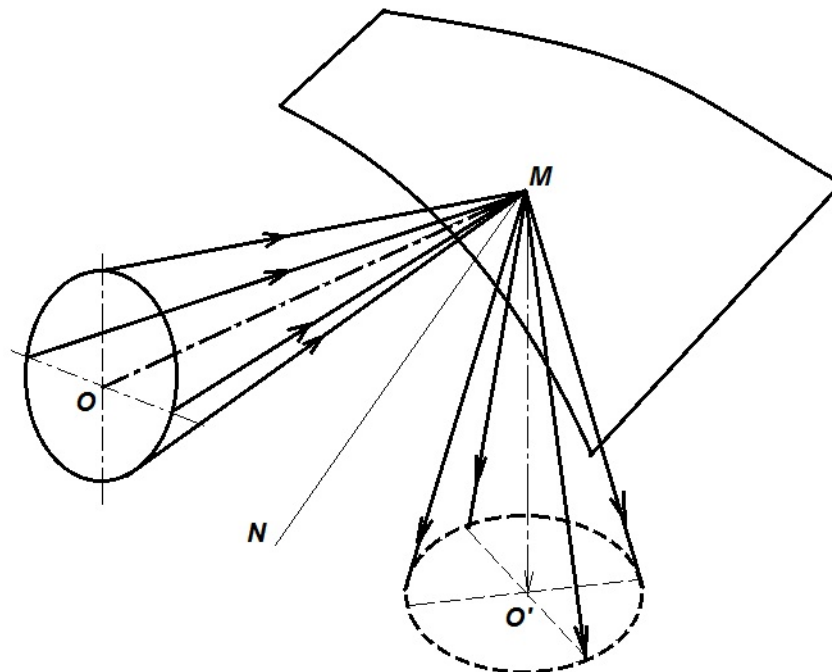


Fig. 3 The grouping rays in conical bundles

The modeling process can be divided into three stages:

1. Generate random rays of IP. Each point is determined by the radius vector ray point outcome, departure from the EC or the reflection from the surface relative to an

arbitrarily chosen basis, the unit vector direction and the weight of the beam.

2. Constructing trajectories of these rays. This step is to determine the sequence of states of the beam, the calculation of the intersection points and the directions of beam reflection from surrounding surfaces.

3. Register rays on the working surface.

The software for automated system is developed in order to carry out such calculations and then design of light device [1-3]. The use of the automated modeling and design system allows:

- to develop the light devices of different constructions for different purposes promptly and effectively;
- to evaluate the technical-economic efficiency of light system;
- to determine the main parameters of light device system and involve it with construction of light device as a whole.

The raw data for the program LighTooLux 1.1 (fig.4-5) is the required light distribution, the light source type, the count and location of the light sources, the material optical factors, the radiation useful angle.

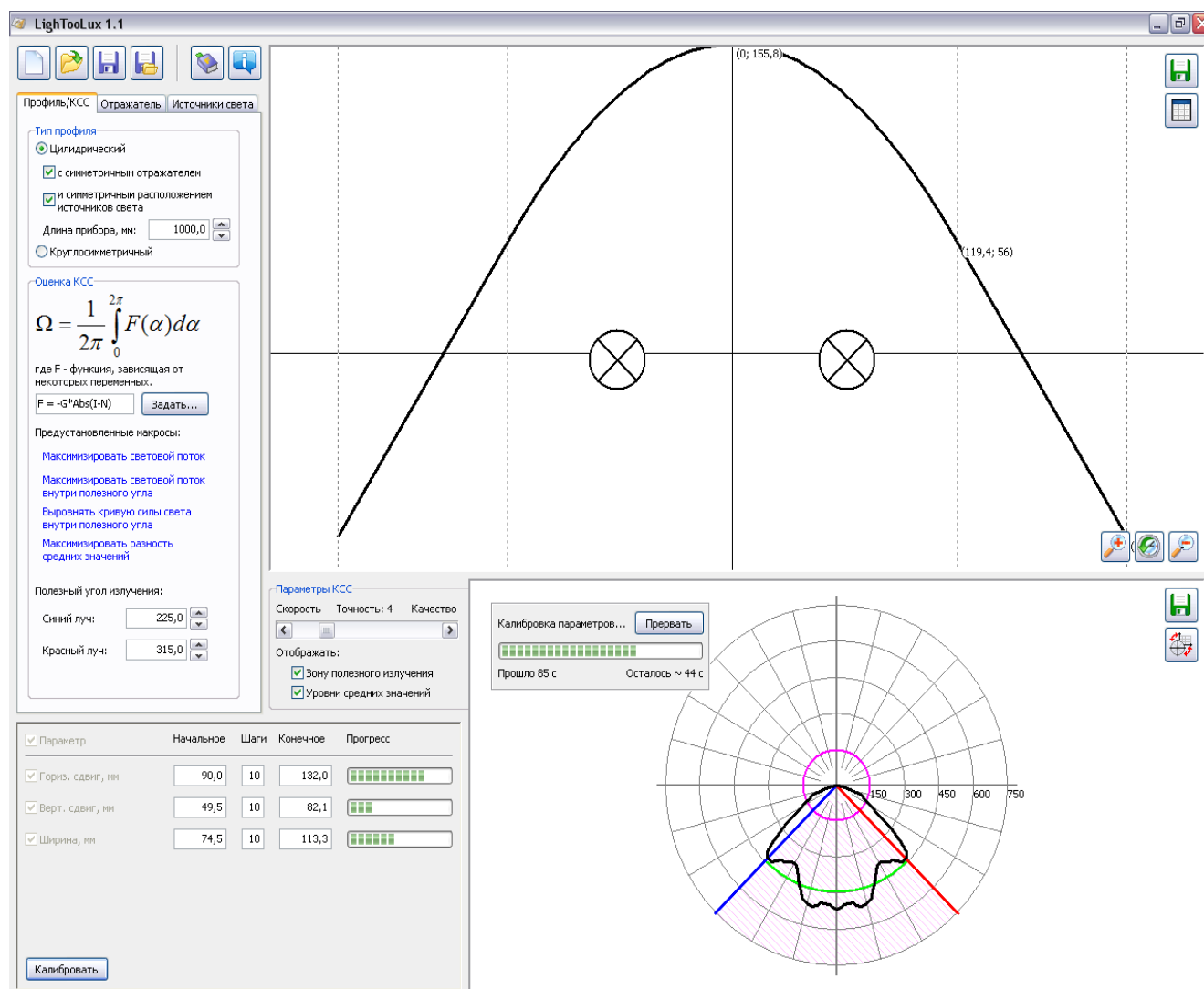


Fig. 4 Work window of program *LighTooLux 1.1*

There are following standard ways of light power curve evaluation in the program:

- 1 light stream maximization;
- 2 light stream maximization inside radiation useful angle;
- 3 light power curve leveling inside radiation useful angle;
- 4 maximization of difference between average light power inside radiation useful angle and average general light power.

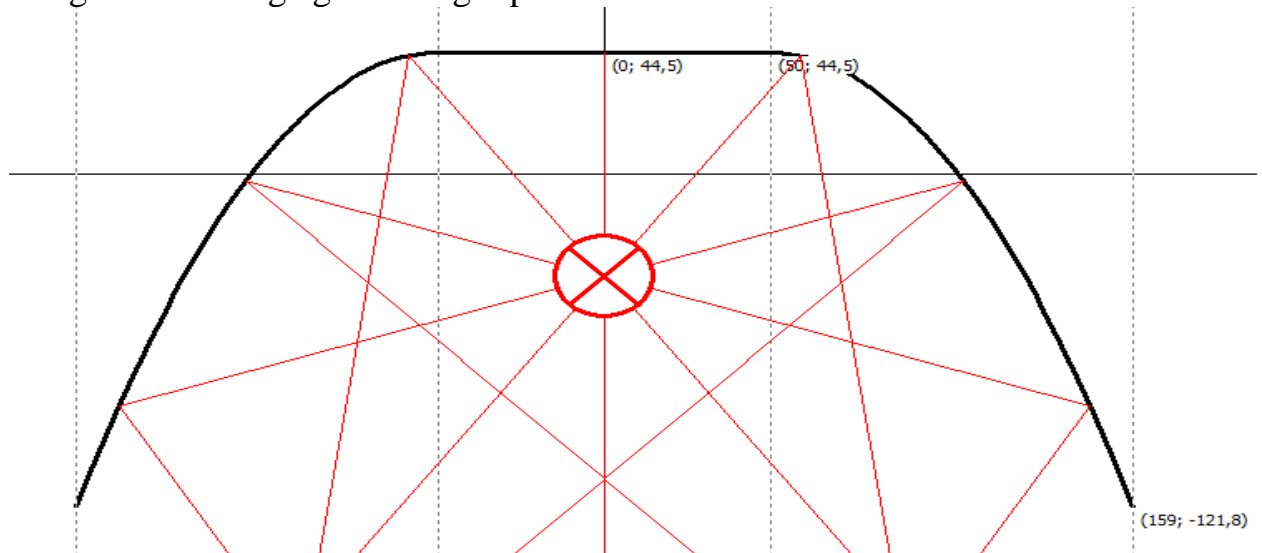


Fig. 5 Example of the reflector

CONCLUSION

To confirm the adequacy of the system were constructed profiles reflectors real light sources and their light intensity curves. They showed a perfect match to the originals. Fig.6 shows the simulated reflector lamp type LSPO 2×58 with respective light intensity curve.

Thus, the developed program LighTooLux 1.1 allows calculating and building the reflector profile as a matter of information about light sources, material reflection factors, light power curve types and other data.

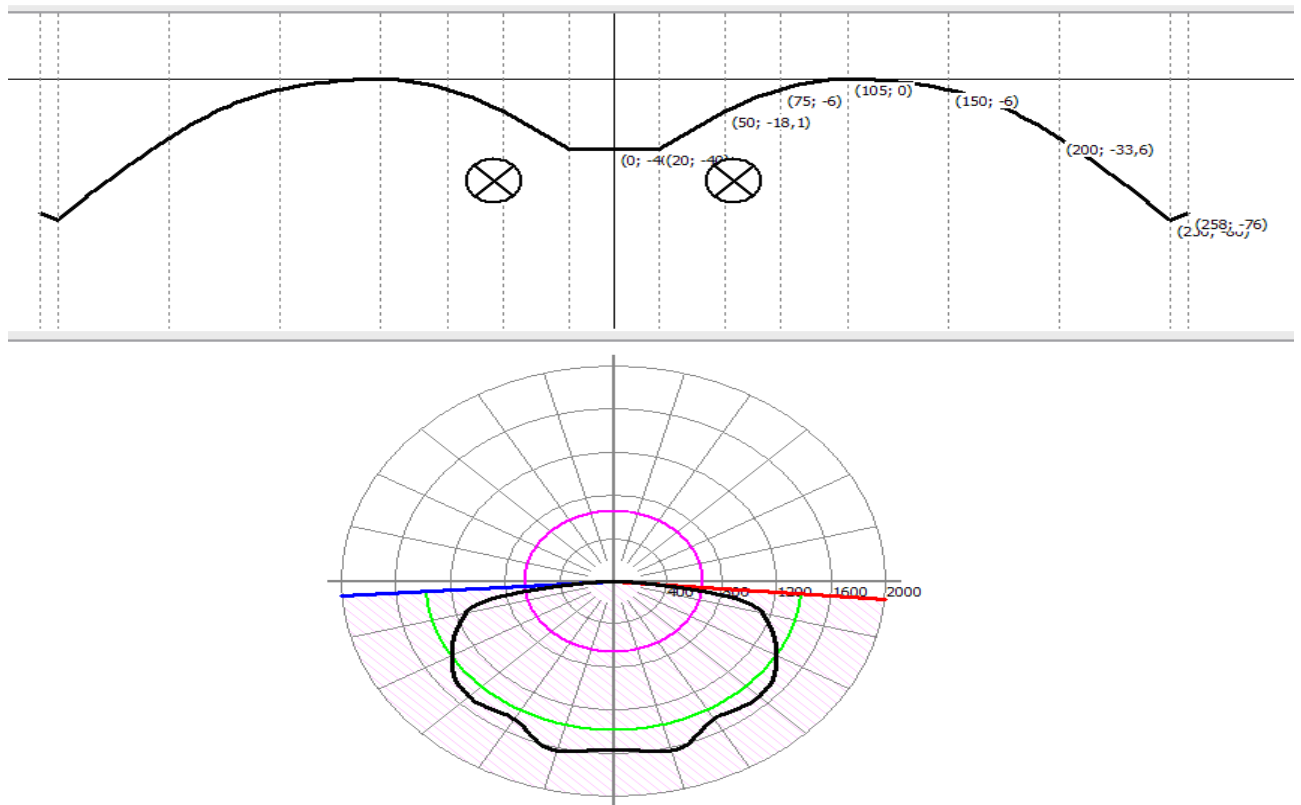


Fig. 6 Reflector lamp type LSPO 2×58 with respective light intensity curve

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J21410-009

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IMITATION MODELING OF CITY LOGISTICS

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Abstract. In this paper it is shown that for constructing an adequate model of city logistics, it is necessary to identify and systematize the main factors for functional areas, which are the basis of the logistical passport of the city.

Key words: logistics, city logistics, imitation modeling, logistic factors.

A city is the center of consumption of commodities, distribution, and also productive center. This activity is straight related to transporting of loads. As far as development of a transport infrastructure, her negative influence grows on the vital functions of city : corks on roads, contamination of environment, consumption of energy and many other fallouts. Complex approach allowing to increase management efficiency transport streams, here, diminishing negative consequences, offers new direction is Logistic of city. In many countries this direction develops quickly, is used in a municipal environment, in particular in a communal sphere. In addition, application of approaches and methods of Logistic of city, favourably affects on the economy of region on the whole, and similarly promotes the competitiveness of city. Work in area of Logistic of city offer the solutions, related to the public infrastructure, land-tenure, management by a transport and transportations, ecology of region. The value of Logistic of city increases in metropolises, with the high-slay

of population, developed industry and industry, where the amount of the personal, public and freight transport grows rapid rates.

The logistic systems function in the conditions of vagueness of environment. In such cases a study and development of prognoses of socio-economic parameters of municipal educations are a desirable factor. [1]. At a management factors must be taken into account material streams, many of that carry casual character. In these terms creation of analytical model setting clear quantitative betweenness by the different constituents of logistic processes can appear either impossible or too expensive.

The logistic uses for an analysis the wide spectrum of methods from different areas: methods of mathematical statistics, theory of casual processes, simulation, game theory techniques, theories of the graphs et cetera. Programmatic realizing a simulation model is possible, both in the math processor of MS Excel and in the dedicated systems:

- for a discrete design are the systems based on description of processes or on network концептах, – Extend, Arena, ProModel, Witness, Taylor, Gpss/H-Proof и так далее;

- for the systems oriented to the continuous simulation - models and methods of system dynamics, – Powersim, Vensim, Dynamo, Stella, Ithink et cetera.

In many works for research of the difficult systems take approach imitation design. Basic dignities of imitation design it is been: possibility exactly enough to describe the designed process, flexibly to vary structure, algorithm and parameters of the system, to use modern computers, what duration of experiments, and also model cost, allows to shorten. Кроме того, имитационные модели наглядны для использования и анализа полученных результатов не профильными специалистами.

However, analysing the systems of imitation design (Simullink на базе Matlab, VenSim, VisSim, Dynamo, Имитак, GPSS, GASP, Экомод на базе Maple, Salm (в т.ч. Visual Slam), SimScript, SDX, SimWalk, AnyLogic, Powersim, Ithink, Экспресс-Радиус, Когнитрон, Arena) it be possible to say, that the imitation systems become more application-oriented. In the systems inculcate the specialized sets of concepts and elements from a certain subject domain. As a result the software products oriented to the design of the technical systems, it is difficult to apply to the specialists of economic profile and vice versa.

An imitation design is plugged in itself by two basic processes: first - constructing of model of the real system second is raising of experiments on this model. Thus next aims can be pursued: а) to understand behavior of the logistic system; б) to choose strategy, providing the most effective functioning of the logistic system.

An imitation design is effectively used in next cases:

1. There is not the complete mathematical raising of the decided task, or the analytical methods of decision of the set forth mathematical model are not yet worked out.

2. Analytical models are present, but procedures are so difficult and labour intensive, that an imitation design gives more simple method of decision of task.

3. Analytical decisions exist, but their realization is not possible because of insufficient mathematical preparation of present personnel.

However it is necessary to take into account that at the construction of model a deep and detailed analysis is required, because processes in the logistic systems carry probabilistic character and yield to the design only at introduction of certain sort of assumptions.

Imitation a design well showed oneself in many scientific directions. So in-process [2] it is shown that in areas related to the enhanceable danger, or with heavy tolls resources the use of computer models is practiced a long ago. As it applies to such intricate and multivariable problem, as logistic of city, the use of imitation design is a necessity [3].

In logistic distinguish next functional areas: purchase logistic; productive logistic; distributive logistic; transport logistic; logistic of supplies; warehousing logistic; logistic of service; informative logistic and it is separately possible to distinguish financial streams (at administrative level), as responsible for realization of many directions of regional logistic. A financial stream in logistic is understood as the directed motion of financial means circulatory into the logistic system, between the logistic system and environment, necessary for providing of effective motion of certain material stream. Financial streams serve a material stream.

For each of the brought functional areas over factors allowing to estimate efficiency of functioning of this direction are distinguished.

- Purchase logistic: volumes of material expenses, amount of unfulfilled agreements on delivery, expenses on deliveries, amount of suppliers, volumes of deliveries, coefficient of reliability of suppliers, coefficient of material well-being by material resources, periodicity of deliveries.

- Productive logistic: volume of material and labour resources, coefficient of implementation of production plan, level of rhythm of production, level of loading of equipment, resource-demanding, фондоемкость, labour productivity, volume of the produced products, volume of recurrent wastes, duration of operating cycle.

- Logistic of supplies : volumes of productive supplies, uncompleted production volumes, coefficient of turnover of supplies of products.

- Warehousing Logistic: volume of the prepared products on storage, shelf-life on storage, expenses on warehousing, storage facilities.

- Distributive logistic: expenses on a sale, level of reliability of delivery, amount of returns, common amount of orders, evenness of deliveries, specific gravity of market of products, profit yield from realization, profitability of sales, coefficient of increase of production distribution, volume of unfulfilled deliveries.

- Informative logistic: amount of sources of origin and consumption of information, speed of circulation of documents, level of dataware, quality of informative service.

- Transport logistic: volume of transport transportations, amount of transport vehicles on kinds, general volume of transport expenses, remoteness of transport routes, volumes of expenses on transporting.

•The Financial streams (administrative) : regional acuestss, regional charges, deficit, account payable on beginning of year, трансферты, municipal debt.

This set of factors it can draw on for forming of logistic passport of region.

The design of financial streams of Logistic of city it is suggested to carry out the module responsible for execution of local budgets. Such model was worked out and in 2010 a copyright certificate is got about registration of software product [4]. A model is based on two constrained algorithms. The first algorithm is used for a management by execution of profitable part of budget. Second - is used for a management execution by expense part of budget. This model, execution of local budget (on every municipal district, municipal district, in the cut of municipal districts - on settlements) allows to imitate, and also system of execution of local budgets of the Volgograd area, exposing a dynamics and size of all receivables and charges of budget, taking into account basic factors and intercommunications, influencing on the process of execution of budget [5].

For an industrial city with the developed industrial complex in that the far of large and shallow basely-ware-house, communal enterprises is situated the Logistic of city is not only desirable, and by necessary direction of development. Practical meaningfulness of simulation models allowing, it is difficult to over-estimate. Study of factors necessary for creation of simulation model of logistic of city continues to remain an actual task for developers.

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J21410-010

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MODELING OF HUMAN BEHAVIOR IN EMERGENCIES

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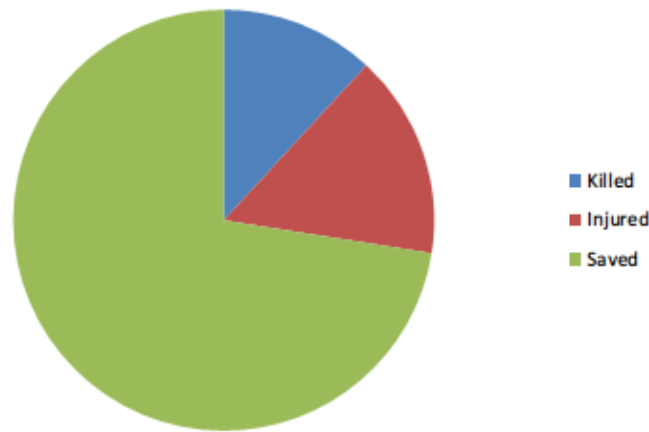
Abstract. In this paper we describe the using of Weka for extracting hidden rules and patterns in the collected statistics of emergencies in the Arkhangelsk region. Decision trees, built by means of methods J48 and Random tree, were used to find out hidden rules, which are very important for developing a mathematical model.

Key words: modeling, human behavior, Weka, statistics, emergencies, fires, analyzing, mathematical model, data mining, psychology, decision trees.

Introduction

Emergency is a situation in a certain territory, established as a result of accidents, natural hazards, disasters that may cause or have caused human casualties, damage to human health or the environment, considerable material costs.

More than 5, 5 thousand fires occurred in the Arkhangelsk region from 2011 to 2013, as a result 343 people were killed and 453 people were injured. So, we need constant and widespread activities aimed at protecting the population and territories of Russia.



Picture 1 – Statistics of people in emergencies in the Arkhangelsk region (2011-2013)

One way to prevent accidents is to develop a mathematical model. A mathematical model is a representation of the realities belonging to physical life with a number of meaningful symbols. Mathematical modeling is the process during which we try to mathematically define a nonmathematical situation, phenomenon and the relationships between the situations, and find out mathematical patterns within these situations and phenomena. So, our mathematical model must reconstruct and analyze the best route, which allows people to get out of the risk area for the least time span [4].

Phases of mathematical modeling.

If we want to develop this mathematical model we should solve following tasks:

1. to collect statistics on emergencies in the Arkhangelsk region for the period from 2011 to 2013, analyze the causes and sources of emergency, to assess the consequences;
2. to analyze human behavior under threat, choose the parameters to determine patterns of behavior of simulated objects;
3. to study manuals and technical literature on the human behavior in emergencies;
4. to find and analyze expert judgments about the level of technical safety in building of a mass congestion of people in the Arkhangelsk region, make conclusions;
5. to make a description of the emergency, which will be the base for the simulation model;
6. to make the formalization of the model;
7. to develop the mathematical model;
8. to explore its characteristics;
9. to identify the parameters of the model and make its verification;
10. to create a software program, which includes virtual models of space and allows you to simulate the situation of an accident and find the shortest and safest way out of the building.

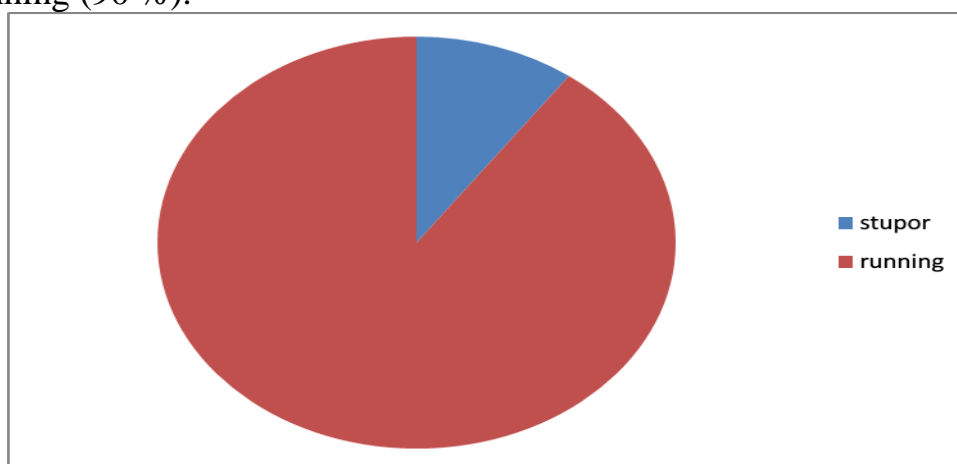
Modeling human behavior is a new area of mathematical modeling. When we develop a mathematical model, which describes situations with people, we can face

the challenge - a complete mathematical description of the behavior of a single person is not possible, because many rational and irrational influence on his actions [3].

However, the behavior of a large group of people in a standard situation can be easily predicted and is well described by probabilistic pattern. According to the law of averages, even if one person takes nontrivial actions, it won't influence on group actions.

Individual and collective human behavior in emergency situations is largely determined by the fear caused by the awareness of the danger. There are two common forms of panic attacks:

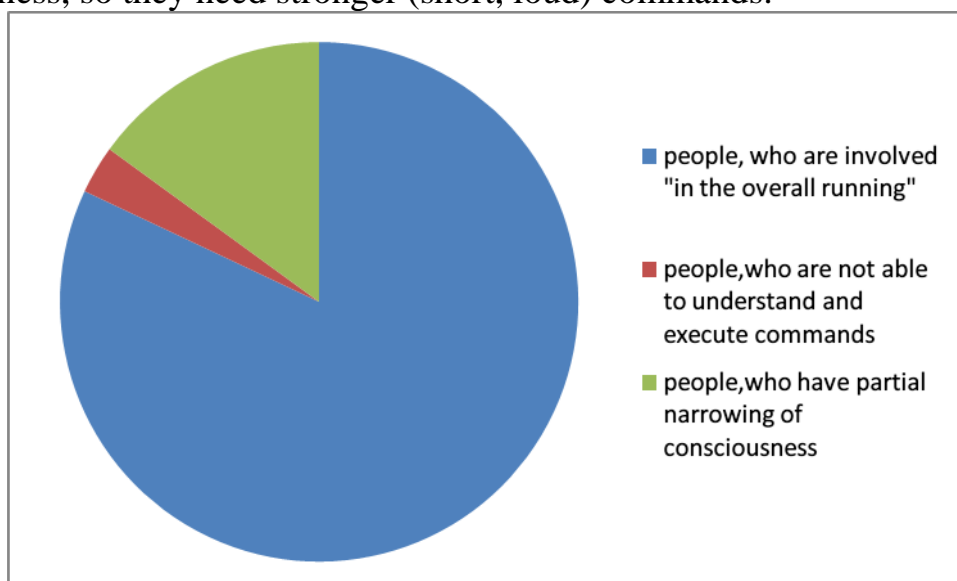
- Stupor (10 %);
- Running (90 %).



Picture 2 – Correlation of panic attacks

In the first case we can observe relaxation, lethargy actions, total confusion, and complete immobility, when a person is not able to execute the command. Such panic attacks are more common for children, teenagers, women and the elderly. Therefore, during fires they often remain in a room [4].

Studies of the crowd structure show that less than 3% of people are not able to understand and execute commands. From 10 to 20% of people have partial narrowing of consciousness, so they need stronger (short, loud) commands.



Picture 3 – Human behavior in emergencies

The bulk (90%) represents the involved "in the overall running" people who are able to sum up the situation and execute rational actions, but they are also afraid and they create adverse conditions for an organized evacuation.

It is very difficult to realize simulation of a real emergency situation that can check efficiency of evacuation plans. It also requires significant material costs. Therefore, there is a task to create the easiest and most detailed way that can imitate emergency situations. From this standpoint, mathematical model of human behavior in emergencies satisfies all conditions and is the best decision of this task.

We have collected statistics on fires in the Arkhangelsk region for the period from 2011 to 2013. Received data were analyzed by means of Data Mining.

Data Mining is the set of intelligent analysis of data. Its main feature is to find out hidden rules and patterns. The person is not able to find more than three patterns even in small samples. Methods of Data Mining allow to find out "hidden knowledge" in large databases [1].

We use Weka to find out hidden rules and patterns in the collected statistics.

Weka is the set of visualization means and algorithms used for data analysis [7]. Weka includes means for pre-treatment of data, classification, regression, clustering, selection of signs and visualization. If we want to create new approaches in machine training we can also use Weka.

Decision trees

Decision tree is an algorithm of analysis which defines a step-by-step way of making a decision which depends on the values of particular parameters. Each node is a point of making a decision which depends on the values of parameters. Transitions between nodes are also made according to particular values of parameters [2].

Algorithm J48

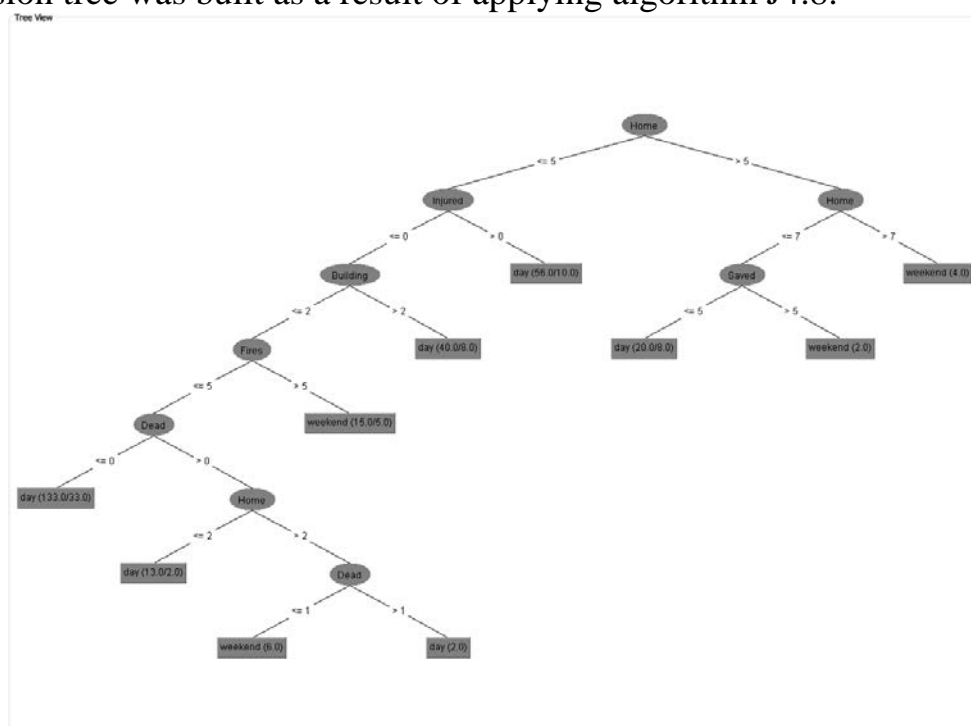
Algorithm J48 builds decisions trees which nodes have unlimited amount of branches. This algorithm can work only with discrete dependent attributes, so it can solve only classification tasks. Algorithm works both with nominal and numerical variables. Missing data do not prevent the work of algorithm, because it is supposed that missing data are distributed proportionally to frequency of occurrence of existing values [6].

If the received tree is too great, then J48 executes the grouping of a few nodes or replace a tree node by a lying below sub tree.

We have analyzed fire statistics from 2011 to 2013 to reveal hidden patterns. The information was analyzed and structured in the form of a table that includes:

- number of fires per day;
- number saved people per day;
- number of deaths per day;
- number of injured people per day;
- type of fire: fire in the business or residential sector;
- day: weekend or weekday.

A decision tree was built as a result of applying algorithm J4.8.



Picture 4 – A decision tree built as a result of applying algorithm J4.8

If the number of fires in the residential sector lies in the interval (0, 5) and the number of fires in the industrial sector lies in the interval (0, 2] there will be dead people (probability – 77.32 %). If the number of fires in the residential sector lies in the interval (5, 7], more than 5 people will be saved. More than 7 fires can occur at the weekend. On weekdays if the number of fires in the residential sector is less than 5 there will be injured people. On weekdays if the number of fires in the residential sector is less than 5 and the number of fires in the industrial sector is more than 2 there won't be injured people.

Table 1

Algorithm J48

Day	Residential sector	Industrial sector	Injured people	Dead people	Saved people	Fires
weekend	Less than 5	From 0 to 2	0			More than 5
	Less than 5	From 0 to 2	0	More than 0		From 0 to 5
	Less than 5	From 0 to 2	0	0		From 0 to 5
	From 0 to 2	From 0 to 2	0	More than 0		From 0 to 5
	From 2 to 5	From 0 to 2	0	From 0 to 1		From 0 to 5
	From 5 to 7				More than 5	
	More than 7					

weekday	Less than 5		More than 0			
	From 2 to 5	From 0 to 2	0	More than 1		From 0 to 5
	Less than 5	More than 2	0			
	From 5 to 7				Less than 5	

Conclusion

Data analysis is playing an important role for the construction of a simulation model. If we have a large set of statistics it can find out certain patterns. Due to these patterns we can get rules that characterize manifold data types. They can help us to build up an effective mathematical simulation model.

More than half a century scientists and researchers solve the problem of detection of implicit patterns in the human behavior in emergencies, which occur in enclosed spaces, but before the beginning of the XXI century the majority of their works had only theoretical significance.

Today we can understand the practical importance of solving these problems, since understanding of reasonable practicality of introducing new technologies precedes a long process of creation a system that will prevent future emergencies, and justification of its usefulness.

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REALISATION OF COLLISION DETECTION

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Abstract. In this paper we describe different ways of collision detection. Also we examine mathematical realization of collision detection between two spheres.

Key words: collision detection, formulas, realization

There is a huge amount of different collisions in games. Almost all games have collisions: car wheels contact the ground, cars hit each other or ball bounces the floor. Collisions are so common that when you are thinking about programming it you decide that it is easy and ordinary task. And when it comes to realization a lot of problems such as shortage of processing power appear. So I'd like to talk about how it works in games.

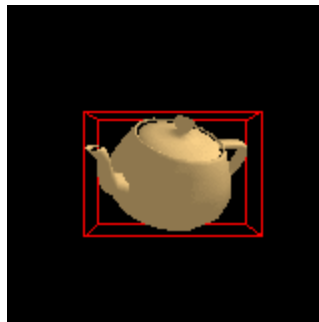
The main motto of the collisions in games is "simplify". Modern models of cars, plains and other are complicated and have enormous amount of polygons. If we are going to check the collisions of every polygon in our game we should provide all players of our product with supercomputers. According to this we will simplify our models to easy shapes such as spheres and parallelepipeds. There are three easiest methods of simplifying models: bounding sphere and two types of bounding boxes - axis-aligned and oriented.

Bounding sphere is simple, fast and rough method to detect collision.(pic. 1)



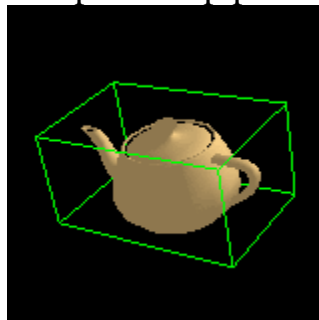
Picture 1. Bounding sphere

When we use axis-aligned bounding box we put our model into the box with axis-aligned sides.(pic. 2)



Picture 2. Axis-aligned bounding box

In oriented bounding box sides of parallelepiped haven't axis align.(pic. 3)



Picture 3. Oriented bounding box

We can surround our model with one bounding box or sphere but it may be too rough for us, so we can just use as many bounding objects as we wish. Although we should remember that we simplify model. Let's examine realization of collision detection between two bounding spheres.

Let's imagine that we are modeling a collision of two balls in two dimensions. Some people would say that it's an easy task and we should only take centers of the balls, find the distance between them and compare it with the sum of its radiuses.(1)

$$(R_1 + R_2)^2 \leq (x_1 - x_2)^2 + (y_1 - y_2)^2 \quad (1)$$

Well, if the balls are slow and big it will work, maybe. To tell the truth, model of two big slow balls collision is so useless in modern world of Hadron Colliders that we should think deeper. Let's imagine that we are modeling the collision of two rapid balls in two dimensions. Honestly, I have used the first solution in my project but when the speed of the balls becomes bigger than its size, they start occasionally teleport through each other without collision. So, the second solution was powered by

a brute force with dynamic programming. I took two balls and started to move them by tiny steps counting the distance between them. And it worked until the number of balls was small enough. When it reached a few hundreds, the frame rate decreased. So, our task transforms into the final version: making a model of collisions between large amount of rapid moving balls. It is the moment when we start to think: "There should be a mathematical solution". It exists, of course.

Let's try to find the time of collision. If we know the time of collision, the speed and the starting position, we know the place of collision, don't we? So, let's take a vector equation of position of moving body from physics.(2)

$$\bar{x} = \bar{x}_0 + \bar{v}t + \frac{\bar{a}t^2}{2} \quad (2)$$

To make the task a bit easier let's imagine that the balls have constant velocity and we would check the collisions between all pairs of our balls so we remove acceleration from this equation(2) and duplicate it for the second ball.

$$\begin{cases} \bar{x} = \bar{x}_0 + \bar{v}_x t \\ \bar{y} = \bar{y}_0 + \bar{v}_y t \end{cases} \quad (3)$$

Now we have two equations and three unknown variables. As everybody knows if we want to solve the system of equations we need as many equations as unknown variables. So we have missed the radiuses of balls. Now we have all what we need to find the time of collision.(4)

$$\begin{cases} \bar{x} = \bar{x}_0 + \bar{v}_x t \\ \bar{y} = \bar{y}_0 + \bar{v}_y t \\ (R_x + R_y)^2 = (\bar{x} - \bar{y})^2 \end{cases} \quad (4)$$

To sum up we have found a mathematical solution for detection of collision between two balls and now can easily find the time of collision and decide to collide it or not.

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**IMPLEMENTATION OF THE PRINCIPLES OF LMS MOODLE
INTERACTIVE LEARNING TOOLS**

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Abstract. The paper discusses the theoretical aspects of the research opportunities using LMS Moodle to implement the principles of interactive learning in the learning environment.

Keywords: interactive teaching, learning environment, principles of learning, task oriented system LMS Moodle.

Introduction.

Relevance of the topic.

At the present stage the leading factor in the Ukraine education joining the European educational space is the efficient use of global information potential by students. The Law of Ukraine “On the Concept of National Informatization Program” [8] designates the need to prepare young people studying to perceive constantly growing information flow and for self-education. If earlier students learning activities carried out directly in the process of classes, lectures and workshops, in libraries, at home, and the forms and boundaries of such work were quite blurred, with the advent of distance learning management systems, such as LMS Moodle (Modular Object-oriented Dynamic Learning Environment), organization of interactive learning indirectly by means of distance learning technologies becomes possible.

Accordingly, there is the problem of finding the optimal form of active learning activities in the LMS Moodle learning environment, aimed at building students creative abilities, the combination of their personal, social and professional development, and therefore the nature of the content and forms of educational interaction – different levels of interactivity: communication with computers, but not the people; user – document; user – user.

The practical aspects of the use of ICT and Internet technologies in education is considered by many domestic and foreign scholars. Scientific works in the field of psychological, educational, social and philosophical aspects of educational process informatization are widely known (A.O. Verbitsky, B.S. Hershunsky, O.I. Pometun, A.V. Khutorsky), educational use of information technology (M.I. Bashmakov, V.P. Bepalko), identifying the principles of interactive learning and their implementation in the educational environment (A.V. Andreev, I.D. Bekh, O.M. Goldin, E.D. Patarakin, I.P. Podlasyy, A.V. Khutorsky), integration of classroom training and distant forms of learning (A.V. Andreev, A.M. Goldin, V.N. Kukharenko, E.D. Patarakin, E.S. Polat, A.V. Khutorsky and others).

At the same time with the existing practical experience of distance learning technologies application in education, in our opinion, the theoretical base of their use in interactive learning is insufficiently researched.

The purpose of this article is to research of LMS Moodle capabilities in the implementation of the interactive learning principles in an educational environment.

Leading world educational systems use e-Learning as a promising technology, based on active self-education student activity that has information, instrumental, communication resources of Internet to deal effectively with professional tasks in the individual mode and pace with the support of a teacher who serves as an instructor and mentor.

The study of high school practice of using e-learning allows one to select a number of platforms – e-learning systems that have the greatest popularity in Ukraine and abroad: JoomlaLMS, SharePointLMS, QuizForce, WordForce, Avanta, Prometheus, eLearning Server 3000, PT course, LMS Moodle, WebCT, STELLUS, Classroom assessment. The most widespread e-learning system today is LMS Moodle [6]. The interface of LMS Moodle is translated into 82 languages and is used in almost 50 thousand organizations from over 200 countries [11].

LMS Moodle is focused on creating an educational environment that would flock to the various information flows and provides enough features to support communication and collaboration [2]. LMS Moodle toolkit have a rich variety of interactive elements. LMS Moodle let add active elements to a course for students individual work [3]. Educational environment created by the LMS Moodle, allows to carry out various kinds of active educational activity.

As shown by the analysis of scientific-methodological publications and practical experience of the past five years, the most complete solution to the problem of students training activity intensification promotes by LMS Moodle with such didactic qualities like ease of use and accessibility, effectiveness of the information space organization, interactivity and multimedia, reliability and security.

Statement of the material. Development and educational use of innovative learning technologies, including interactive technology based on the principles of creating a comfortable learning environment, creativity, collaboration, use of science and technology acquires the greatest value of modern education. According to a number of researchers (A.O. Verbitskyy, O.I. Pometun, A.V. Khutorskyy) interactive teaching methods focused on active cooperative training activities, communication, interaction of teacher and students. “Interactive” means “capable of interaction” (dialogue) with anything (e.g., a computer) or with someone (human) [16]. Therefore, online learning is first of all dialogue training. Dialogue is also possible with traditional teaching methods, but only on the lines of “teacher – student” or “teacher – a group of students (the audience)”. In interactive learning dialogue also built on the lines of “student – student” (work in pairs), “student – a group of students” (group work), “student – audience” or “group of students – audience” (presentation of group work), “student – computer” or “group of students – computers” (in the Internet).

Most often the term “interactive learning” is mentioned in connection with the information and computer technology, using Internet resources. As shows the analysis of the reputable scholars works (M.I. Bashmakov, V.P. Bepalko, A.O Verbitskyy, B.S. Hershunskeyy, A.I. Pometun, A.V. Khutorskyy etc.), improving the quality of professional training of future specialists in terms of effective development of their individual characteristics is ensured by introduction of modern information and communication technologies in educational process. The main difference of computer from other means of learning is the opportunity for dialogue – not a formal dialogue but interactive dialogue that enhances the student’s active role in their own learning [13]. Increasing requirements of modern education, the development of Internet technology facilitates the creation and development of the learning environment. Increasing requirements of modern learning tools, the development of Internet technology contributes the creation and development of the educational environment.

At Kharkov Institute of Trade and Economics of KNUTE teachers of Department of Mathematics and Computer Science under the research work on “Theoretical and methodological basis of improving the content and technology training in universities of trade and economic profile” decree № 161-0 KITE KNUTE “On the performance scientific research” of February 15, 2013, the theoretical and practical issues of LMS Moodle implementation in the learning process. The theoretical aspects of the interactive learning environment in LMS Moodle is currently working out. Considering this to provide interactivity to the learning process should be based on the following principles: the principle of subjectivity; principle of individual approach; principle of consciousness and activity in education; principle of practical orientation; principle of cooperation; principle of rational combination of collective and individual forms and methods of training activities; principle of open feedback.

Let’s consider their implementation on the example of remote interactive training course “Information systems and technologies in food production” developed by the teachers of Department of Mathematics and Computer Science, which functions on the basis of LMS Moodle [17].

Distance course “Information Systems and Technology in Food Production” includes training tools created with the resources and interactive elements of LMS Moodle, which allows to organize interactive activities for students and teachers. This course provides a variety of activities: information (provision of educational material); practice (working with educational material); communication (discussion of educational material, implementation of cooperative training activities, advice); estimating (control of individual and cooperative activities). This creates a learning environment in which modern information and computer technology are necessary means of active cognitive activity of the student, first and reliable assistant in solving educational and professional objectives – storing, organizing information, registration records, information and organization of cooperative academic collaboration.

In our opinion the LMS Moodle provides the user to create a learning environment that is the better, the more people it is actively forming, filling and repeatedly editing information. In order to increase the effectiveness of independent work of students used technology group projects. The group project “My first virtual Café” was designed and introduced in the educational process.

Information technologies can effectively implement the general principles of learning through its didactic features. At the same time, when implementing of LMS Moodle in the learning process a number of specific principles arises acceptable for information technology. To increase the efficiency of the educational process in the training of students in in studying discipline “Information technology and systems in food production” along with the general didactic principles specific principles that reflect the essence of students active learning activities organization in a learning environment are used [1, 7, 14,15 18].

The principle of subjectivity. In traditional training learning content usually refers to adoption of the underlying sociocultural experience, selected according to educational purposes. Such content is determined by the educational program. In the content of professional and practical training of engineers and technologists of nutrition students using information and communication technology and Internet technology is embedded in the specialist training model, reflecting the subject-professional and social context of the future profession [12]. The main feature of this method is a repeated increase in “supporting information”, the availability of an appropriate educational information environment and interactive learning process. When using interactive teaching methods content of training is the activity aimed at development of student’s personal world view in this or another subject area [10].

The content of learning is shaped not by the compilers of programs but “here and now” by students themselves in the course of their personal movement on individual educational path.

Knowledge is primarily understood as a personal experience add-on and the product of mental activity on comprehension and structuring of this experience [7]. At the convenient time course provides students with new opportunities: possibility at any time to examine the necessary theoretical material presented in the form of interactive lectures; read the additional source with hyperlinks; test one’s knowledge using different levels of tests that match the topics studied discipline. Using the convenient system of training events planning allows students to estimate the

complete picture of their educational activities and enables to adjust the path of its development.

The requirements of the **principle of individual approach** and LMS Moodle allow the learning process to adapt the learning material to the individual capabilities of students who can adjust training rate, further study of obscure meaningful items, etc. With LMS Moodle interactive elements – “Task”, “Test”, “Lecture”, “External application”, “Glossary”, “Wiki” the control of students’ basic knowledge in Informatics and knowledge of enterprise activity of restaurant business organization is carried out. This allows to determine the level of knowledge of the theoretical basis of each each student, identify errors and topics that need to be repeated. While organization of self-study this principle became particularly gain in importance.

As a result of cooperative activities – information sharing in the creation and information editing by interactive element “Wiki” of LMS Moodle a cooperative document – the concept of enterprise restaurants was developed. Self-study involves performing individual tasks on explanation of viability in the market environment of business ideas offered by students.

The principle of consciousness and activity in education reflects the essence of the activity concept [4, 9]. According to this principle the formation of professional skills of future engineers-technologists realized on explaining the significance of information and communication technologies in the modern conditions of domestic enterprises of restaurant business functioning, the prospects of using of knowledge and skills in the future professional activities, involving students in assessment of projects developed by them. Problem-based learning methods implemented by resending problem situations to students using the interactive feature of LMS Moodle – “Glossary” for company restaurant concept development, its chapters and the whole document. Solving professionally oriented tasks by students involves an independent study of the given initial conditions, identifying possible alternatives solutions, the optimal option choosing and its reasoning using such LMS Moodle interactive element as “Task”.

The principle of practical orientation. To achieve the skills acquisition of solving professional tasks by means of information and communication and Internet technologies specialized professionally oriented tasks that reflect the real economic situation of the domestic market were used [12]. objectives and contain modern data enterprises restaurant industry: creating a plan for the appearance of the enterprise; development of menus, calculation charts; performing market research; determining yield optimization of production processes.

The principle of cooperation. The principle of cooperation in LMS Moodle system is meant primarily as a real, not a “toy” equality of participants in the educational process, students and teachers. The teacher now is not a “bearer of knowledge” but an equal partner in the educational communication, i.e. is “teacher-leader” as opposed to “teacher-driver” [5]. As a result of this principle is the distinction between the concepts of “teacher” and “student” is erased. The second part of the principle of cooperation personal educational achievements in the form of open personal portfolios created in the process of studying the discipline.

One of the course objectives for each group was creating a glossary of terms (“Glossary” tool) and the Handbook of specialized application software (“Wiki” tool) for the automation of restaurant business enterprise activity. Carrying out these tasks, students edited documents together, tracked all of the changes made to one or other co-author (with the possibility to return to any of the options). Assessment of the student’s achievements was made by a teacher on the basis of mutual evaluation of students in the course of presentation of the projects.

Applying the principle of rational combination of collective and individual forms and methods of training activity, one can stay in the learning environment successfully interact with one or more educational groups. A network of users arises with the same rights that can: corporately edit documents in various formats, to communicate as equals, keep records [14] in chats and forums. Instructional space, while remaining personal, is decentralizing. The ability to create groups allows teacher to organize cooperative work on projects, assigning each project under a single platform in the network.

Thus, the organization of learning activities in micro-groups using such interactive elements of LMS Moodle as “Glossary” and “Wiki” lets us build relationships within the group, bringing an element of co-creation and collaboration.

On the one hand we get a working area for the placement of materials, on the other hand, the value of each participant within this platform is set by himself, or rather the contribution that he makes to the common cause.

The essence of the **principle of open feedback** is obligatory expression of a member or all group members of ideas or objections regarding the tasks. In the course of work with any interactive element of the course, the student had the opportunity to perform any action: to write a message, to make a choice, to formulate a definition, etc. Due to the action of this principle a correction of expressions and opinions occurred. This principle is implemented in the course using LMS Moodle tools that allow to organize a cooperative discussion: “Glossary” – when creating the dictionary definitions by students; “Wiki” – when formation of the application software dictionary; “Forum” – when making decision on the choice of software for automation of the restaurant industry in the process of communication; “Chat” – when on-line counseling. Explanations on the different sections of the course, announcements, surveys attracted the attention of students in active learning activities. The result is a set of feedback.

Conclusion.

The conducted analysis allows making conclusions that the implementation of the principles outlined above promotes active student involvement in the communication process, though indirect, that is a necessary feature of interactivity. Teaching students in the environment of LMS Moodle, organized according to the principles of interactive learning, allowing them:

- to analyze training information, creative approach to mastering educational material and to make it more accessible of learning;
- to formulate their own opinion, to express it correctly, to prove their own point of view, to argue and to debate;
- to listen to the other person, to respect an alternative opinion;

- to simulate different social situations, to enrich their own social experience through the inclusion of a variety of life situations;
- to build constructive relationships within the group, to determine their place in it, to avoid conflicts or resolve them, to seek compromises, to engage actively in a dialogue to find common solutions dialogue;
- to develop the skills of project activities, self-study, performing creative works in order to achieve this goal.

A promising area of research on LMS Moodle tools can be a theoretical study and practical implementation methods for using them in interactive learning.

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J21410-013**Gorbatenko L. A.****EXCEL - VBA USING IN DISTANCE LEARNING***Odessa National Maritime University*

Abstract: Using tabular processors in remote educational process. Particular attention is paid to EXCEL.

Keywords: distance learning, Excel.

One of the emerging approaches to learning is distance learning, when the learner is physically separated from educational institutions and can not take advantage of the university licensed software packages and funds. In addition, users often have to face a number of relatively simple tasks of modeling processes in a variety of objects. Thus, as in distance learning, as well as in industrial activity is convenient use of common modeling tools based on accessible for any user and easiest to learn software products.

One of such available package is Excel that allows implementation of various numerical methods and has a convenient means to visualize the result of simulation. Together with Excel, you can use VBA - quite a powerful tool in software development and relatively easy to learn.

Using of Excel-VBA allows simplifying development and improvement of methods and modeling techniques in linear and nonlinear dynamical systems and branched, as well as in thermal facilities. In terms of the possible use of modeling techniques in Excel the following tasks are available:

- Approximation of the experimental data [1].
- Numerical solution of systems of nonlinear algebraic equations [2].

- Parametric identification of dynamic elements and branched systems [3] - [4].
- Numerical solution of ordinary differential equations and systems for modeling the dynamics of systems with lumped parameters [5] - [6].
- Modeling processes in branched systems [7] - [8].

In the case of approximating the experimental data is mainly used the method of least squares with minimization of the functional (sum of squared residuals) by descent method (Excel) or direct methods (Excel-VBA).

Methods of difference techniques and polynomial approximation used in developing of solving problems of parametric identification of dynamic objects [3] - [4], including the delay [4]. Basic requirements for development - invariant of methods to raw data, reliability and simplicity.

As mathematical models the objects of identification are most commonly used equation:

$$A \cdot \frac{dY}{d\tau} + Y = K \cdot X \quad (1)$$

$$C_2 \cdot \frac{d^2Y}{d\tau^2} + C_1 \cdot \frac{dY}{d\tau} + Y = K_1 \cdot X + K_2 \cdot \frac{dX}{d\tau} \quad (2)$$

Where τ - time

$X(\tau)$ - impact

$Y(\tau)$ - object response

A, C_1, C_2, K, K_1, K_2 - coefficients reflected the properties of the object.

Should be considered that the experimental $X(\tau)$ and $Y(\tau)$ can be noised..

The whole area of changing variables $X(\tau)$ and $Y(\tau)$ is divided into intervals of time, which may overlap each other (Fig. 1).

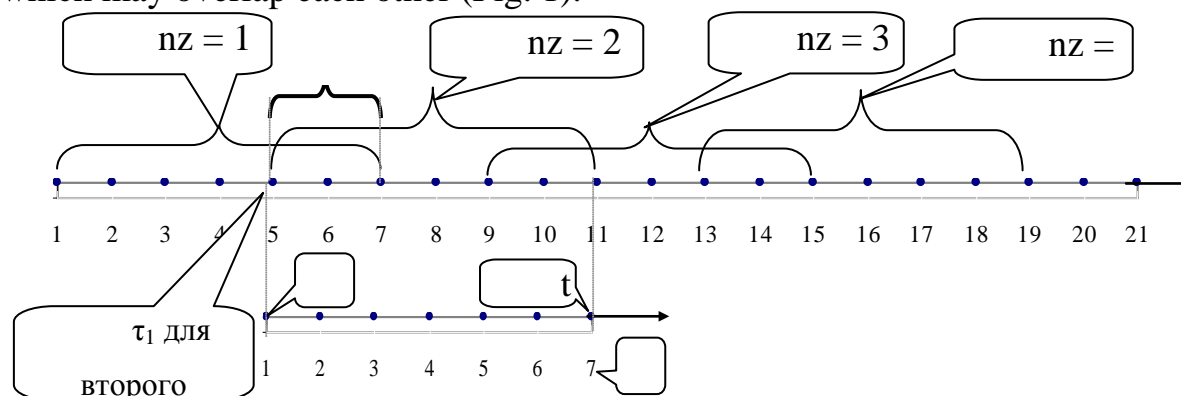


Fig. 1 Indexing of time points in the approximation $X(\tau), Y(\tau)$

At each interval (interval index - nz) is used locally within each interval independent variable - t . Dependence of $X(t)$ and $Y(t)$ in each interval approximated appropriate functions (eg , low degree polynomials). In principle, on the approximating function specific restrictions are not imposed.

Performing identification models of dynamic systems with lumped parameters include of several steps:

- for times by differentiation of the experimental data defined derivatives X', Y' and Y'' ;

- the values of functions and derivatives are substituted into the equation which must be identified and determined value of the functional δ (sum of squared discrepancies of the left and right sides of the equation for all the considered time points);

- values of the coefficients of the differential equation which must be identified determined by minimizing the functional δ by one of descent methods or solving the resulting system of linear algebraic equations by the direct method.

Considered algorithm is easily implemented in Excel and can reliably identify objects even when processing very noising $X(\tau)$ and $Y(\tau)$.

Some difference methods are often used for solving ordinary differential equations and their systems do not always provide the stability of the solution. Therefore, methods have been developed, which can be classified as analytical and grid [2], [6], [9].

The essence of the approach is that on the interval of integration (step independent variable) the impact of X reflected by the linear dependence (or assumed to be constant, equal to the average value of X in the interval). Within the interval of integration are using the new coordinate axis t , as shown in Fig. 2, and an performed analytical solution of equation (1).

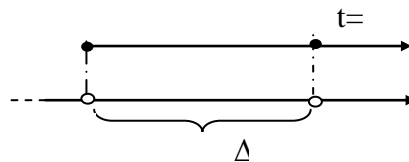


Fig. 2 Interval of integration

The results of analytical solutions for ordinary differential equations are written in the form of two or three-point difference scheme [9].

Similar schemes have absolute stability and low methodological error [6].

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Zapadniuk M.M.

ENHANCED INTENSIFICATION HYDROCARBONS USING ENERGY VIBRATIONS SONAR

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Abstract. Improving hydroacoustic tooling technique of bottomhole formation zone for increase of oil and gas recovery. On the base of analysis of summation in theoretic and experimental data the technique of reliance of optimal parameter of hydroacoustic tool of regulated frequency and power in proposed. The recommendations of application of hydroacoustic tool for the rock with different permeability and porosity. The optimal frequency band and intensity of influencing the bottom-hole zone are determined

Key words: katagenesis, oil and gas pool, well, productive layer.

Most of the used stimulation methods such as perimeter and contour water flooding, thermal and chemical effect, injection of steam, various acids and solvents, hydraulic fracturing, injection of gas and surfactants, polymer solutions and other agents have some significant disadvantages, the main of which is environmental disfunction leading to irreversible processes in the reservoir. Methods of hydrocarbon production stimulation such as vibrowave, acoustic and hydroacoustic methods based on physical bed stimulation do not have these drawbacks. Listed methods are used with a variety of technologies and technical means.

Devices for impulsive formation treatment are placed on the surface and very close to the pay bed. The use of elastic vibration generators located in the well,

allows to draw vibration source to the object of effect and to reduce the impact of energy loss to overcome the distance from the source to the pay bed.

Researchers have proposed dozens of generators of different designs to produce elastic vibrations, but most of them are not widely applied because of scientific invalidity for the industrial application.

Hydroacoustic valve-type generators generate high-amplitude pressure fluctuations but their operational life is very short. Generators fail due to the development of its nodes shock loads that exceed yield threshold of periodic load of construction materials. Most generators of hydroacoustic devices are based on the use of only Laval nozzles that cannot guarantee the efficiency at greater depths and the ability to control frequency and intensity while processing. The expected results are not achieved also by the use of vortex or toroidal cells. Effects of acoustic vibrations energy on the structure of hydrocarbons, cement stone, mechanical properties of rocks, thermobaric characteristics are not fully investigated.

The authors have developed and tested generators of various types, based on theoretical, experimental and industrial studies (Patent of Ukraine №№ 58651, 63181, 63187). Having analyzed operational characteristics of the devices and their effective influence on bottom-hole zone of formation it is offered to apply hydroacoustic pulse generator that has no movable structural parts and has high abrasion resistance, adjustable power and effectively works at great depths and can also be used in horizontal and inclined wells for decolmatation of bottom-hole formation zone and increasement of hydrocarbon production.

In order to determine the nature of propagation of elastic waves based on Gassman theory [1] a mathematical model was developed to describe the relationship between stresses and deformations in viscoelastic medium under the action of hydroacoustic energy fluctuations and the system of equations:

$$\begin{cases} \frac{\partial u_i}{\partial t} + \frac{1}{\rho_{0,s}} \frac{\partial \sigma_{ik}}{\partial x_k} = F_i f(t) \\ \frac{\partial \sigma_{ik}}{\partial t} + M \left(\frac{\partial u_k}{\partial x_i} + \frac{\partial u_i}{\partial x_k} \right) + \left(\frac{\rho_{0,s}}{\rho_0} K - \frac{2}{3} M \right) \delta_{ik} \operatorname{div} \vec{u} = 0 \end{cases} \quad (1)$$

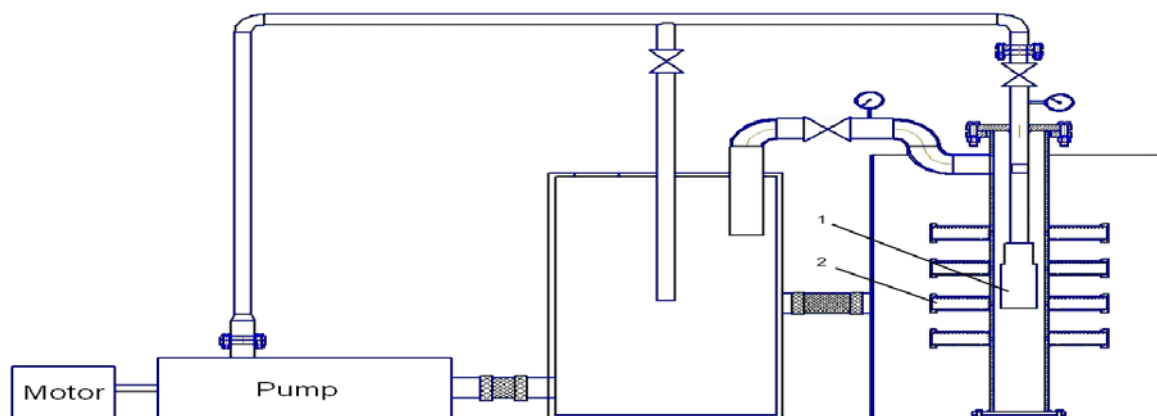
where $\rho_{0,s}$ - partial density of porous medium, $\rho_{0,l}$ - partial density of liquid; $\rho_0 = \rho_{0,l} + \rho_{0,s}$, $\rho_{0,s} = \rho_{0,s}^f (1 - m_0)$, $\rho_{0,l} = \rho_{0,l}^f m_0$, $\rho_{0,s}^f$ and $\rho_{0,l}^f$ - physical density of elastic porous medium and fluid correspondingly; m_0 - porosity; δ_{ik} - Kronecker delta; σ_{ik} - Stress tensor; $\vec{u} = (u_1, u_2)$ - velocity vector of particle displacement in porous media; $\vec{F} = (F_1, F_2)$ - vector of mass forces ; , $K = \lambda + \frac{2\mu}{3}$, $\lambda > 0$, $\mu > 0$ - Lamé coefficients.

The methods of Lagern integration transformation in time and finite-differences are used for numerical solution of the problem. This algorithm helps to perform effective calculations while modeling complex built compatible viscoelastic and porous medium and to explore wave processes emerging in such medium.

Computer model was developed using software Solid Works simulating the operation of hydroacoustic vibration generator in actual practice by changing all properties both structural and dynamic to optimize geometry and energy parameters.

Computer model to determine optimal constructive parameters of hydroacoustic pulse generator for a variety of geological and technical conditions based on theoretical and experimental studies was also worked out.

Experimental studies of hydroacoustic pulse generator are carried on experimental stand (Fig. 1). This device provides an opportunity to study bottom-hole zone treatment in wells and the impact of energy fluctuations on casing elements and bottom zone.



1-hydroacoustic generator of fluctuations, 2- core holder.

Fig.1. Experimental stand to study operational characteristics of hydroacoustic generator

Recommendations on the use of hydroacoustic pulse generator for a variety of rocks with porosity from 1.5 % to 40 % and permeability from 0.02 mD to 6477 4 mD based on the analysis of theoretical and experimental studies of domestic and foreign scholars [2] and on our own research have been elaborated. We found that the most effective decolmatation occurs at low frequencies and optimal values of the radiation intensity that varies according to the range from 5 kHz to 100 Hz and $I/I_0 \geq 10\%$. The construction of hydroacoustic generator of elastic vibrations [3] that operates in the frequency range of 1.5 kHz -100 Hz, intensity $I/I_0 \geq 10\%$, and has a high impact on efficiency of bottom-hole formation zone treatment for decolmatation in depth of 2 m is offered.

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**THE IMPROVEMENT OF THE SURFACE QUALITY OF
WORKPIECES BY COATING**

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Abstract. The paper considers the coating of the work surface of the narrow walls of the mold using thermal spray coating way to improve the quality of produced billets. It was proved experimentally, that the coating leads to a decrease in the longitudinal, transverse and netlike cracks on the slab surface, which increases the yield in the subsequent rolling billets.

Key words: thermal spray coating, mold, deterioration of the narrow walls, cracks, quality of billets.

One of the main ways to improve a surface quality of continuously casting slabs is to create conditions for monotonic cooling along length and width of a mold metal slab caster on continuous casting machine (CCM). Deterioration of the work surfaces of the mold walls is accompanied by increase of the air gap between them and continuously forming ingot, which leads to a deterioration in the cooling conditions and to a heating of the crystallizing metal surface and, in a pinch, – to a crust break of the ingot under the mold. Various coating of the work surface of the mold walls leads to a higher resistance, stability of the cooling conditions of the cast metal, and to a lower number of cracks on the slab surface [1].

The quality of the slab surface is determined by thermal state of the caster mold CCM, which largely depends on compliance the profile formed by the mold walls to

the profile surface of continuously casting ingot, and by conditions of further secondary cooling of the ingot. The deformity of the slab surface caused by arachnid cracks is largely conditioned by it.

Furthermore, cracks may occur on the slabs during casting on curved CCM, when ingot bending and unbending occurs, that also leads to the slivers on its edges while sheets are rolling. Significant influence on the crack formation has a presence in the steel casted on CCM of nitrides and carbonitrides, which leads to a drastic reduction in its plasticity within a brittleness temperature range of 700...950 °C [2]. Active cooling of the edge zones of the continuous casting ingot leads to the fact that the temperature of the metal in these zones reaches the upper limit of the interval of brittleness before the ingot straightening zone is out of range, which significantly increases the probability of the formation and development of cracks.

In recent years to improve the quality of slabs there has been active reconstruction of CCM in Russia and in other countries, new machines equipped with thermal state control systems in the mold and crust break preventing system of the ingot have been constructed [2].

A method of calculating the thermal state of the mold slab CCM allow you to choose the geometrical parameters and work surfaces material of the mold walls [3].

After calculating the shrinkage curves of the ingot in the mold, the authors [4] choose the desired profile of the mold wall, which ensures the most uniform deterioration of the copper along the length of the mold, and thereby uniform metal cooling in it. In conditions of JSC "Magnitogorsk Iron and Steel Works" kits with trimensional taper range adjustment on the narrow walls were tested, and in conditions of JSC "Severstal" kits with a complex parabolic profile were tested [5]. These measures give a more uniform deterioration of the work surfaces of the narrow walls, and thereby uniform cast metal cooling. As a result, a reduction of destruction of the slab surface by cracks was recorded.

Currently the most promising direction of reducing the deterioration of the work surfaces of the narrow walls and of improving the surface quality of obtained slabs is considered a various coating of the mold wall.

One of the first Russian metallurgical enterprises, where coating of the slab mold was used, was JSC "Severstal". Low mold cooling with drilling channels and loop cooling system could lead to the coating delamination. LLC "Korad" specialists developed a new mold design, which allows to use thin walls with slotted channels and direct-flow cooling system in old case. LLC "Korad" organized work on galvanic coating of old mold walls and carried out tests at JSC "Severstal"[5]. During the tests two types of coatings were used "KME Europa Metal AG" (Germany): AMC-HN20 - a coating of nickel with hardness 220 HV, and AMC-HN40 - a coating of an alloy of nickel with cobalt with hardness 400 HV. As a result, the number of slabs affected by surface defects (about 6 times) decreased, and an increase in durability of mold walls was indicated. Tests have shown that the effect on the quality of two types of coating is the same. The work surface of the mold wall wasn't fully coated with nickel, but only partly. Nevertheless, surface quality of arachnids (netlike) cracks meets the quality of billets prepared using casting mold with completely covered work surfaces.

However, galvanic coating is used only with thin-walled slotted mold CCM and isn't used with thick-walled mold. To improve the surface quality of the slabs, which are produced using the metal casting by thick-walled mold, can help thermal spray coating.

Experimental studies were carried out under conditions of the productive capacity of the "NLMK" JSC, where the work surface of the narrow copper walls M1R with adjustable mold using thermal spray coating method were coated with a nickel-based alloy. The required purity grade of the work surface of the walls was ensured due to the mechanical processing. Using mold with coated walls (R-7) and without coating (R-3) cross-section 250×1850 mm in the converter shop №2 at CCM №5 11 heats of high manganese steel S355JR were casted, which often have multiple cracks on the billets.

Inspection of the casting mold R-7 after removal from the CCM on the stand without disassembly and narrow walls after the removal of mold showed, that the deterioration of the coating occurred only in the corners of the bottom wall. The rest of the work surface of the narrow walls on the mold coating remained unchanged (fig.1 и 2).

A comparative analysis of two parallel slab surfaces of streams №9 and №10 CCM №5 with normal (R-3) and experimental (R-7) mold identified fewer longitudinal cracks on the meltings №2, 3, 5, 9 and 11 using experimental mold. Furthermore, transverse cracks were found on slabs of melting №3 casted using normal mold, whereas there were no such cracks on slabs casted using experimental mold.



**Fig. 1 - R-7 Mold
after removal from the CCM on
stand**



**Fig. 2 – Narrow wall of the mold
R-7 after its dismantling**

Metallographic analysis of the billets carved from narrow edges of the slabs after latest melting, which were casted using normal and experimental mold, indicated, that netlike cracks occupied 0,1 and 6,6 % of billets, respectively (fig.1).

The results of the rolling of sheets from the obtained slabs (table 2).

Table 1

**Surface quality of the slabs analysis without (stream №9)
and with coating (stream №10) on the narrow wall of the mold**

Casted melting number	Mold	Number of cracks		Netlike cracks (% of the sample area)
		longitudinal	transverse	
2	R-3	9	—	—
	R-7	7	—	—
3	R-3	14	5	—
	R-7	13	—	—
5	R-3	9	10	—
	R-7	6	10	—
9	R-3	9	10	—
	R-7	7	10	—
11	R-3	13	5	6,6
	R-7	11	5	0,1

The table 2 illustrates that 1,2 % of sheets are sorted, which are made of slabs casted using mold (R-7) and 4,3 % using normal mold (R-3).

It may be that a significant improvement of the surface quality of the slab can be possible using simultaneous deposition on work surfaces of narrow and wide mold walls.

Table 2

The results of the rolling of the slab casted using experimental and normal mold

Stream number	Rolled, t	Sheets sorted, t				
		total	including defect			
			longitudinal cracks	transverse cracks along fold	transverse cracks	sliver
9	1737,8	74,8	28,2	33,5	13,1	0
10	1744,2	21,6	4,1	15	0	2,5

Conclusions

1. Experimental studies showed that thermal spray coating of the entire work surface of the narrow walls of the mold reduces the number of longitudinal, transverse and netlike cracks on the slab surface improving the metal yield.

2. To improve the quality of the slab surface is advisable to make thermal spray coating of the work surface of the walls of CCM.

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Birukov A.B., Safyants S.M., Gnitiev P.A.

COMPARISON OF CONVECTIVE HEAT TRANSFER INTENSITY IN PULSED AND UNPULSED MODES OF HEAT TRANSFER AGENT SUPPLY

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Abstract. In this paper on physical model, which is geometrically similar to typical chamber furnace with rolled-out hearth, convective heat transfer is studied for modes of pulsed and unpulsed heat transfer agent supply. Appropriate criteria equations are obtained and 10-20% intensification of convective heat transfer coefficient is grounded in case of heat transfer agent supply change from unpulsed to pulsed mode on condition that average heat transfer agent flow rates are equal.

Key words: product thermal treatment, air-cooling process, chamber furnace, convective heat exchange intensity, pulsed heat transfer agent supply.

Production quality in heavy industry is depend on how accurately technological mode is kept during all production stages.

One of the methods for improving production quality is using thermal treatment for steel products, which allows us to increase steel hardness and solidity up to two-three times [1]. The process of heat treatment consists of three consecutive operations: heating the metal at a certain rate, holding at this temperature for some time to uniform billet temperature and cooling at a predetermined process speed. Nowadays heating and soaking processes are controlled with required accuracy, but

metal air-cooling process is not enough controlled today. This part of heat treatment have a big impact into the final result of treatment process and it is one of the longest part (e.g. operation time of air-cooling process of steel sheets annealing operation in bell-type furnace takes 60-90 hours [2]), therefore in practice there is an issue in getting criteria dependencies, describing the process of convective heat exchange between metal and cooling air in the furnaces is of decisive importance. Obtained dependences allow to define the heat transfer coefficient with a specified accuracy, that helps maintaining the cooling rate at the specified level, and therefore it leads to better product quality.

For studying convective heat exchange at various modes of cooling air supply to the furnace geometrically similar model of chamber furnace with rolled-out hearth is constructed, where heating, soaking and cooling operation can be implemented. Schemes of model and hydraulic circuit are given in work [3].

In laboratory conditions, several experiments were carried out to obtain the criteria dependencies, which describe convective heat transfer between the studied bodies and cooling airflow supplied in unpulsed mode. In work [4] authors have obtained the corresponding equation which is looks like:

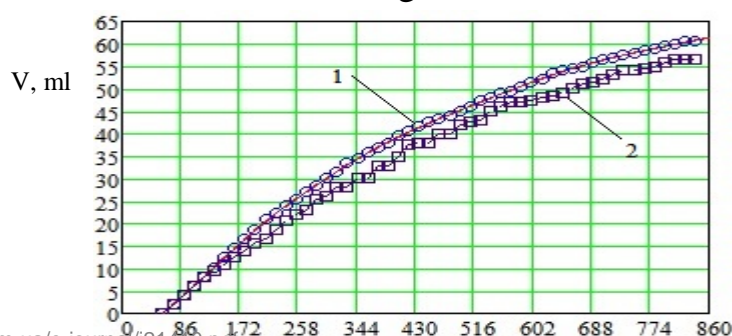
$$Nu = 1,022 \cdot Re^{0,531} \cdot Pr_{\kappa}^{0,36} \cdot \left(\frac{Pr_{\kappa}}{Pr_{ct}} \right)^{0,25},$$

where multiplier 1.022 and degree for Reynolds criteria 0.531 were determined using the logarithm operation, presenting results in logarithmic coordinates and analysis of the resulting curve using the regression method.

For studying pulsing mode of air cooking supply considered unit is equipped with device for generating low frequency airflow pulsation. Schematic device illustration is presented in work [3]. This device consists of a disk mounted on a rotatable shaft. Disc diameter is chosen so that when it rotates to 90 degrees the distance from the edge of the disc to the internal pipe wall is 1-1.5 mm, it allows to provide 87% channel overlap.

Carrying out of the experiments in pulsed mode is completely similar to the experiment in unpulsed mode, which described in work [4]. Average flow rate of cooling air is set to be equal in experiments for studying both modes of air flow. Device for pulsations generating is capable of generating frequencies in the range from 0.1 to 1.7 Hz. In this paper, 1.6 Hz frequency is employed.

Volumes of flowing out liquid formed during the melting of ice cubes for unpulsed and pulsed modes are shown in Fig. 1



1 –pulsed mode with 1.6 Hz frequency; 2 unpulsed mode.

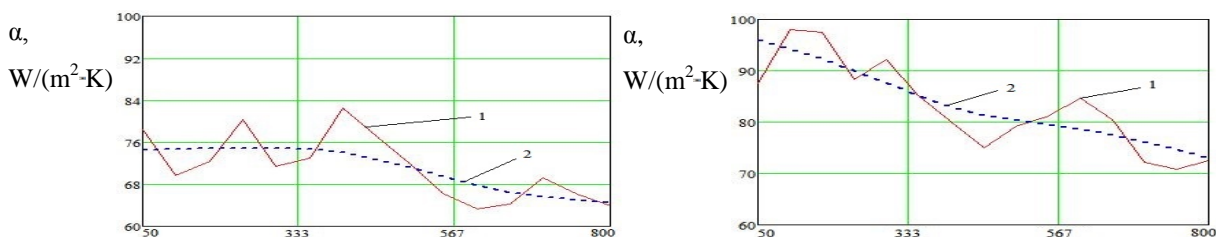
Fig. 1. Flow rates of unpulsed and pulsed mode.

Comparing flowing rates it is possible to see increasing the volume of liquid in pulsed mode of air flow, which qualitatively indicates intensification of the process by using pulsed airflow. The figure also shows that in the first minutes flowing rate identical in the two modes, but eventually pulsed mode shows the volume growth and in the end of experiments, the difference reaches to 7%.

The experimental data rates at pulsed mode is similar to a method of processing unpulsed experiment in work [4]. For example, changing the coefficient of heat transfer for both modes are shown in Fig. 2:

unpulsed mode

pulsed mode



1 - experimental values of the heat transfer coefficient, 2 - curve treated by the spline interpolation method.

Fig. 2. Dependence of heat transfer coefficient in time.

These graphs demonstrate difference τ, s heat transfer coefficient in pulsed τ, s unpulsed modes which is caused by different intensities of the processes.

Characteristic of the process intensity can be a Nusselt criterion. Dependence of the experimental values of the Nusselt criterion on the time is shown in Fig. 3

unpulsed mode

pulsed mode

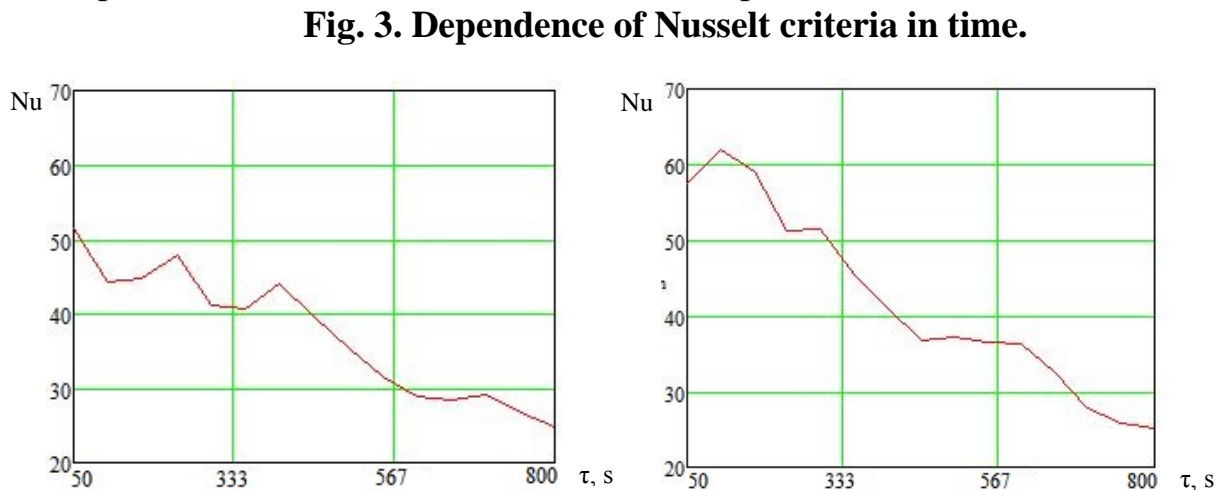


Fig. 3. Dependence of Nusselt criteria in time.

In order to obtain the coefficients of the criteria equation for the pulsed mode additional criteria Strouhal is introduced, which characterizes the influence of flow processes non-stationarity. This criterion is calculated by the following dependence:

$$Sh = \frac{v \cdot d}{\omega} ;$$

where ν – fluctuations frequency, Hz;

d – character size of flowed over bodies, in this case – calculated diameter of ice cubes in each moment of time, m;

w – speed of gas flow, m/s.

Time dependence of the Reynolds criteria for two modes is looks like:

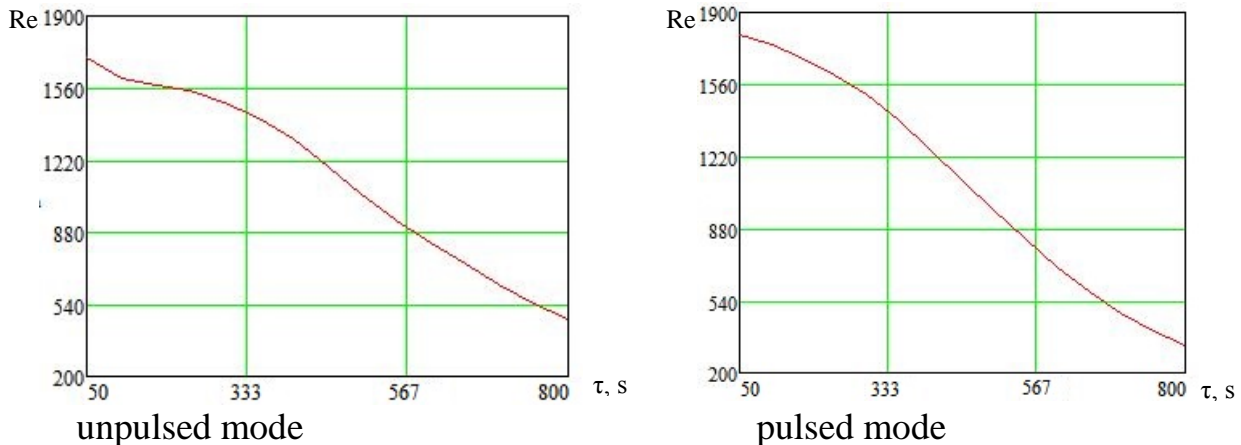


Fig. 4. Dependence of Reynolds criteria in time.

For getting unknown coefficients we use the regression method of solving that will give the looked-for values of the multiplier, degrees for Reynolds and value of the degree for the Strouhal criteria. In order to use the regression method for solution an additional experiment is conducted at a pulsation frequency 1.2 Hz and obtained summary data array was processed. As result following coefficients of the equation describing the convective heat transfer in a laboratory model of the furnace in pulsed mode of air supply were got.

$$Nu = 2,134 \cdot Re^{0,504} \cdot Pr_{\kappa}^{0,36} \cdot \left(\frac{Pr_{\kappa}}{Pr_{ct}} \right)^{0,25} \cdot Sh^{0,093};$$

In order to estimate the accuracy of the regression analysis method coefficient of determination is found [5], which value for obtained equation is $R^2 = 0,901$; this ratio is the proportion of the variance of the dependent variable deviations from its average value. According to Cheddok scale obtained value indicates a very high quality characteristics coupling strength between the obtained values for the regression analysis and data obtained during the experiment.

Conclusion:

Comparing the dynamics of fluid flow in pulsed and unpulsed modes experimentally it is possible to conclude that switching to pulsing airflow allows us to strengthen the coefficient of convective heat transfer by 10-20 %, assuming the equality of average airflows. In this paper criterion equation was obtained for describing convective heat transfer in the pulsed mode of cooling air supply. This equation has a very high strength connection with the data obtained during the experiments, which allows us to estimate intensity of heat exchange process more

accurately and thus provides guidance for determining necessary flow rate of cooling air and blowing devices number and arrangement.

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Polishchuk A.V., Kazak N.I., Polishchuk V.N.
THE INFLUENCE OF MIXING FREQUENCY ON ALKALINITY OF BIODIESEL WHILE PURIFYING

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The methods and results of studies of the effect of frequency of rotation of the agitator shaft alkalinity of biodiesel in its cleaning. The optimal frequency of the agitator shaft in the neutralization of the biodiesel at 40 °C

Keywords: biodiesel, alkalinity, stirrer speed, neutralization, methyl ester, soapstock

Introduction. In the production of bio-diesel (methyl ester) with the traditional technology to speed up the methanolysis reaction the alkaline or acid catalyst is obligatory applied. Heterogeneous catalyst is rarely used in diesel fuel production, mainly homogeneous catalyst is used. In case of acid catalyst reaction application reaction time is one to 45 hours, alkaline – from a few tens of minutes to 8:0 (depending on the temperature and pressure) because of more rapid passage of methanolysis reactions mainly used alkaline catalyst (potassium or sodium hydroxide), whose solution in methanol is added to fats for biodiesel. The catalyst does not react is methanolysis and only makes it more rapid. Therefore, it remains completely in manufactured diesel biofuel, causing corrosion of the engine. Corrosion products, falling into the gap between the cylinder and the piston, causing them to abrasive wear. In the fuel system, they can clog fuel filters, or even

block the work of fuel equipment because of the impossibility to spray fuel through the injectors [1].

Analysis of recent research. One way to remove the catalyst of biodiesel by technology of production is its neutralization of acid, and then deleting soapstock. In [2] estimated an optimum amounts of 1% aqueous solution of citric acid to neutralize the biodiesel to alkalinity below 5 mg/kg in accordance with DIN 51606 [3] that at biodiesel pH 9,45 are 4,5-6 ml per 100 ml of the methyl ester, at pH = 8,32 – 4-5 ml per 100 ml of the methyl ester. Mixing of reagents were carried on a magnetic mixer at frequency of rotation of the magnetic stirrer 214 RPM. However, the influence of neutralization of biodiesel with other frequencies of mixer rotation were not determined. Therefore, **the objective of our research** is to estimate the influence of mixer rotation frequency on alkalinity of biodiesel when it is purified.

The results of research. Methyl ester for research was produced from oil of false flax (83%) with acid value 7,75 mg KOH/g, with a magnetic mixer at a temperature of 40°C for 15 min mixed potassium methyleate (17%). The reaction products were washed in funnel (fig. 1, b), where they was dividing into methyl ester and crude glycerolspent for two hours.

82% of methyl ether and 18% of crude glycerine were received as a result. Crude glycerol was poured. The methyl ester was distilled at a temperature of 65°C (fig. 2) with constant aeration to remove excess methanol (0,9% of the methyl ester).

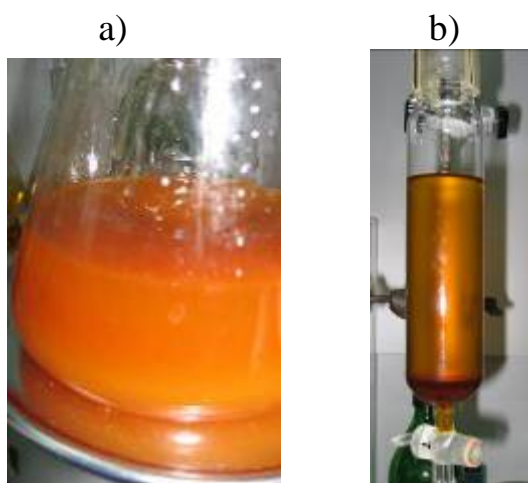


Fig. 1. Production of biodiesel:
a – mixing of reagents on the magnetic agitator;
b – separation of reaction products of methyl ether and crude glycerine



Fig. 2. Remove residual methanol in biodiesel

Determination of the effect of mixing frequency on alkalinity of biodiesel while its purification was carried out on a laboratory facility, consisting of a liquid thermostat ТЖ-TC-01/16 and up-gar mixer EUROSTAR Digital.

Sample of the diesel biofuels purified from methanol with volume of 300 ml poured in a capacity of 0.5 litres, which is fixed on a tripod, and placed to the water in the liquid thermostat (fig. 3).

On the same tripod was fixed an up-gear mixer with stirring rod with inclined

blades. The spin was adjusted to the required frequency of the mixer rotation.



Fig. 3 Laboratory facility to determine the influence of mixing frequency on alkalinity of biodiesel when it is purified

The study was carried out at temperatures of neutralization 20°C and 40°C the mixer shaft rotation frequency 200, 350, 500 and 650 RPM (fig. 4). The mixing time was 5 min. From Figure 4 the mixer shaft rotation speed 200 RPM does not cause perturbations of the methyl ester and its movement in the glass close to the laminar. On increasing speed of mixer shaft in diesel biofuel appears funnel, the depth of which increases with increasing stirrer shaft speed and at 650 RPM bottom funnel almost reaches the stirrer blade.

After neutralization of the methyl ester was poured into dividing funnel (fig. 5) or polyethylene bottles (fig. 5, b) and left for 2-3 days (increase the temperature of the environment decreases separation time).

While gravity sedimentation at the bottom of the bottle or funnel settles soapstock–potassium salts, soap formed as a result of the neutralization of potassium hydroxide, citric acid (fig. 6), and methyl ester with clouded becomes transparent.

Lighted biodiesel is poured out and its alkalinity is defined in accordance to the methodology described in [4].

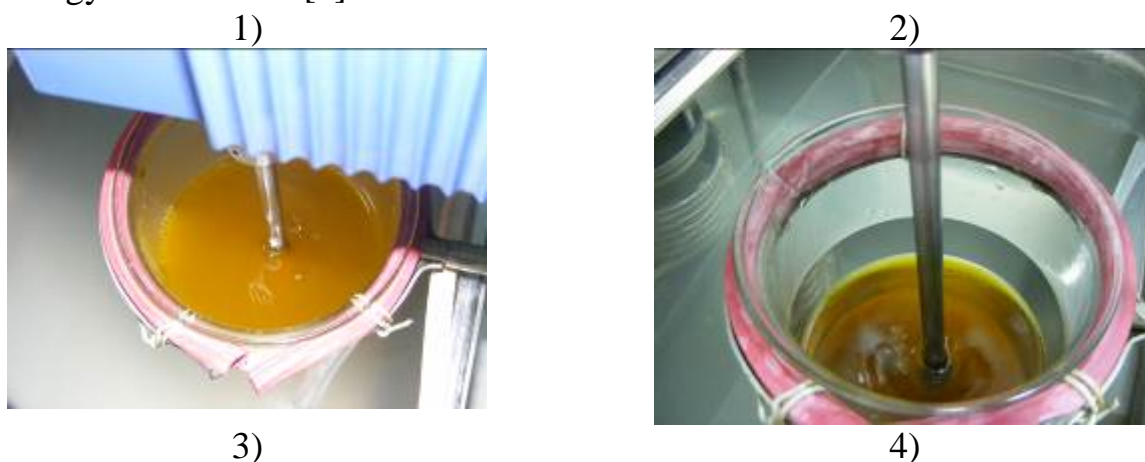




Fig. 4. the neutralization of the methyl ester by stirring with the rotation speed of mixer shaft: 1 – 200 rpm, 2 – 350 rpm, 3 – 500 rpm, 4 – 650 rpm

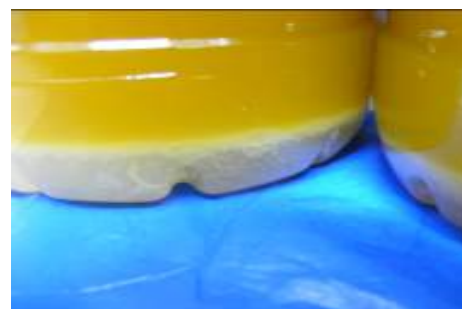
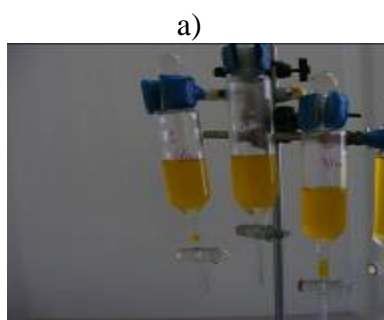


Fig. 5. The gravity sedimentation of neutralized methyl ester: a – in the separating funnels; b – transfusion in polyethylene bottles

Fig. 6. Sediment of potassium salts in the bottom of plastic bottles

The results of experimental research of the influence of mixer settings on alkalinity of biodiesel in its neutralization are shown in the fig. 7.

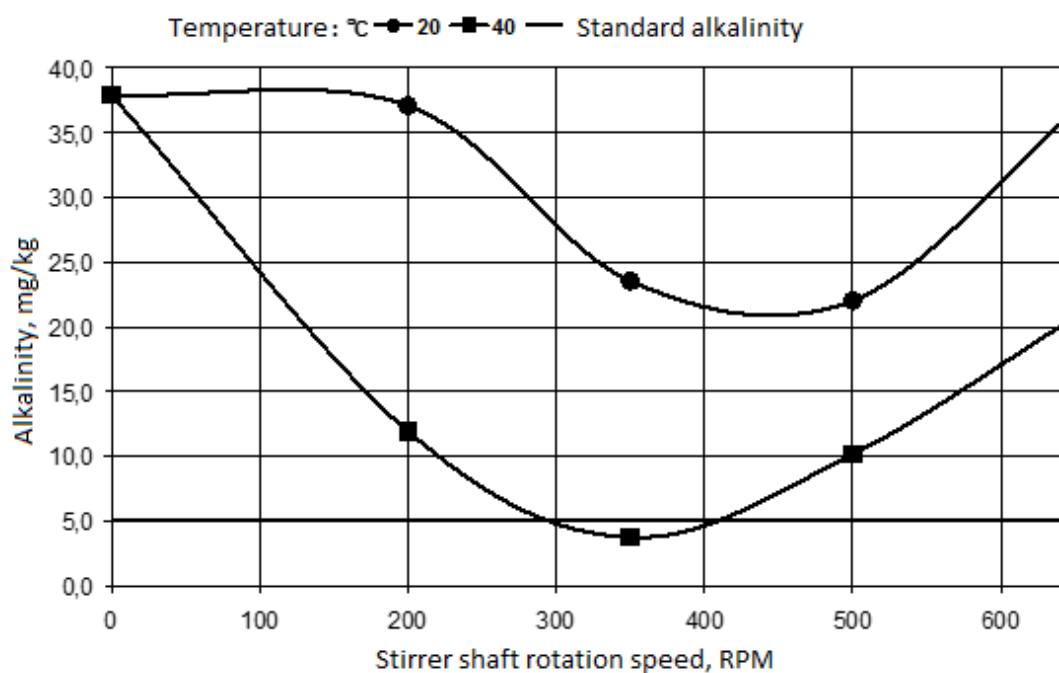


Fig. 7. the dependence of the alkalinity of the methyl ester of mixer rotation frequency when its neutralization

Initial alkalinity biodiesel in the experiments was 37,9 mg/kg. As shown in Fig. 7, reducing the alkalinity is observed when the neutralization process temperature was 20°C. With the methyl ether alkalinity below 5 mg/kg (according to the standards DIN 51606) for all values of the stirrer shaft speed. At the temperature 40°C the optimal frequency of rotation of the stirrer that decreases biodiesel alkalinity below 5 mg/kg (namely 3,7 mg/kg), is 350 RPM. As with decreasing mixers speed, and at its height, biodiesel alkalinity increases and exceeds the value specified in the standard. Poor methyl ester neutralization with low frequency of rotation of the stirrer is caused by poor mixing of reagents, at high stirrer shaft speeds – the formation of the crater, which also makes it difficult to shuffle.

Conclusions

At offset 40° the optimal frequency of rotation of the stirrer that decreases biodiesel alkalinity below 5 mg/kg. As with decreasing mixers speed, and at its height, biodiesel alkalinity increases and exceeds the value specified in the standard. Bad methyl ester neutralization with low frequency of rotation of the stirrer is caused by poor mixing of reagents. At high stirrer shaft speeds – the formation of the crater, which also makes it difficult to shuffle.

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**BIOTECHNOLOGY OF GOAT'S SOFT CHEESE "ORION"
PRODUCED BY THERMO ACID METHOD OF CHEESEMAKING**

Summary. *The data of the biochemical content of the control batch of cheese "Adygeysky" and the experimental batch "Orion" produced by the traditional technology of cheese making, respectively, and with the use of the cheesy kind of the biopreparation "WPP-C" developed by us have been presented in the article.*

It has been established that the proposed biotechnological method of cheese making provides the output of the product that contains the higher amount of protein and essential amino acids as compared to the values of the control batch of the product.

Key words: goat's soft cheese, biochemical composition, protein, amino acids.

I. Introduction. The demand for the food with high nutritional and biological value has increased for the last ten years. Goat's milk and dairy products made from it meet the above requirements.

The improvement of the existing traditional technology of soft cheese “Adygeysky” from cow’s milk by thermo acid method of cheese making and the development of a new technology of the analogous type of the product from goat’s milk are actual when conducting the investigations in the above direction. It should be pointed out that the data on the technology of soft cheese by thermo acid method of cheese making from goat’s milk are limited in the scientific literature.

In addition to that because of the lack of the normative basis – State Standards for soft cheese from goat’s milk and technological instructions to them, milk processing on the industrial basis in the conditions of milk-processing plants has not been done yet.

Problem setting. The aim of the study was to substantiate the use of the biotechnological approaches, particularly, the cheesy kind of the biopreparation “WPP-C” developed by us to work out the technology of goat’s soft cheese “Orion” by thermo acid method of cheese making the analogue of which is cheese “Adygeysky” from cow’s milk.

For this purpose the control batches of soft cheese from cow’s milk and the experimental ones from goat’s dairy raw materials with the use of the cheesy kind of the biopreparation “WPP-C” have been produced. The comparative evaluation of the mass rate of the protein and amino acid content of the cheese made in accordance with the traditional technology and a new one developed by us have been made.

It is known that cheese is believed to be the most important “protein- calcium-fat” concentrate. It differs from other dairy products not only by high biological value but by its high digestibility [1]. One of the possible trends in the development of business in cheese making is the production of such types of cheese for which there is no competition from the side of the assortment of the existing plants [2].

First of all it refers to soft cheese from goat’s milk because the technology for its making has not been developed yet. Higher biological and nutritional value of soft cheese is determined not only by the higher content of fat as compared to hard cheese but by a large amount of soluble protein and vitamins in it [3]. When making cheese “Adygeysky” by thermo acid method of cheese making that got the name “Maysky” the conducting of such technological operation as milk homogenization provides the increase in the coagulation of milk protein from 10 min. to 25...30 min.

It reduces the loss of protein and fat into the whey from the clot that is received during the shorter period of time as compared to the proposed period [4]. To improve the consistency of cheese “Adygeysky” the heat treatment of milk is done at the temperature regimes approved before 94...96 ° C and the precipitation of protein and fat is carried out by coagulant after cooling the milk to the temperature 75...85 ° C.

The coagulation is done by the whey at 35...40° C in the amount of 12...18 %. The period of clot self pressing is increased from 10...16 to 60 min. If the skim milk was used instead of the whole milk the mixture was cooled to 70...75 ° C and the coagulation was done 15...18 % by sour whey heated to the temperature 35...40° C [5]. To increase the biological value and the output of soft cheese - prototype “Adygeysky” the temperature of milk heating was increased up to 96...99 ° C, the curd whey with the acidity up to 230° T in the combination with protein concentrates in ratio 10:0,1:1,0 was used as a coagulant. Salting (pickling) of cheese is done in the

brine [6]. To make soft cheese the necessary amount of sour whey and CaCl was added to the raw whole milk to normalize it. The above milk was in the cheesy basin together with the skim milk. The dairy mixture with the acidity 40...60° T was heated to 70...85 ° C, kept for not less than 10 min. without mixing, then the whey was poured away and the clot was poured out in the forms and the self pressing is done. Then a cheese was rubbed by salt and cooled in the refrigerating chamber [7]. It has been established that when the temperature of milk treatment is lowered from 95 ° C to 85 ° C the output of cheesy mass is decreased on average by 4, 8 % and from 95 ° C to 75 ° C by 2,6 %. The decrease in the mass rate of fat in the initial raw milk from 3 % to 2 % and the temperature of milk treatment from 95...85 ° C reduces the output of cheese.

It is connected with the increase in the regimes of milk treatment that enhance the process of denaturation of whey proteins and involves them in the clot [8 - 9].

The technology of making the biopreparation "WPP-C" developed by us that is the liquid part of thermally treated cheese-whey suspension has been used before to make goat's hard rennet cheese with high temperature of second heating of "Swiss" type under the conventional name "Solnechnyy".

It has become known from the previous publications that the use of the above preparation provides the decrease in the terms of the product ripening by 12...15 days as it was specified in the normative documents (60 days – the period of ripening) [10].

The methods of the improvement of the technology of goat's hard rennet cheese making with the use of two biopreparations of dairy and cheesy kinds "Whey parafood", abbreviated "WPF" are protected by two declaration patents of Ukraine for the useful model (№ 58357 and № 59226) under the same name "Method of making rennet cheese from goat's milk" registered in the state list of patents of Ukraine for useful models of 11.04.2011 and 10.05.2011, respectively [11 – 12].

All the above mentioned gives the grounds to suppose the possibility to use the above biopreparation to produce other types of cheese including the production of soft cheese by thermo acid method of cheese making from goat's milk.

It should be pointed out that in 2009 we developed the State Standard of Ukraine for soft cheese from goat's milk (Soft cheese from goat's milk. General technical conditions (SSTU XXXX: 2009), that passed all stages of the review and agreement. However, because of the unknown reasons, possibly because of the ineffectiveness of the officials it has not been appeared in the shops of standards.

Materials and methods. The determination of the physical and chemical composition was done instrumentally (by the devices) in the experimental centre of the Institute of Animal Science of UAAS of Ukraine, accredited in accordance with the requirements of ISO/IEC 1725; 2006 (ISO/IEC 1725; 2005, accreditation certificate № "T621 in the National Agency of Accreditation of Ukraine).

For calibrating infrared analyzer in determining the percentage of fat mass was used acid Gerber method (GOST 5867 and DSTU ISO 1211), the determination of total protein (protein) was carried out according to the requirements of ISO 8968-1 Kjeldal's method and DSTU ISO 8968 -5, determination of amino acid composition

in accordance with ISO 13903:2005 «Compound animal feed. Determination of the amino acid. »

Results. The main values of the technological process of goat's soft cheese "Adygeysky" in accordance with the existing normative documentation on the product from goat's milk are the following: content in dry matter, % not less than 45%; protein, not less than 16,5 %, content of moisture, % not more than 60 %

- content of salt, % not more than 2,0 %. In order to improve the biochemical composition of goat's soft cheese and to increase its output in accordance with the new technology of the above-mentioned goat's soft cheese the cheesy kind of the biopreparation "WPP-C" developed by us, in the amount of 0,002...0,04 mass., % was added to the pasteurized skimmed, whole goat's milk or to the normalized mixture of goat's milk. The rest of the technological operations were conducted in accordance with TU 10.02.847 – 90 and the technological instructions to them. Thus, to accelerate the whey coagulant acidity growth 1,0...2,0 % of the ferment prepared on the pure cultures of the Bulgarian, acidophilic or other kinds of thermophilic rods was added to the whey. The filtrated whey with the acidity 85...120 ° T in the amount of 8...10 % was added to the normalized dairy mixture prepared to the coagulation [13]. The physical and chemical values and the output of the control and the experimental batches of the goat's soft cheese "Adygeysky" and the experimental batch of cheese "Orion" made by the traditional technology and the technology developed by us are given in Table 1.

It can be seen from Table 1 that the content of fat, moisture in the experimental batch of cheese and its active acidity was higher at 0,96 ($P \geq 0,95$) and 3,69 % ($P \geq 0,99$) as well as at 0,3 pH unit ($P \geq 0,95$) as compared to the analogous values of the control batch of the product (without the use of the biopreparation "WPP-C").

Table 1

Physico-chemical characteristics and yield of soft goat cheese

Parameters	Results of the investigation	
	Control № 1	Experimental № 2
Mass rate of fat in dry matter, %	45,01±0,10	45,01±0,10
Mass rate of moisture in cheese, %	54,06±0,5	57,75±0,22
Mass rate of common salt, %	2,0±0,08	2,0±0,09
Active acidity, pH unit of cheese made	5,4±0,08	5,7±0,05
Expenditure of normalized mixture of milk from 1000 kg of raw material, t	9,34±0,20	9,24±0,19
Output of cheese from 1000 kg of normalized mixture	107,1±0,21	108,2±0,21

The presence of the higher content of moisture in the soft cheese made with the use of the cheesy kind of the biopreparation "WPP-C" can be explained by the larger amount of protein in the experimental batch of cheese and, respectively, by their increased ability to keep moisture.

The presence of the higher content of fat, protein and moisture in the experimental batch of soft cheese had a positive effect on its quality (taste, flavour and colour) and its consistency as compared to the analogous values in the control

batch of cheese. It allowed to evaluate the quality of the experimental batch of cheese by 4 points higher than that of the control one.

The output of the experimental batch of cheese № 2 from 1000 kg of milk with the use of the biopreparation was more by 1,1 kg ($P \geq 0,99$) as compared to the analogous values of the control batch of the goat's soft cheese № 1 (made without the use of the above biopreparation).

The values of the protein and amino acid composition of the experimental and the control batches of goat's soft cheese "Orion" have been given in table 2.

Table 2

Amino acid composition of goat's soft cheese, mg/100 mg

Parameters	Results	
	Control № 1	Experimental № 2
1	2	3
Mass rate of protein, %	19,66±0,02	21,87±0,02
Aspargin	1,24±0,02	1,21±0,04
Threonin	0,73±0,04	0,87±0,02
Serin	0,81±0,03	1,03±0,03
Glutamin acid	2,41±0,01	3,21±0,02
Prolin	1,65±0,024	1,67±0,03
Cystin+Glycin	0,77±0,02	1,27±0,01

Continued table 1

1	2	3
Alanin	0,43±0,02	0,62±0,02
Valin	0,74±0,01	1,00±0,014
Methionin	0,37±0,02	0,51±0,02
Isoleucin	1,00±0,02	0,94±0,02
Leucin	1,39±0,01	1,66±0,04
Thyrosin	0,73±0,01	1,12±0,02
Phenilalanin	0,70±0,02	1,01±0,02
Hystidin	0,46±0,01	0,59±0,03
Lysin	1,09±0,02	1,37±0,01
Argynin	0,61±0,02	0,82±0,01
Total amount of essential amino acids: threonin, valin. methionin, isoleucin, leucin, phenilalanin, lysine, argynin	6,63±0,04	8,18±0,01

It can be seen from table 2 that the content of protein and the mass rate of amino acids in the experimental batch of cheese "Adygeysky" "Orion" was higher by 2,21 and 1,55 % ($P \geq 0,95$) as compared to the analogous values in the control batch of cheese.

Conclusions.

1. The technology of goat's soft cheese "Orion" developed by us will provide the enrichment of the ration of the population of Ukraine by the product of high biological value (with higher content of protein and amino acids).

2. The use of the cheesy kind of the biopreparation "WPP-C" when making goat's soft cheese promotes the increase in its output.

3. The resource saving technology of soft cheese by thermo acid method of cheese making do not need the use of the complex expensive equipment and that is why it can be introduced into practice in the conditions of milk processing plants and mini-plants on private farms.

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J21410-019

Turok E., Silchuk T., Kulinich V., Tsiurlikova V
THE COMPERATIVE CHARACTERISTICS OF IMPROVERS OF
DIFFERENT BRANDS OF THE BREAD PRODUCTION IN RESTAURANT
INSTITUTIONS

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Annotation. The article is devoted to the research of the comparative impact assessment of different brands' improvers on the quality of rye-wheat bread. It describes their influence on the biochemical processes, constitutional and mechanical properties of dough, and quality of bread

Key words: bread, improvers, dough, rye flour.

I. Introduction. Rye-wheat bread is popular among the Ukrainian people. It is proved by nutrition science that in compare with wheaten sorts of bread rye-wheat bread is more useful. There are a lot of irreplaceable amino acids, vitamins B and PP and more iron (in 30%), twice more magnesium and potassium in rye flour then in wheat flour. Fat and diabetes sick people, people that suffer from bars and anemia are recommended to eat bread that hastens metabolism in the organism. [1]

Preparation of rye-wheat bread using a traditional technology is a quite long process. As for restaurants institutions, applying this technology is almost impossible. At this point it is much more considerable to use accelerated technology of rye-wheat bread production.

Nowadays market offers a lot of improvers, which can be used toward this end. But there is a question concerning the selection of improvers' brand, which will be effective for the accelerated technology of bread production. Comparative description gives possibilities to find the optimum variant of improvers, which can be used in restaurant institutions for rye-wheat bread production.

The most popular improvers are "Bavaria" ("Irex" Germany), "Agram black" ("Irex" Germany) and "Mole Granum" ("SantaVita" Ukraine).

The usage of these improvers gives a lot of advantages.

II. Data and methods. The comparative valuation of bread quality, which was produced with a help of "Bavaria", "Agram black", "Mole Granum" improvers, was held.

"Bavaria" and "Agram black" improvers are dry ferments that are used for production of wheat and rye-wheat sorts of bread with the usage of accelerated technology and in a traditional way. "Mole Granum" is an improver based on gluten for rye-wheat bread.

Improvers were measured out norm, that was average to the averaged norm offered by producers, particularly for "Bavaria" – 2,5%, for "Agram black" – 0,9%, for "Mole Granum" – 1,5%.

The rye-wheat bread was produced by means of accelerated technology. Correlation of rye and wheat flours was 50:50. Mixing was made by using laboratory's flour mixing machine. Mixing time period was 5-7 minutes. The products were formed by hands, flour fermentation was 30 minutes, at the temperature $t = 30 \pm 2$ °C, final production was held at the temperature of $t = 30 - 32$ °C and relative humidity of 75-80%. The bread was baked in the oven and with a help of special forms in an air-o-steam at the temperature $t=200-220$ °C. Titrated acidity of semi-finished products was measured by the titration mash method. The change of the viscous-plastic properties of bread were investigated depending on the flour ball was spreading and changes of bread's gas keeping ability. Finished products were analyzed according to the indexes of buck part of moisture, acidity, porosity and specific volume of bread, which were defined by standard methods.

Porosity of crumb was determined with a help of Zhuravlev device.

III. Results. As a result of research it was determined that the duration of technological process of rye-wheat bread preparation in an accelerated technology way is much quicker than usage of traditional technology. The time period of bread fermentation with adding improvers was 30 minutes, the stand period of bread storages was 40-50 minutes. At the same time bread prepared with a help of accelerated technology with improvers had good quality.

From received results it is visible (tab. 1), that the "Agram black" improver addition distinguishes the acidity of dough from other samples of dough with "Bavaria" and "Mole Granum" improvers. This is explained by the high own acidity of improver. The duration of product's standing time with "Agram black" was shorter then with two other improvers.

Determination of specific volume showed that the biggest specific volume was in the samples with "Agram black" improver. With addition of complex bread-backed improver "Agram black" the volume of dough during 1,5 hours of

fermentation increases actively, so gluten of dough strengthens and more actively keeps cumulative carbonic acid (fig. 1).

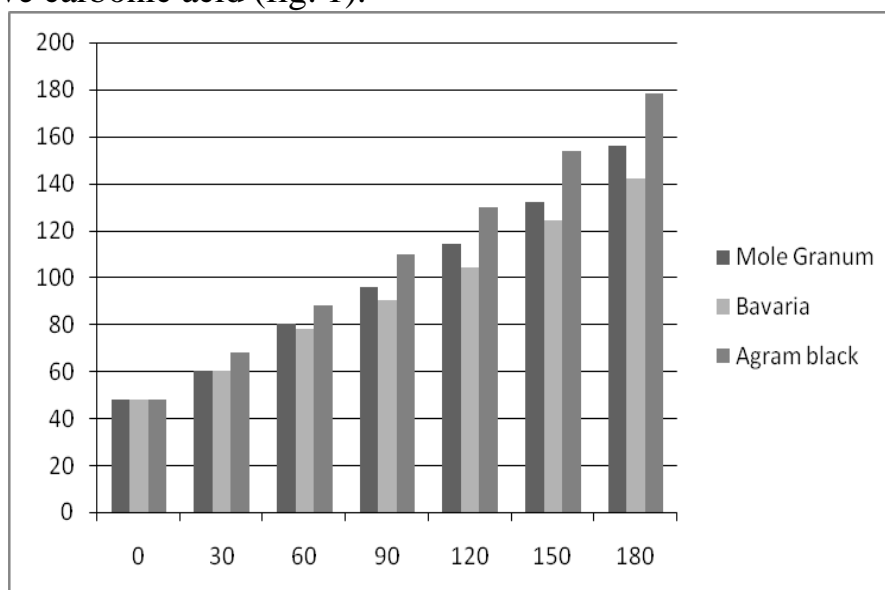


Fig. 1. – The impact of bread-backed improvers “Mole Granum”, “Bavaria”, “Agram black” on the gas-deterrent ability.

It is determined that appearance, condition of crumb, porosity, taste and aroma with addition of improvers “Mole Granum”, “Bavaria”, “Agram black” almost don’t differ from each other, but it is necessary to note that samples with “Agram black” are darker than samples with “Mole Granum” and “Bavaria”.

Based on the results of research the highest index of porosity showed the sample “Mole Granum”, but samples with “Bavaria” and “Agram black” have not least pleasant commodity appearance and well fluffed up crumb. The smallest specific volume had sample with “Agram black” improver, but it didn’t influence the commodity appearance of sample.

Ready products had pleasant taste and rye-wheat bread aroma.

Table 1

The influence of bread backed improvers “Mole Granum”, “Bavaria”, “Agram black” on the indexes of technological process and quality of rye-wheat bread

Indexes	Amount of added improvers, % to the mass of flour		
	Mole Granum 1,5%	Bavaria 2,5%	Agram black 0,9%
Dough			
The start acidity of dough	3,6	4,2	4,4
The duration of fermentation	30	30	30
The duration of dough standing, minutes	40	40	35
Final acidity of dough, minutes	4,6	5,6	5,8
Bread			

Acidity, degrees	4,6	5,0	5,3
Porosity, %	64	65	63
Specific volume, cubic cm /gram	1,76	1,66	1,76
Humidity, %	45,0	45,0	45,0
Appearance	Shape is correct, surface is strait		
Condition of crumb	Elastic		
Porosity	Equal, thin-walled		
Taste and aroma	Peculiar to rye-wheat bread		

Conclusion. Hold investigation showed that it easy to vary and improve the quality of such product as bread with a help of different additions. For restaurant institutions usage of researched samples is expedient in production of rye-wheat sorts of bread with usage of accelerated technology. Improvers of all brands provide quality of products which comply with demand of normative documentation. Almost for all indexes despite of the fact that the concentration to mass of flour was the smallest, leader positions takes “Agram black”. It guarantees the least duration of product’s standing period and darker coloring of bread’s crumb.

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**THE INFLUENCE OF ENOGELATIN ON THE QUALITY OF
DOMESTIC WINE MATERIALS**

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In this work the influence of the liquid enogelatin (home produced) on the quality of wine materials and their permanence is considered. Enogelatin has higher level of reciprocity with phenolic compounds, increases organoleptic qualities and provides long lasting permanence of drinks.

Keywords: grape, wine material, quality, phenolic compounds, enogelatin, argosite, finning, permanence.

Viticulture and wine manufacturing have always been important branches of Ukrainian agro-industry. This branch occupying not very large territory in agricultural areas has a significant influence on the socio-economic development of regions. It is extremely important for increasing living standards of population and it is an important budget-forming factor of the Ukrainian agro-industrial sector.

Ukrainian vast variety of soil and climatic conditions and relief provide a possibility of appearing interesting wine-manufacturing micro regions, where high quality wines of different types are produced: from light, soft, table and champagne wines to fully oily and silky dessert wines.

Ukrainian wine manufacturing branch is widely spread in 6 regions: Crimea Autonomous Republic, Trans Carpathian Region, Zaporizhia Region, Mykolaiv Region, Odessa Region and Kherson Region.

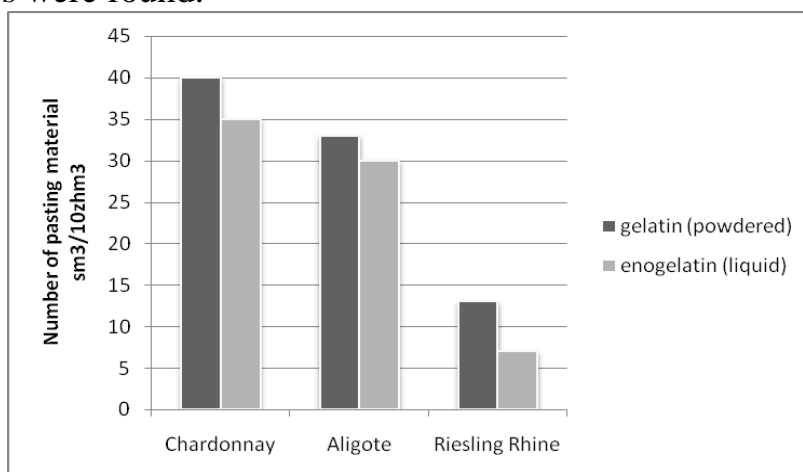
The special demand to the manufactured product is its permanence – conditions under which no undesirable changes of physico-chemical and organoleptic qualities appear in wine during the warranty period. These changes are caused by turbidity, mostly colloidal.

The **aim** of the investigation is to analyse the influence of the enogelatin(home manufactured) on the quality of the wine-making materials and their permanence. The domestic manufactured gelatin (powdered), which is traditionally used for wine manufacturing, possesses a number of essential disadvantages: a long lysing period, a smell of an animal glue, a complicated process of wine-making manufacturing under the low temperature, different adhesive and flocculate abilities [1]. On the contrary, enogelatin has higher level of interacting with phenolic compounds (in comparison to the traditional gelatin in the process of the wine-material manufacturing) and increases organoleptic qualities and provides a durative permanence of drinks; it also has the weak finning ability[2].

Methods of the investigation. The investigation was conducted on the white dry champagne wine-making materials made of the following grape varieties: Aligote, Chardonnay and Riesling which were manufactured during the season 2013 at LLC “ZolotaBalka” (Simferopol), HMC “Lymanskyi” (Mykolaiv Region, Ukraine) and a single proprietor firm (Berehove, Trans Carpathian Region).

The influence of the finning agents of enogelatin (liquid form), gelatin (powdered form), argosite on the quality of the wine-making materials was investigated.

Firstly, the physical and chemical features of wine-making materials and schemes of manufacturing were defined depending on the trial finning of the wine-making materials by gelatin, enogelation with argosite (home manufactured). And their optimal doses were found.



Picture1. Results of the trial finning of the wine materials

The results of the trial finning showed the tendency towards the reduction of doses of enogelatin in comparison with powdered gelatin (Picture 1).

On the basis of the trial finning, the elaboration of the laboratory parties of the wine materials from different regions of Ukraine was conducted. The results show

that the usage of enogelatin allows getting steady wine materials using smaller dose of the finning material.

The content of the basic components – alcohol, sugars, titrated acids, general essence – practically did not change.

Table 1

The influence of the finning materials on the physico-chemical qualities of the investigated wine materials

Qualities	Wine materials from the varieties of grapes								
	RieslingRhine			Aligote			Chardonnay		
	before manuf acturi ng	G+A	Enogel. +A	before manuf acturin g	G+A	Enogel .+A	before manufa cturing	G+A	Enogel. +A
Volume fraction of alcohol, %	10,5	10,5	10,5	11,6	11,6	11,6	10,8	10,8	10,8
pH,	3,1	3,1	3,1	3,4	3,4	3,4	3,3	3,3	3,3
Mass concentration of sugars, gr/dm ³	1,0	1,0	1,0	1,0	1,	1,0	1,3	1,3	1,3
Mass concentration of titrated acids in recalculation to wine acid, gr/dm ³	6,9	6,9	6,9	6,4	6,4	6,4	7,2	7,2	7,2
Mass concentration of volatile acids in recalculation to acetic acid, gr/dm ³	0,48	0,48	0,47	0,48	0,48	0,47	0,42	0,42	0,41
Mass concentration of the suggested essence, gr/dm ³	18,3	18,3	18,3	17,7	17,7	17,7	19,1	19,1	19,1
Mass concentration of phenolic substances, mgr/dm ³	420	410	406	520	513	507	470	452	447
Quantity of total SO ₂ , mgr/dm ³	81	80	77	80,1	78,6	74	94	91,2	88,3
Quantity of free SO ₂ , mgr/dm ³	24	19,1	17,8	29	27,3	24,1	17	15,3	12,8

G – gelatin (powdered);

Enogel. – enogelatin (liquid);

A – argosite.

The data of the table 1 shows that manufacturing wine materials by different finning materials does not influence greatly basic physico-chemical qualities. But great changes are found in the reduction of phenolic substances in all manufactured wine materials. So, while manufacturing wine materials by gelatin with argosite, the reduction in wine materials is (mgr/dm³): in Riesling – 10, in Aligote – 7, Chardonnay – 18. In comparison to manufacturing by enogelatin with argosite this discrepancy is higher and it is: for wine material from Riesling – 1, for Aligote – 13, for Chardonnay – 23. Consequently, manufacturing wine materials by enogelatin with argosite significantly decreases the amount of phenolic substances in 5 mgr/dm³ averagely, that positively influences firmness and permanence of the wine materials.

The change of the quantity of the total sulphurous acid before and after finning can be observed in the investigated wine materials: the quantity of the total SO_2 decreases after finning in all wine materials in 6 mgr/dm³ averagely, and the quantity of the free SO_2 decreases for Riesling – 6,2mgr/dm³, in Aligote – 5 mgr/dm³, Chardonnay – 4,2mgr/dm³. It positively influenced organoleptic qualities of the investigated wine materials.

The investigation of the kinetics of the wine materials manufacturing process shows that the reciprocity of enogelatin with wine components takes place practically immediately and finishes basically within 1 minute that corresponds to the investigation of the other authors [3].

Table 2

Optic and Potentiometric characteristics of the wine material from grape variety RieslingRhine

Qualities	Wine material		
	Source	After manufacturing	
		Gelatin according to GOST 11293	Enogelatinliquid
1	2	3	4
Intensity of colouring I	0,1000	0,1000	0,092
Shade of colouring T	3,0	2,9	3,0
Yellowness index G	9,68	8,70	9,13
D ₄₂₀	0,074	0,070	0,069
D ₅₂₀	0,025	0,024	0,023
1	2	3	4
D ₆₂₅	0,001	0,006	0,000
Potentiometric Characteristics:			
E _{нисх.}	404	414	410
E _{нкон.}	250	248	246
Δ E _h	154	166	164
Acidness index	0,42	0,47	0,48
Mass concentration, mgr/dm ³ :			
Polymeric forms of phenolic substances	169	160	157

Conclusions. The results of the investigation showed that manufacturing wine materials by enogelatin (together with mineral sorbent) is an effective technological method of stabilization of wine materials and it is recommended for wide usage at manufacturing enterprises in comparison with powdered gelatin.

The comparison of polymeric forms of phenolic substances in the investigated wine materials before and after finning shows that their amount decreases greatly after finning – after manufacturing by gelatin it decreased by 9 mgr/dm³, by enogelatin – by 12 mgr/dm³.

The results got from the laboratory investigations are mathematically processed with the help of Excel, the correlation coefficient is found which is 0,95.

The investigations show that the amount of the phenolic substances in the wine materials from the varieties of grape Aligote, Chardonnay and RieslingRhine decreased significantly after finning in comparison to the samples before finning.

The mass concentration of the free and total sulphurous acid in the investigated wine materials had some slight changes which influenced positively organoleptic qualities of the wine material.

Manufacturing wine materials by enogelatin together with argosite provides stability of the wine material, allows decreasing the amount of enogelatin itself and argosite, improves organoleptic qualities.

The conducted analysis helped to find out that finning significantly influences all investigated characteristics, which stipulate quantitative and qualitative characteristics of the wine material and simplifies the process of manufacturing. Enogelatin has low gelling ability that allows using it in the process of wine materials manufacturing under low temperatures.

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J21410-021

Raschepkin A.N., Korotkiy I.A., Fedorov D.E.

**CALCULATION OF CRITICAL SPEEDS OF MOVEMENT OF AIR AT
FLUIDIZING FREEZING OF BLACK CURRANT**

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Abstract. In work calculation of critical speeds of movement of air in the fluidizing freezers device for berries of black currant was made. As a result of calculations dependences of critical speeds of movement of air on its temperature are established. On the basis of researches the range of admissible speeds of movement of air for fluidizing freezing of berries of black currant is recommended.

Key words: fluidization, black currant, freezing

Products of a phytogenesis are one of bases of a diet of the person. The nutrition and biological value of many vegetable products used in food isn't called any questions. The berries which are a source of vitamins, mineral substances and other biologically active components, at hit in a human body have essential impact on many physiological processes proceeding in it. Among the Russian flora black currant is one of the most valuable representatives of berry culture. Medical properties of black currant are caused by existence in it the ascorbic acid which contents makes to 400 mg of %, and also vitamins C, In, R. [1, 2] Besides, black currant is rich with iron, lemon, apple and organic acid, pectin, tannins, carotene, pro-vitamin A and other useful substances.

Unfortunately, specifics of climatic conditions of northern regions of Russia limit possibility of the year-round use of berries. For conservation of this type of raw materials use various techniques one of which is freezing. Low-temperature processing of berries allows to prolong the term of their storage within many months, this way is one of the most widespread and simple methods of conservation. Correctly picked up modes of freezing allow to keep quality indicators and a nutrition value of foodstuff in the maximum degree, to exclude a overripening, and also to reduce losses of natural losses of fruit and berry raw materials. [3]

For berries the fluidizing freezing at which cold air is blown through a layer of berries that brings them into a suspension is most widespread. The fluidizing freezing is especially effective for gentle garden types of berries as allows to provide fast freezing and at the same time partially to keep a berry form after transportation. [4] For development of technologies of a fluidizing freezing of berries it is necessary to know such parameters as temperature of processing and critical speeds of movement of air.

Thus, the purpose of this work is calculation of critical speeds of movement of air at a fluidizing freezing of berries of black currant.

Data on characteristics of a frozen product are necessary for determination of optimum speeds of movement of air. Mass and volume characteristics of studied grades of black currant are presented in tab. 1.

For determination of critical speeds of movement of air the following technique was used. [5]

Table 1

Mass and volume characteristics of berries of black currant

grade	Mass of a single product, g	Density of a product, kg/m ³	Diameter of a single product, mm
Lisavenko's memory	1,4	1067	13÷14
Seedling pigeons	1,1	1082	12÷13
Shukshin's memory	0,9	1070	11÷12
Black pearls	1,7	1075	14÷15
Beauty of Altai	1,1	1059	12÷13
The fluffy	0,8	1063	11÷12

Critical speed of movement of the w'_{cr} air, characterizing the beginning of fluidization paid off on a formula (1):

$$w'_{cr} = \frac{\nu_a}{d_e} \times \frac{Ar}{1400 + 5,22\sqrt{Ar}}, \quad (1)$$

where ν_a – kinematic viscosity of air, m²/s;

d_e – diameter of spherical part of a product.

Archimedes's number was determined by a formula (2):

$$Ar = \frac{g \cdot d_e^3 \cdot (\rho_p - \rho_a)}{\nu_a^2 \cdot \rho_a}, \quad (2)$$

where $g=9,8 \text{ m/s}^2$ – acceleration of gravity;

ρ_p, ρ_a – density according to a product and air.

Critical speed of movement of air w''_{cr} , the characterizing speed at which ablation of a product is possible was determined by a formula (3):

$$w''_{cr} = \frac{v_a}{d_e} \times \frac{Ar}{18 + 0,6 \cdot \sqrt{Ar}} \quad (3)$$

Results of calculations of critical speeds of movement of air in the range of temperatures $-13 \div -43^\circ\text{C}$ are presented in fig. 1.

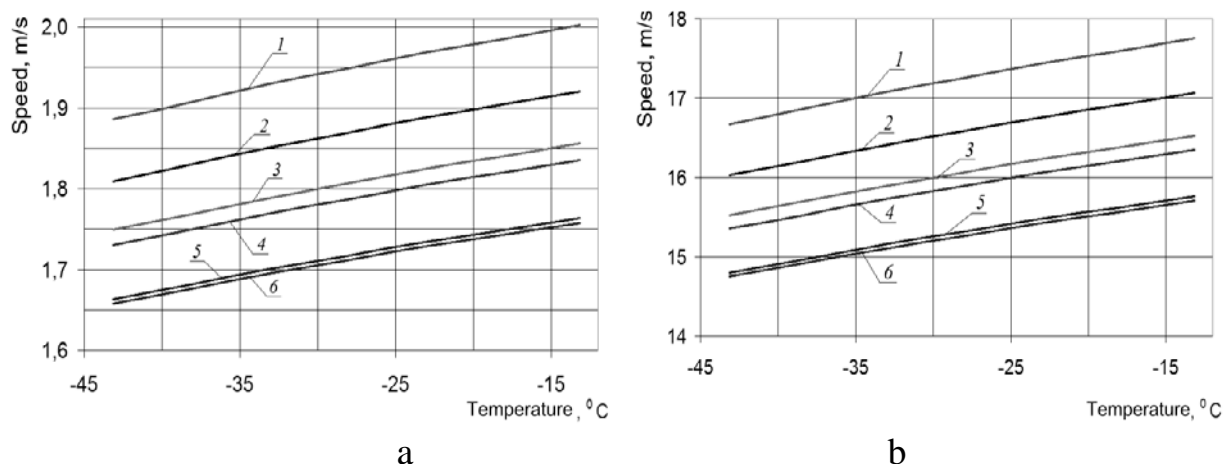


Fig. 1. Dependence of critical speeds of fluidization of berries of black currant 1- "Black pearls"; 2- "Lisavenko's Memory"; 3- "Seedling pigeons"; 4- "Beauty of Altai"; 5- "Shukshin's Memory"; 6- "Fluffy":

a) speed began fluidizations; b) air speed at which ablation of berries is possible.

Proceeding from results of calculations, the range of speeds of movement of air for all studied grades of berries of black currant at which fluidization is observed, i.e. from emergence of a fluidized layer to the speed at which ablation of berries is possible, makes from 1,24 to 17,7 m/s in the temperature range from $-13 \div -43$ of $^\circ\text{C}$. As each of grades of black currant is characterized by the range of critical speeds of movement of air, it is possible to recommend the range of speeds at which the fluidization phenomenon without ablation of berries for all studied grades is guaranteed: from 2 to 11,5 m/s.

Thus, on the basis of the conducted researches the admissible range of speeds of movement of air in the fluidizing freezers device for freezing of berries of black currant which made from 2 to 11,5 m/s was calculated. The presented results of researches can be useful when developing technologies of low-temperature data processing of types of berries.

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Gun'ko S.M., Trynchuk A.A.

**QUALITY OF MUSHROOMS OF OYSTER PLEUROTUS
DEPEND ON DURATION AND TEMPERATURE OF STORAGE**

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Investigations of influence of storage temperature and term of storage on the marketability and nature losses of mushrooms of oyster pleurotus were presented in this article.

Keywords: mushrooms, oyster pleurotus, conditions of storage, time of storage, quality of oyster pleurotus.

Introduction. Volume of growing and consumption of edible mushrooms grow every year both in our country and abroad. This is because they successfully combine taste with high nutritional value. Fruit bodies of mushrooms contain 40 - 46% crude protein, 2 - 3% crude fat, 1 - 2% carbohydrates and vitamins B₁, B₂, C.

Mushrooms can be grown all year round and no light area, weather, soil conditions harvesting of 1 hectares 11 thousand quintals a year. The world's population consumes about 5 million tons of mushrooms, in the forests are going to

only 0.6 million tons, and the rest - are grown on mushroom farms. Today in our country produces about 30 tons of mushrooms, most of which is oyster [1-2].

The process of storing mushrooms accompanied by loss of marketable quality, changes in the biochemical composition of substances and they are subject to natural loss in weight, so they must be stored under low temperature [3-4].

Temperature, which provides the best preservation mushrooms within 0-2 ° C, but provide this regime all the way from the manufacturer to the trade network is not always possible. Therefore, the aim of our study will determine the effect of different storage temperatures on the marketability of mushrooms of oyster pleurotus and their natural losses.

Materials and methods. The studies were conducted during 2008-2011. Storage mushroom of oyster pleurotus strain NC -35. This is high-performance, wide-spread, suitable for growing all year round and multi-purpose strain.

Mushrooms stored in the four cold chamber KX-6IO with a working volume were 6 m³ equipped electric lighting and appliance control temperature and humidity.

Storage options in chamber – temperature: minus 1, 1, 3, 5 °C, relative humidity - 90±1%. Control – mushrooms stored at temperature of 1 °C. Duration of storage – 6 days; repetition – four-time. Commodity quality mushrooms was evaluated visually. Mass loss was determined by fixed samples.

Results. Based on the literature review and performed our previous studies for the research it was found maximum long term of mushrooms, which provided them with appropriate quality and 6-day storage temperature - minus 1, 1, 3, 5 °C.

Changing the quality of mushrooms was determined after 6 days of storage, depending on the organoleptic characteristics and their marketability.

The best storage temperature for mushroom of oyster pleurotus temperature was 1 ° C (control) (Fig. 1). Mushrooms meet the requirements of the standard: whole, elastic without significant changes in color and odor.

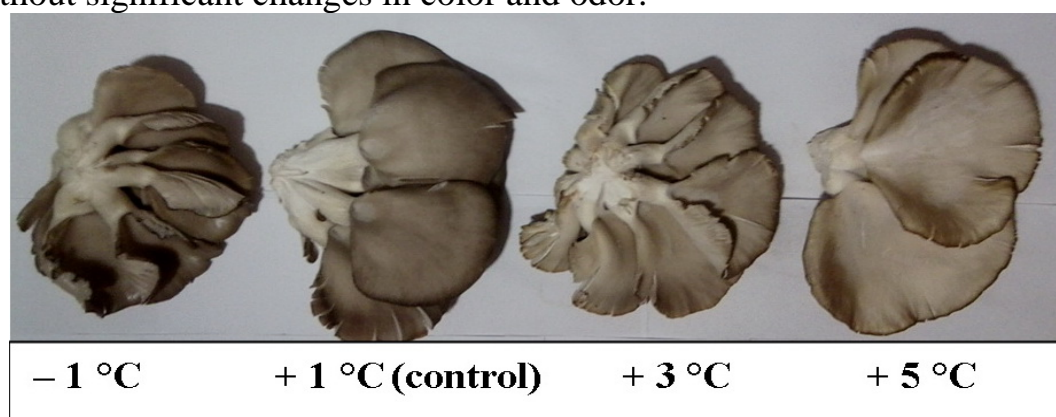


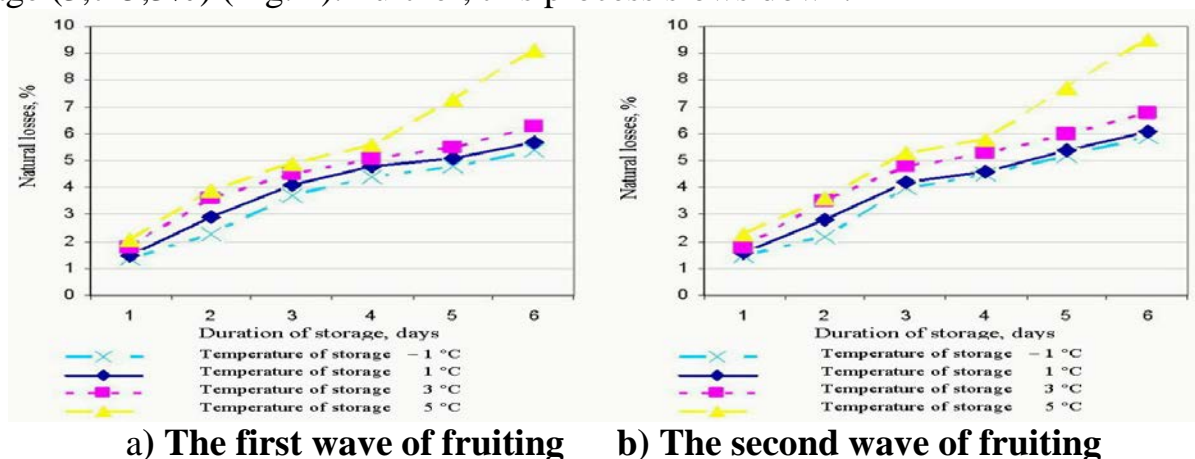
Fig. 1 - Oyster pleurotus of strain NC-35 after storage during 6 days at the different temperatures

With increasing temperature storage oyster lost its marketable quality. Elasticity decreased, increasing the number of fruiting bodies of the cracked edges, the color changed from dark gray to gray-beige. At a temperature of 5 ° C was observed appearance of spider webs white hyphae of the mycelium, which is typical oyster and demonstrates the process of aging mushrooms and ripe spores. These mushrooms are unsuitable for sale in fresh but can be used for processing. Keeping mushrooms of

oyster pleurotus at minus 1 °C carry out to their partial freezing. After thawing of fruiting bodies lose marketable quality, but their flavor properties and structure was not completely lost, obviously due to the high content of dry solids (9,4-10,3%), chitin and structural features of cells. For these fruiting bodies of mushrooms should consider their use in processing.

Mushrooms belong to the juicy products that contain a significant amount of free moisture, so the storage they lose a certain amount of its weight. During of storage oyster pleurotus lost of weight, which include lost of dry matter and moisture.

Fruit bodies of oyster pleurotus have large scale of evaporation, resulting in high natural weight loss during storage. Lost of weight is more during the first 3 days of storage (3,7-5,3%) (Fig. 2). Further, this process slows down.



a) The first wave of fruiting b) The second wave of fruiting

Fig. 2 - Dynamics of natural loss of weight mushroom of oyster pleurotus of strain NC-35 during storage at different temperatures, %

At 5 °C for 5 days natural losses begin to rise, due to the loss of dry matter in preparation for mushrooms spore ejection. General natural losses of oyster mushroom were 5,4-9,5% (Table). The lowest natural losses observed for fruiting bodies of mushrooms fruiting first wave (5.4%) at storage temperature minus 1 °C, and the highest - for the second wave of mushrooms storage at a temperature of 5 °C (9.5%).

Table

Preservation of fruit bodies of oyster mushroom strain NC-35, depending on the temperature settings, %

Temperature of storage, °C	Natural losses of weight	Output of non-tradables fruiting bodies	The output of commodity fruiting bodies
The first wave of fruiting			
-1	5,4	75,2	19,9
1(control)	5,7	0,5	93,8
3	6,3	3,1	90,6
5	9,1	8,7	82,2
The second wave of fruiting			
-1	5,9	78,2	15,9
1(control)	6,1	1,1	92,8
3	6,8	3,9	89,3

5	9,5	9,9	80,6
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This can be explained by the large area of evaporation, but the number of unusual fruiting bodies is low and amounts to 8.7% for the first wave and 9.9% for the second at 5 °C. The largest yield of marketable products obtained at a temperature of 1 °C - 93.8% for the first wave and 92.8% – for the second.

Increasing storage temperature oyster pleurotus reduces the output standard fruiting bodies. However, the most unfavorable in terms of output of commodity production is temperature minus 1 °C. At the same time, studies have revealed that the oyster mushroom after storage at minus 1 °C and the subsequent defrosting is able to recover the structure and these mushrooms after sorting can be used for processing and the production salted or canned mushrooms.

Conclusions

1. The most optimal temperature for storing mushrooms oyster mushroom 1 °C. When it increases to 3-5 °C, after 6 days of storage, loss of marketable mushrooms. They are not suitable for implementation in fresh. At minus 1 °C freeze oyster, but after defrosting it can restore its structure and therefore it is necessary to consider their use in processing industry.

2. Keeping quality mushroom fruiting second wave is lower than the first. This dependence can be explained by the loss of nutrients in the compost second wave of fruiting and appearance of various infections.

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Gun'ko S.M.

**EFFECT OF CONDITIONS AND DURATION OF STORAGE ON THE
TECHNOLOGICAL PROPERTIES OF GRAINS OF WINTER WHEAT**

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The results of researches of influence of conditions and duration of storage on the technological properties of grain of winter wheat are presented.

Keywords: Winter wheat, conditions of storage, duration of storage, technological properties of grain of winter wheat.

Introduction. In the grain balance of Ukraine leading place had winter wheat [3]. The main task for the future is to increase production and improve the quality of the grain on the base intensification. Increase production and harvesting of grains of different cultures is fundamental condition to supplies of people by foods, seeds, industrial by raw materials, animal by fodder and creation of state reserves [2].

Only a small part of the grain wheat from the manufacturer comes to individual consumers and more them originally stored or processed in various sectors of the national economy. We can improve productivity and dramatically increase the grain harvest, but not get the desired effect, if at different stages of promoting the product to the consumer will be great lose of weight and quality [1]. According to the

International Organization for Food and Agriculture (FAO) annually lost of grain and grain storage was 10 ... 15 % [5].

Reducing losses in wheat quality and quantity in storage was considered as one of the most important ways to reduce food shortages [4].

The purpose of research was study of varietal characteristics, conditions and duration of storage of winter wheat on its technological properties.

Materials and methods. In studies used samples of winter wheat varieties Perlyna Lisostepu and Myronivs'ka 65. Analyses of samples of wheat were carried out on the chair of storage, processing and standardization of plant products of National University of Life and Environmental Sciences of Ukraine in the 3-time repetition. The object of research was the quality of wheat research varieties in the long-term storage in controlled temperature condition (5 ... 10 °C). Control was quality of winter wheat research varieties during storage in unregulated environment (fig. 1).

In the experimental samples of wheat before storage and after 1, 3, 6, 9, 12 months determined technological indicators of quality: 1) moisture; 2) grain unit; 3) vitreous of grain; 4) quantity of gluten; 5) quality of gluten; 6) number of falling. We used the most widespread in industrial practice and research methods determination quality of wheat and its products.

Results. The main factor that determines the direction and intensity of physiological-biochemical processes during storage of grain is its humidity. Grain of wheat was keeping with moisture from 13.0 till 14.5 % and remained with humidity that does not exceed the critical (Fig. 2a).

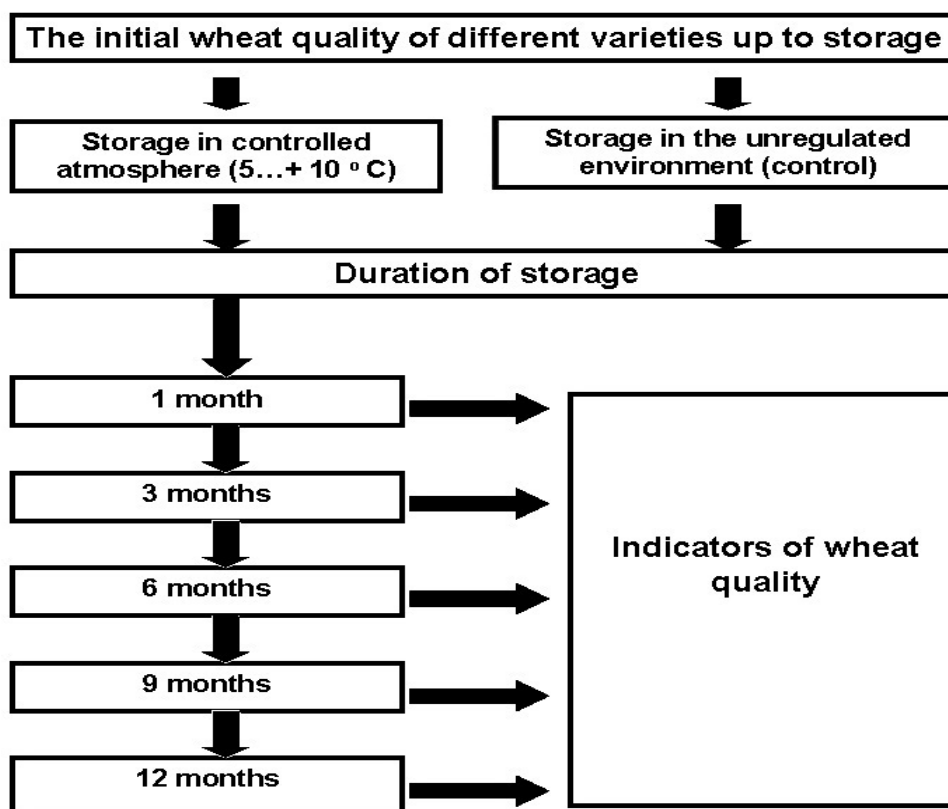


Fig. 1. Scheme of studies

Analyzing these results we can see that moisture samples of wheat grain varieties Myronivs'ka 65 and Perlyna Lisostepu during of storage slight changes in the unregulated and regulated temperature regime. However, it should be noted certain objective laws. In particular, at the beginning of storage (up to 3 months) in both cases humidity decreases slightly and then (to 12 months) increases. The dynamic of humidity change was same in both regimes, but its fluctuations in regulated regime was less as a result lower temperature fluctuations.

The dynamics of changing grain unit in the wheat grain which storage are presented on Fig. 2b. As shown on Fig. 2b, grain unit in samples of wheat research varieties in process its storage changed insignificantly. Regime of storage on this quality indicator was not affected. This can be explained by that fact the rate of grain unit is closely linked with humidity of grain. Humidity of grain was within critical and don't significant fluctuations, because grain unit was not changed significantly.

During the one year of storage quantity of vitreous grains was not recorded significant changes (Fig. 2c). A slight increase vitreous of grain noticed at the beginning its storage when passing postharvest ripening, but not all varieties. This quality index increased as a result biochemical processes that formation of more composite substances (proteins, fats). In the aggregate, rate of grain vitreous was quite low. Regime of storage on quantitative changes of this index was not affected.

The quantity and quality of gluten is depending on variety and growing conditions. As can be seen from Fig. 2d, depends on quantity of gluten, wheat samples differed not significantly. Least gluten content had sample of grain variety Myronivs'ka 65 – 21.6 %. N.S. Berkytova and I.A. Swedova affirm that during post-

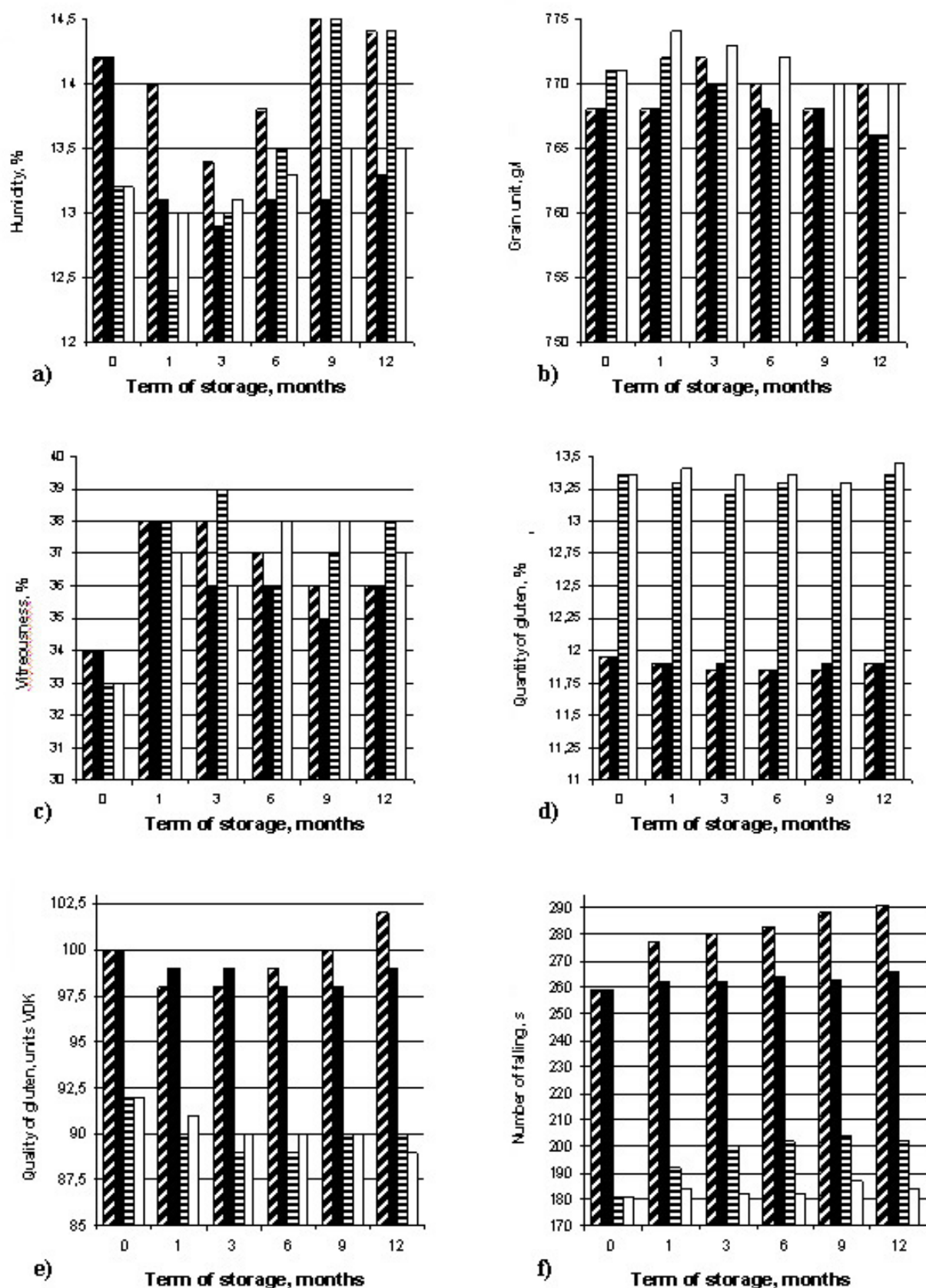


Fig. 2. Technological indexes of grain quality: a) humidity; b) grain unit; c) vitreous; d) quantity of gluten; e) quality of gluten; f) the number of falling

Unregulated temperature regime Myroniv's'ka 65
 Regulated temperature regime Myroniv's'ka 65
 Unregulated temperature regime Perlyna Lisostepu
 Regulated temperature regime Perlyna Lisostepu

harvest ripening in the first 30 days after harvesting and in the following terms (2 – 3 months), the quantity of gluten essentially does not change.

Increasing of gluten quantity during period of storage at most to both experimental varieties was 0.5 %. In this case, it should be noted that in controlled conditions, this quality index was more stable during storage and almost unchanged, which characterizes this regime of storage is more favourable to maintain grain quality for a long time.

Quality of gluten in Ukraine, unlike other regions of the world is essential.

This is due to the fact that Ukraine is very widespread corn bag that in some years, damaging up to 20 % of grain. Maximum allowable level of damaging is in the range 2-3 %. Gluten quality characterizes its physical properties – elasticity, extensibility and gas-retaining abilities.

The quality of wet gluten during storage improved (Fig. 2e), it has become more elastic, although these changes in both studied samples of grain of winter wheat were not great and were an average of 2 units VDK. Adjustable temperature regime of storage make for to the strengthening of the gluten and unregulated – relaxation.

Autolytic activity of flour of normal quality was low do not influence on the quality of bread. When harvested grain in rainy weather possible its germination. In this grain increased activity of enzyme, especially α -amylase. Starch transferred to dextrin and then to sugars. In this case, baking properties of flour is degenerate. Bread make from this flour has sticky with cavities crumb and dark-colored crust.

The lowest falling number in during two years of investigated in variety Perlyna Lisostepu – 181 sec (Fig. 2f),. In view of the high falling number varieties of wheat had low baking properties. Bread is pale, strong to heat and low volume. This is grain need increased activity amilolytic enzymes. During the storage we observed in both the experimental samples of wheat general trend to increase the falling number.

However, it should be noted that the samples of wheat grain variety Myronivs'ka 65 values of falling numbers were high enough already on the start of storage (259 s) and after 12 months of storage increased to 291 s and 266 s, depending on the regime. Such high rates of falling numbers indicate that dough from this grain would be "tight" of gluten and as a result obtain bread with low volume. In general, it should be noted that the value of index falling number more stable and low during storage in controlled regime but with unregulated and therefore we can conclusion that this regime promotes to better preserve indicators quality of grain.

Conclusions

1. Change that occurs in grain during storage depends on the initial quality. Thus, in wheat variety Myronivs'ka 65, which had weak gluten during the storage in uncontrolled conditions it deteriorates. This is carrying out to deterioration of baking properties, decreasing absorption capacity and dough diluted. Such, this is grains best kept in the cooling state (index of quality VDK more stable during year).

2. In the long term storage of grain should be used adjustable temperature regime, since in this case its quality indicators remain more stable than in the normal granaries.

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J21410-024

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**USING NATURAL PLANT MATERIAL IN PRODUCTION
TECHNOLOGY OF COTTAGE CHEESE***Kharkov Institute of Trade and Economic KNTU**Kharkiv, ln. O. Jarosz, 8, 61058*

Abstract. An important trend in the formation of a proper balanced diet in a complex environment of today is to increase the nutritional value of products through the addition of physiologically functional ingredients in its traditional preparation technology. Construction of new innovative technologies from dairy and plant material in the technological process of production of cottage cheese to enrich these products with vitamins, minerals and pectin, cellulose; been improved organoleptic and physico-chemical characteristics of the innovation cheese.

Keywords: «innovative technology», «nutrition», «workflow», «physiologically functional ingredients», «nutritional value», «vitamin and mineral content», «fermentation», «milk-plant system».

Introduction and background. The results of epidemiological studies and organized monitoring nutritional status strongly suggests that the structure of nutrition Ukraine is characterized by significant imbalances. As a result of malnutrition in Ukraine in 2009-2014 years doubled incidence of endocrine disease, metabolic disease, there is a marked tendency to dial excess body weight and obesity, widespread cardiovascular diseases, cancer [1]. It is therefore a priority to provide quality nutrition to enrich the diet is essential for the body with vitamins and minerals through improvement of basic foodstuffs physiologically functional components.

Important role in the diet of people take dairy products relating to everyday consumer products. Enrichment of functional ingredients of this product is one of the most reliable ways to eliminate the deficit of essential substances. It should be stressed that the combination of dairy and vegetable proteins is the optimal composition of the amino acid composition. The study aimed at finding opportunities to enrich it necessary vital macro- and micronutrients are promising in terms of expanding the traditional range of dairy products by kompozytsionuvannya raw materials, such as dairy and vegetable [2]. Significant demand curd, which is typical for high protein, fat, organic acids (lactic acid) and, conversely, the absence of pectin, a relatively low content of vitamin C, B, some minerals. In turn, the use of natural vegetable- fruit juices as foods rich in vitamins C, PP, B₁, B₂, B₆, P; minerals - phosphorus, iron, calcium, cobalt, iodine; carbohydrates - sugars, starch, pectin, cellulose, will enrich these products essential micronutrients contribute to the normal functioning of the body. Thus, offering technology manufacturing cottage cheese from milk and vegetable and berry juice, you can create the perfect product for the amino acid, vitamin and mineral content . Varying based products during their manufacture, enriching them of essential nutrients, you can achieve a certain orientation physiological effects [3].

Traditional technology of preparation of natural yogurt cheese at the first stage of pasteurized milk (t = 85 ... 95 °C for 15 ... 20s), followed by the fastest cooling to

room temperature; at the second stage - using sourdough fermentation of sour cream or yogurt. Sour milk mixed, a sealed container put in a warm place ($t = 28 \dots 32 \text{ }^{\circ}\text{C}$) to form a clot (5-7h), avoiding peregivshuvannya. Then separate the clot from cheese whey vidpresovuyut and cool. As you know, sour milk due to the presence of lactic acid bacteria that promote lactic acid fermentation of lactose and consequently milk. Often accompanied by lactic fermentation alcohol, if present in the environment of so-called dairy yeast. When lactic acid fermentation of lactose occurs simultaneously and acid coagulation of casein fractions of milk proteins. A decline in negative charges casein micelles, casein structure is disturbed calcium - phosphate complex with the release of soluble calcium, which in turn destabilizes calcium micelles.

Based on the analytical data for research on the creation of innovative cottage cheese, enriched by natural physiologically functional ingredients was selected cabbage juices, cranberry viburnum, apples and oranges. Given that vegetable, fruit and berry juices contain sugars and organic acids, we can predict that they will positively influence the souring of milk. Surveys were chosen different ratios of natural juices and milk and milk offered cereal model systems (table.1.).

Table 1**Characterization of milk-plant model systems**

Name	Samples								
	№1	№2	№3	№4	№5	№6	№7	№8	№9
Milk	100 %	90%	90%	90%	90%	80%	80%	80%	80%
The juice kale	-	-	-	-	10%	-	10%	-	5%
Cranberry juice	-	10%	-	-	-	10%	-	10%	-
Orange juice	-	-	-	10%	-	-	-	-	10%
Apple juice	-	-	10%	-	-	-	-	10%	5%
Juice viburnum	-	-	-	-	-	10%	10%	-	-

Studies have been conducted to determine the effect of organic acids, vegetable, fruit and berry juices in the process of fermentation of milk. To this end, the proposed dairy and cereal model systems skvashuvally at $28 \dots 32 \text{ }^{\circ}\text{C}$. Established that, in all samples, regardless of the type of vegetable, fruit and berry juice, duration of fermentation mixture decreases (Fig.1.).

For example, dairy and vegetable mixture with 90% milk and 10% cranberry juice skvashuyetsya 4 hours more, compared with the traditional model number 1. Similar results were observed for a mixture of 80% milk, 10% juice and 10% viburnum cabbage juice. It should be noted that the presence of 10% of cabbage juice in milk-plant system (sample number 5) has virtually no effect on the duration of the fermentation mixture, because of the low content of organic acids in cabbage and weakly acidic medium juice ($\text{pH} = 6.2$). The minimum period of souring milk demonstrated in the sample number 6 with a mixture of 80% milk, 10% juice cranberry juice and 10% viburnum, which is 17 hours, 6 hours less compared to the traditional model. Thus, we can conclude that the addition of natural juice positively affects the fermentation process, accelerating the duration of clot formation.

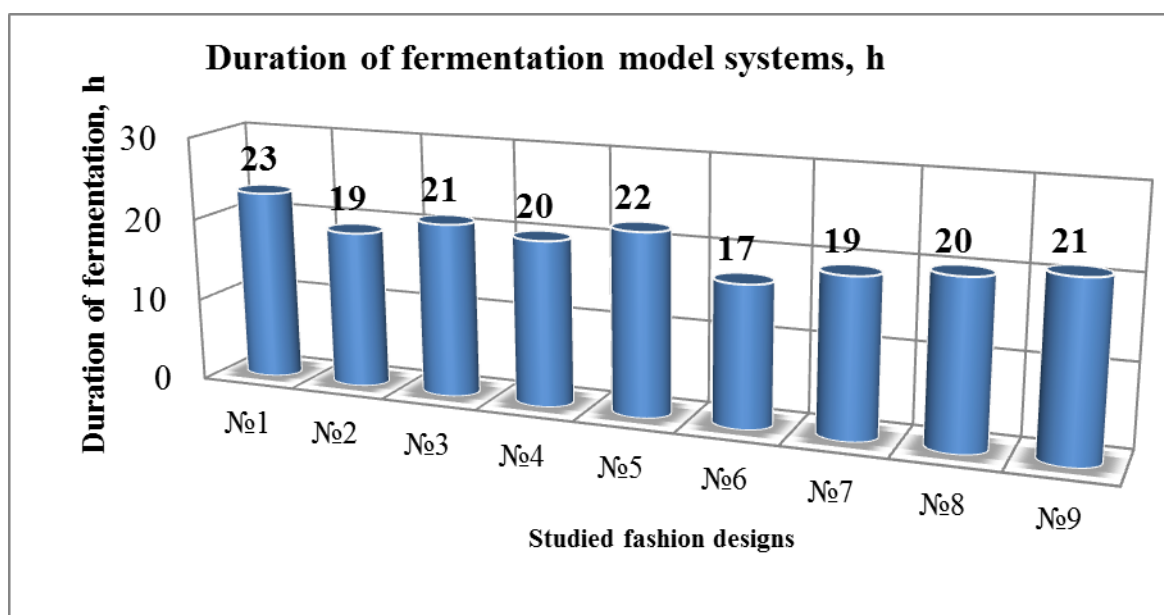


Fig. 1. Tryvalist studied lactic fermentation of plant systems, depending on the type and concentration of vegetable, fruit and berry juice

It should be noted that natural vegetable-fruit and berry ingredients are characterized by high titrated acidity (presence of free acids, acid salts, organic compounds), which certainly increases the acidity formed milky plant compounds and, consequently, the acidity of cheese clots (Fig. 2.).

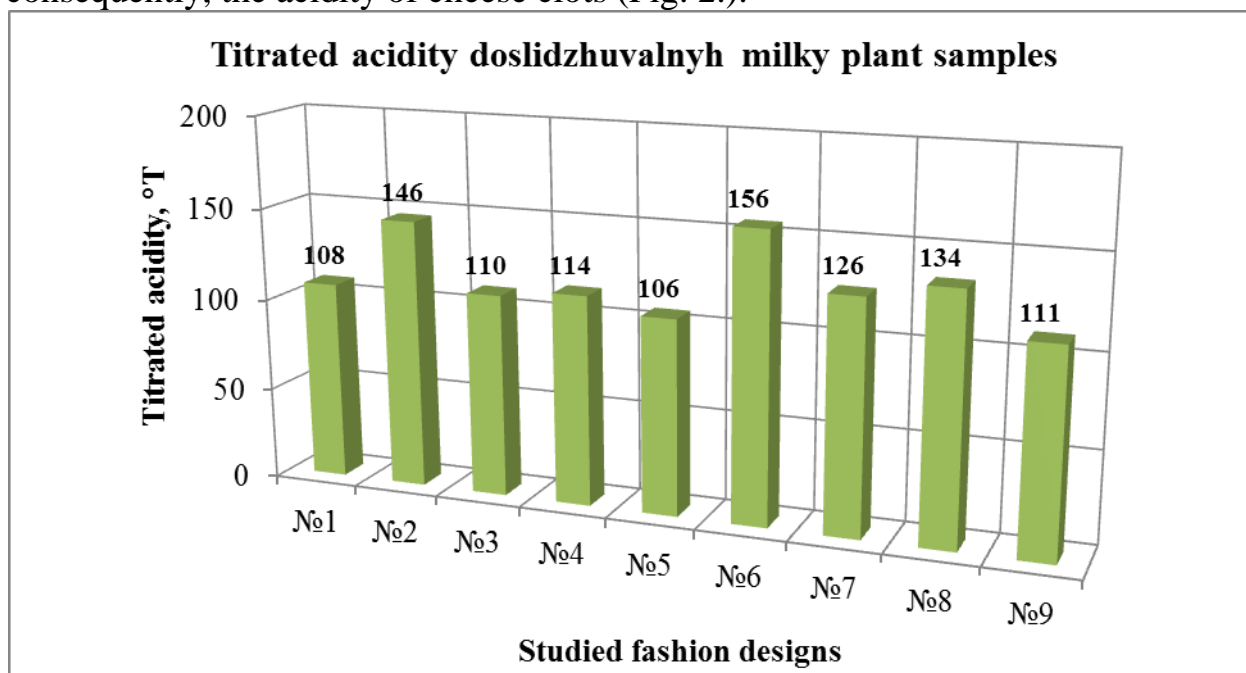


Fig. 2. Dynamics acidity doslidzhuvalnyh milk-plant systems

Thus, the maximum titrated acidity during fermentation is sample number 6 - 80% milk, 10% cranberry juice and 10% viburnum, which is 156°T, 48T° higher compared with the traditional model number 1. In contrast, in the sample number 5 with 90% milk and 10% of cabbage juice titrated acidity values decreased by 2 °T, because of the low content of organic acids and pH close to neutral environment. Other doslidzhuvalni model samples are characterized by high acidity titrated to

varying degrees depending on the value and type of juice, compared with the traditional model number 1 (108 °T): № 2 - 146 °T, № 3 - 110 °T, № 4 - 114 °T, № 7 - 126 °T, № 8 - 134 °T, № 9 - 111 °T. It is important that some organic acids contained in natural vegetable - fruit and berry products can inhibit the growth of microorganisms milk by lactic acid concentration of hydrogen ions or by toxicity nedysotsiyovanyh molecules and anions and, consequently, adversely affect the formation of cottage cheese.

An extremely important aspect in creating innovative yogurt cheese is a cheese curd formed mass and serum withdrawal. Studies have shown that the yield of cheese mass directly proportional to the acidity of the milk-plant system: with increasing acidity increases yield of cottage cheese (table 2).

Table 2

These experimental studies on the release of innovative cottage cheese from different milk-plant systems

	Studied fashion designs								
	1	2	3	4	5	6	7	8	9
Index titrated acidity of sample, °T	08	46	10	14	02	56	26	34	11
The mass formed cottage cheese, %	0	3	1	2		3		1	

For example, the highest yield of cottage cheese observed in samples number 2 and number 6 and is 13%, up 3 % compared with the traditional model number 1. The smallest is the way of cottage cheese observed in samples number 5 (7 %) and number 9 (8%) due to the content in a model system of cabbage juice. Thus, we can conclude that cabbage juice inhibits the formation of cheese, and cranberry juice, orange and viburnum with high acidity positive effect on innovation output sour crude, significantly increasing it.

Note that in model samples with high acidity titrated (samples №2, №6, №8) immediately took the acid denaturation of milk proteins, that there was a sudden stvorozhenist milk - plant system and the formation of small clots of denatured protein on the surface of the mixture, turned out to be a positive influence on the process and output of cottage cheese. In these samples, cheese exit marked the largest mass, which is extremely important for further study of the formation of innovative cheese.

Conclusion. Studies have shown that the great promise is to create a unified composition from milk and vegetable - fruit and berry juice in the production of cottage cheese, which provides enriching it with vitamins, pectin, fiber, dietary fiber, and essential micronutrients to the body. It was found that the addition of vegetable, fruit and berry ingredients to milk a positive impact on the process of fermentation, accelerating the duration of clot formation, which can be explained by the presence of

organic acids. In addition, all model samples, regardless of the type and concentration of vegetable and berry juice in milk, increases the acidity of the cheese curd, which is an important technology in the preparation of cottage cheese. An extremely important aspect in creating innovative product research output was cheese mass and serum. It was established that the presence of natural juice in milk has a positive effect on the formation of cheese, significantly increasing its output.

By offering technology manufacturing cottage cheese from milk and vegetable - fruit juices, you can create the perfect product for the amino acid, vitamin and mineral content and partially solve one of the major problems of rational balanced nutrition.

Innovation curd enriched vegetable - fruit raw materials, can be widely used in children, mass and preventive nutrition as a source of complete protein, vitamins, minerals and pectin, cellulose and fiber.

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COST CULTIVATION OIL SEED PLANTS FOR BIOFUEL PRODUCTION

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Abstract: The procedure for determining of the seed plants oil cultivation cost for the biofuels production was designed. The functional suspension cost cultivation oil seed plants their productivity was evaluated.

Keywords: oil seed, winter rape, soybean, sunflower, biodiesel engine, biofuel, cost, yield

Introduction. The raw material for the production of bio-diesel oil can be obtained from oilseeds (sunflower, soybean, castor, flax, barbarea genus plants, which include rape, mustard, false flax, oil radish, cole), fats obtained from microscopic algae, food production waste oil, technical animal fats.

The main problem of recycling waste vegetable oils and technical animal fats is that they contain a lot of free fatty acids that can not be transformed into biodiesel using traditional alkaline catalyst based on potassium hydroxide. Therefore, the technology of used substandard vegetable and animal fats processing into biodiesel is more complex compared to the industrial processing of vegetable oils, biodiesel yield is lower. In this regard, Ukraine biodiesel from waste and substandard vegetable and animal fats is less produced.

Biodiesel from algae in the world only moves from laboratory research phase to commissioning experimental productions. In Ukraine there are only a few experimental production of biodiesel from algae with low productivity, so at this stage of the algae do not play a significant value as a feedstock for biodiesel production in our country.

Thus, the main feedstock for biodiesel production in Ukraine is vegetable oil.

Analysis of recent research. A number of references are given the results of studies of the oilseeds cultivation cost in Ukraine. According to [1], the cost of cultivation of winter rape seeds in 2010 at an average yield of 18,5 t/ha was 232 hrn/kg in 2011 at an average yield of 17,7 t/hectare – 315 hrn/kg, sunflower in 2010 at an average yield of 15,0 t/hectare – 184 hrn/kg in 2011 at an average yield of 18,4 t/ha – 205 hrn/kg, soybean in 2010 at an average yield of 16,1 kg/hectare – 224 hrn/kg in 2011 at an average yield of 20,4 t/hectare – 235 hrn/kg. However not yield crops nor other factors which might affect the cost of growing these crops are missing. From this study it is difficult to establish a relationship of cost of cultivation of oilseeds on factors affecting it (costs for the purchase of seeds, fertilizers, pesticides, lubricants, wages, depreciation and maintenance equipment). The majority of costs in certain production technologies (intensive, rational), areas (polisie, forest-steppe, steppe) did not differ significantly. However, intensification of fertilizer use, especially mineral that is a component of intensive technology of cultivation, leading to an increase in yield of oilseeds. This value is

crucial for its growth is introduced, most costs of cultivation. Therefore, the yield of oil crops is a factor that incorporates all elements of cost.

The **purpose of our research** is to establish the functional relationship of the cost of cultivation of oilseeds on their productivity.

Results. Into the basis of the research sunflower cultivation, winter rape, soybean process maps are laid on [2]. For the formation of 1 kg harvest sunflower seeds from the soil need to flush 6,5 kg of nitrogen, phosphorus 2,7 kg and 15,5 kg of potassium, 1 kg seed yield of soybean – 8,8 kg nitrogen, 2,8 kg phosphorus and 3,6 kg of potassium [3], 1 kg seed yield of winter rape – 8,5 kg of nitrogen, phosphorus 3,2 kg, 8 kg of potassium. By the method given in [4] determined the need for fertilizer to form the desired yield.

Cost of oilseeds cultivation were determined by methods [5].

Rate of fuel consumption per unit of volume of work and number of machine workers shifts and manual labor workers by type of works was defined by standards of fuel for certain work types developed in the Institute "Ukragroprodruktyvnist", and the rules and standards of performance car fuel consumption during transportation was defined with [6]. The hourly wage rate of workers and machine operators, manual labor workers on charges and salary is determined according to [7]. The price of fuel and lubricants, tractors, cars, agricultural machinery, fertilizers, pesticides, etc were taken from price-lists. Depreciation determined taking into account the fact that the machines and equipment belonging to 4 groups for which the minimum allowable useful lives are 5 years old, and the building to 3 groups with the minimum useful life of 20 years.

As a result of the accounts depending on the cost of image cultivation of oilseeds on their productivity are constructed, and presented in Fig. 1.

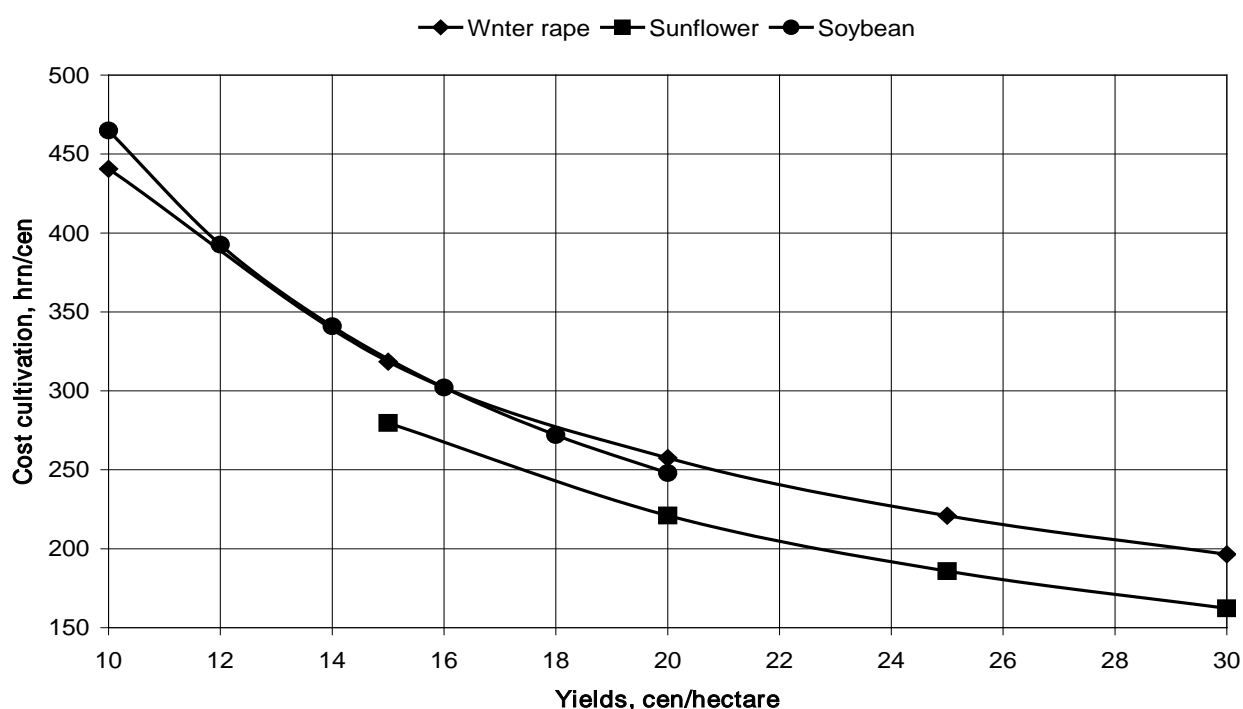


Fig. 1. Cost of oilseeds cultivation

As shown on the graphs, the cost of cultivation of oilseeds is reduced by increasing their productivity. Costs of growing winter rape and soybean production and close to 12-20% higher than the costs of growing sunflower.

Graph of the cost of cultivation of oilseeds on their productivity approximated by the following power function.

Cost of cultivation of oilseeds :

$$\text{- winter rape : } C_{\text{raw.prod}} = 2370,5 \cdot Y^{-0,7366} \text{ when } R^2 = 0,9982; \quad (1)$$

$$\text{- sunflower : } C_{\text{raw.prod}} = 3747 \cdot Y^{-0,9074} \text{ with } R^2 = 0,9999; \quad (2)$$

$$\text{- soybean : } C_{\text{raw.prod}} = 2342,2 \cdot Y^{-0,7862} \text{ when } R^2 = 0,9995, \quad (3)$$

where $C_{\text{raw.prod}}$ – cost of cultivation of oilseeds, hrn/kg; Y – yield, kg/hectare.

Conclusions

Cost of cultivation of oilseeds functionally dependent on their productivity by power dependency. Costs of growing winter rape and soybean production and close to 12-20% higher than the costs of growing sunflower.

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MANAGEMENT OF INVENTIVE ACTIVITY

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Abstract. This paper is focused on one of the most complicated stages of intellectual property objects lifecycle – the stage of objects creation. By analyzing the main points of creative activity involved in creation of industrial property objects (inventions) it is shown that this activity is directly related both to using available knowledge and introducing new knowledge.

Keywords: intellectual property, industrial property, invention, management, knowledge.

Introduction. In today's market environment, in order for an industrial enterprise to provide for its steady functioning and competitive advantages, it needs to create new types of products at the level of inventions or other intellectual property objects. For this reason the management of inventive activity, as an important component of intellectual property management, is a prerequisite for providing an enterprise with an adequate quantity of new technologic solutions, which grow into inventions or utility models after receiving legal protection.

Literature review. General problems of intellectual property management including intellectual property objects management at different stages of their lifecycle were discussed in studies of M. V. Vachevskiy, V. G. Zinov, P. P. Kraynev, N. V. Krasnokutskaya, L. I. Fedulova, P. N. Tsibulyov, L. A. Tsybul'skaya, Alexander Poltorak, Paul Lerner, Daniel Andriessen, Rene Tissen, Lev Baruch, other domestic and foreign scientists.

Analysis of published studies in this topic shows: as certain problems of intellectual property management are being researched, the focus is set not on inventive activity but rather on social and economic aspects of using finished (i.e. already created) intellectual property objects (in particular, organizational arrangements directed towards perfecting the workflow of patent departments, improving the training system for specialists, stimulation of inventive activity and so on) as well as legal problems of management (in particular, marketing research, rights acquisition, adoption of intellectual property in economic circulation) [1, p. 34-37; 2, p. 161-169; 3, p. 37-39; 8, p. 324]. Some specialists explain excess attention to said legal and economic aspects with the fact that already existing intellectual property objects are very convenient for managing (they are strictly defined by the law, they can be assessed and accounted as intangible assets, and they can be used in accounting operations) [4, p. 165]. Certainly, this point of view should be taken into account. However, inventive activity should receive proper attention as well.

Problem statement. A brief review of research papers shows that enterprises and organizations, which choose the course of innovative development, have an impelling need in their own inventions and other intellectual products. At the same time a number of problems of theoretical and practical kind related to intellectual property management in enterprise environment are left to discussion, and certain

questions are yet to be answered. Among the latter questions are problems of intellectual property management at the stage of creation of industrial property objects, when the core activity is making an invention. Hence the goal of this research: to analyze the essential points of invention making and peculiarities of inventive activity management.

Research description. Invention is a form of human intellectual activity in an arbitrary branch of technology resulting in creation of industrial property objects – inventions and utility models, i.e. such new technic solutions which significantly improve previously existing technology. These objects along with production samples, trademarks and other intellectual property objects today become determinative factors of economic development as they play a very important part in activity of modern enterprises. If an enterprise attains clear patents (worldwide novelty, invention level) and legal protection, its production value increases, which translates into larger profits when production is released to economic circulation. As a result, a modern enterprise can successfully meet competition under market economy conditions.

We should note that invention making is urgent, as it is one of important vectors of organizational and intellectual activity of the enterprises in the course of innovative development, but at the same time it is an extremely complicated task. Inventive activity as a component of intellectual property is carried out during the first two stages of intellectual property objects lifecycle. We believe that the most complicated and time-consuming stage is the first one – the stage of objects creation [5, p. 183]. First of all the complexity is connected to creative nature of activity during this stage. Making of invention starts with a search for idea, just like with any other intellectual property object. It can be an idea of a new product (in particular, perfected or fundamentally new production, which makes for significant competitive advantage). Next, this idea is researched, developed, and verified. Result of this stage is an engineering solution, which satisfies the conditions of patentability (for an invention such conditions are: novelty, invention level, and industrial applicability).

In order to obtain a new engineering solution (constructional or technologic) unknown to modern level of technology, an inventor's task needs to be stated and successfully solved. Note that an inventor's task in its core is comprised of certain contradictions. In a broad sense those contradictions arise as a result of inadequacy of actual parameters and properties of technical object in respect to specific requirements (for example, requirements may be posed by existing technology level, peculiarities of usage, or other conditions). Therefore, the process of stating and solving of inventor's task can be viewed as a sequence of operations aimed at revealing, clarification and overcoming the contradictions concealed in the task.

It's worth noting that modern methodic arsenal of researchers includes a full system of simple and complex techniques for solving invention contradictions [6, p. 89-102]. Those techniques allow finding the route to problem solution (or, to be exact, determining a rough direction to the area of possible solutions). Besides, there are numerous heuristic methods for searching creative ideas. Such methods are based on psychology and serve as intensifiers of creative search, in particular "brainstorm", "synaptic", "morphologic analysis" and others. Using of these methods allows

arranging a chaotic search, but still doesn't provide a specific solution, only making the process of inventor's task solving less complicated.

So, there are certain methods and techniques for solving inventor's tasks, which are necessary to know about, but they alone cannot provide the desired solution. In our opinion, successful achievement of the desired result relies not only on knowledge, but also on skilful knowledge management [7, p. 89]. The term "knowledge" in this case represents not only knowledge regarding typical techniques of solving contradictions and heuristic methods we discussed above, but first of all knowledge of individuals (creators of inventions), who need to have a broad-ranged awareness, developed creative skills, and know how to use valuable information properly in addition to just possessing it. Only well-developed specific (creative) thinking of creator, his or her creative imagination, intuition and other personal creative traits, as well as competent usage of information, may lead to successful invention making activity. Undoubtedly, sometimes a situation may arise such that present knowledge is insufficient for solving an inventor's task (search for a promising idea or obtaining the desired technic solution). In such cases, proper management allows setting conditions (for communication between participants of creative process in particular) for producing new knowledge, when the latter will appear as a result of giving publicity to knowledge kept in minds of individual researchers, and further collective discussion.

Conclusion. Inventive activity is a form of human intellectual activity, which takes place during the initial stage of intellectual property objects lifecycle. Product of inventive activity is a new engineering solution, which is the end result of inventor's task solving. The process of inventor's task solving comes down to revealing and overcoming contradictions that arise between the most important characteristics (parameters, properties) of a technic object. Inventive activity as a whole is connected to usage of present knowledge (particularly heuristic methods and techniques) and producing of new knowledge. It requires inventors with well-developed creative skills, specific (creative) thinking, related personal traits, and ability to focus mental efforts. Inventive activity management is a complicated sequence of works in planning, organization and inventor's task solving control, as well as attaining rights for solutions found. It is favorable to successful achievement of the end goal – creation of inventions (utility models), which are prerequisites to steady development and increase of competitive ability of a modern industrial enterprise.

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**INVENTIVE ACTIVITY IN INNOVATIVE PROJECTS OF
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Abstract. In this work we examine activity of domestic industrial enterprises connected with creation of progressive technologies and intellectual property objects. In conclusion of our analysis we define the place and role of inventive activity in innovative projects developed by modern industrial enterprises.

Keywords: project, innovation, invention, intellectual property, industrial enterprise, innovative activity, new product.

Introduction (problem statement). Today, in the age of market relations, some domestic industrial enterprises gradually lose competitive ability as they exhaust the reserve of past novelty developments. Under such conditions it is important to search for ways to stabilize enterprise economic activity. One of possible ways of stabilization is switching industrial enterprises to the course of innovative development. Only rapid development of innovative processes, based on efficient usage of scientific and technic potential, can provide for high and steady rates of economic growth. That's why analysis of problematic questions related to creation of intellectual property objects and progressive technologies development is of current importance. For the same reason it is appropriate to study the place and role of inventive activity in innovative projects of modern industrial enterprises.

Analysis of the latest research papers. Several problematic questions, in particular causes and consequences of inefficient innovative activity of industrial enterprises, as well as questions of energizing innovative development by different means including usage of intellectual property objects, were studied by such scientists as G. A. Androshchuk, M. V. Vachevskiy, L. I. Fedulova, P. P. Kraynev, O. B. Butnik-Siverskiy, A. K. Andrushko, N. S. Krasnokutska, A. Yu. Serbenivska, P. N. Tsibulyov, K. C. Khavrova, L. A. Tsybulska and others.

When it comes to analyzing existing system of innovative projects management across enterprises of Ukraine, the majority of scientists come to conclusion that the main cause of inadequate level of innovation development is the lack of long-term state programs of innovative economy development as well as insufficient support of industrial enterprises (financing level in particular). Also they point at an outdated material and technical base being inefficiently used for research, worsening of qualitative characteristics of scientific manpower and so on.

Some scientists (for example, Vachevskiy M. V.) consider that "one of important aspects of production efficiency development at industrial enterprise is the wide usage of inventions and rationalization proposals, which comprise the foundation for rapid development of technical progress, reaching scientifically proven quotients of production, and ability to create and manufacture production capable of meeting the competition." [1, p. 37]. At the same time M. V. Vachevskiy defines rationalization and invention making as an independent separate form of

creative production activity [same reference, p. 21]. We should note regarding this matter that the majority of specialists study inventive activity in a tight correlation with intellectual property management. Moreover, even one of twelve principles of intellectual property management, which were formulated coming from experience of many management specialists, suggests enterprise executives to create intellectual property objects by their own efforts when needed. [2, p. 184]. That is, in relation to such intellectual property objects as inventions and utility models, this principle actually recommends enterprise executives going for inventive activity while managing intellectual property.

Goal of the research. To determine the place and role of inventive activity in innovative projects of modern industrial enterprises.

Basic concepts of the research. Analysis of statistical data released by State Statistics Service of Ukraine [3], as well as indexes released by Ministry of Economic Development and Trade of Ukraine related to innovative activity of domestic industrial enterprises, shows a positive dynamics of innovation-involved enterprises quantity (tab. 1).

Table 1

Number of enterprises, which were involved in innovative activity

During the year	2005	2009	2011	2012	2013
Number of innovation active enterprises:					
- units	810	1180	1679	1758	1715
- percent (%)			16,2	17,4	16,8

Analyzing the statistical data related to innovative activity of domestic industrial enterprises we can point out that the quantity of innovation-involved enterprises (meaning enterprises, which purposefully created, implemented, and marketed their innovations) increased more than twofold over the period from 2005 to 2013. During last three years this figure stabilized at the level of roughly 17% of total number of industrial enterprises.

Analysis of statistical data also shows that even though there is a positive dynamics in the quantity of innovation-involved enterprises, the portion of enterprises and organizations that actually create and implement intellectual property objects is decreasing every year. For example, according to official statistical data, the total number of enterprises and organizations in Ukraine that created and implemented progressive technologies and intellectual property objects including rationalization proposals in 2013 decreased by 2.6% compared to 2012 and was equal to 2224 (two thirds of that figure is comprised by industrial enterprises). Only 428 enterprises from that number used intellectual property objects in their activity. Each of those 428 enterprises and organizations had approximately 5 inventions and 7 utility models on average (fig. 1).

Statistical data also points at the fact that progressive technologies introduced in 2013 had attained 1012 legal protection documents: 189 – for inventions, 715 – for utility models, and 108 – for industrial samples (during the year) [4].

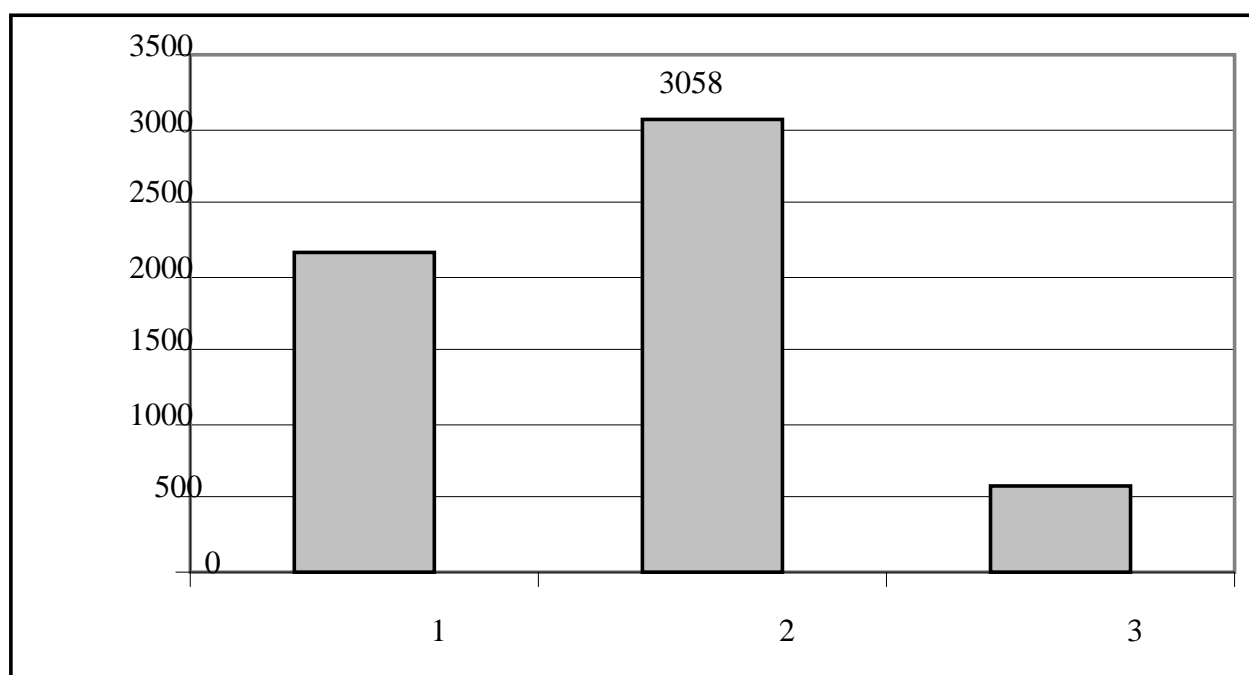


Fig. 1. Number of inventions (1), utility models (2) and industrial samples (3) used in 2013

If we compare the data stated above to a total number of legal protection documents issued annually by “Ukrpatent” (State Intellectual Property Service of Ukraine) – around 4 thousand patents for inventions and over 10 thousand patents for utility models [5] – we can ascertain that modern enterprises are having some problems in the field of invention activity, in particular in the process of invention making and utility model production.

In a broad understanding inventive activity includes all works related to creation and using of inventions or utility models. Timeframe of inventive activity in this understanding covers all stages of intellectual property objects lifecycle: creation, attaining rights, using, protection, and utilization. Creation of intellectual property objects starts off with an idea. The creation process of an industrial innovation in a general form can be viewed in a similar fashion. It also includes temporary stages of lifecycle: starting from introducing an idea to selling new (innovative) product. When we compare an invention and inventive activity to innovation and innovative activity, we should note the following: industrial innovation and invention have a lot in common (in particular, they both start off with an idea of new product, pass the development stage and other similar stages of lifecycle, they feature scientific novelty, production fitness, and other corresponding properties), however not every invention is an innovation, and not every innovation is an invention. The same can be said about activities: innovative activity, according to definition given by law of Ukraine “On innovative activity”, – this activity is directed at using and commercialization of results derived from scientific research and developments, which makes for release of new competitive products and services to the market [6]. As for inventive activity, according to world practice it is defined as intellectual activity, which results in new engineering solutions, which certainly become objects

of legal protection. Simply put, the main field of inventive activity is creation of innovative product in the form of inventions, and the field of innovative activity is mostly commercialization of an innovative product. Undoubtedly, role of inventive activity is rather important. After all, creation of invention and its further transformation into innovative product is a prerequisite for successful innovative activity.

Conclusion. Inventive activity is one of determinative factors in improving efficiency of industrial enterprise activity under present-day conditions. Industrial enterprises will be able to manufacture competitive production and successfully develop only if inventive activity is maintained at high level.

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Varfolomeev A.A., Prodan R.K., Aslamov A.V.
TECHNICAL DEVICE FOR WIRELESS ACCESS TO THE CNC MACHINES

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In this paper we describe the technical device for the use of distance educational technologies for training specialists in CNC machine tools and for the maintenance of projects of new production methods at enterprises.

Introduce the developed program of Moscow State Industrial University aiming to create hardware software system for remote access to the equipment.

The main window of software has a web-interface shown on the fig. 1.

This software can be installing on different models of computers such as desktop, laptop and tablet – the hardware part of this device.



Fig. 1. «Main window of software».

This system is designed for the use of distance educational technologies for training specialists in CNC machine tools and for the maintenance of projects of new production methods at enterprises.

This software package can make a connection to the network cameras in order to observe the equipment basic units (fig. 2), the working area (fig. 3), the control system and to receive and transfer control program_ files. It can transfer images from the screen of the control system for operator consultation in the high resolution.

The scientific importance of this development consists in the use of remote visual monitoring of control programs on CNC machine tools for example, an industrial enterprise (fig. 4).



Fig. 2. «Observe the equipment basic units».



Fig. 3. «Working area of milling CNC machine».



Fig. 4. «Diagram of using technical device with cloud technology».

In our university, this technology is implemented and used in the training of students in the fields of Engineering, Design and Technological support for engineering industries.

The training process is structured so that the student can develop details at all stages of the product life cycle CDIO (from drawing to finished part). Automation of this process is achieved through the use of applications such as PTC Creo, Siemens PLM Software NX through the program of electronic document management software PTC Windchill. Graduates in engineering specialties possess full functionality CAD data systems.

At the stage of Product Life Cycle (parts manufacturing), a laboratory with modern equipment of various technological groups, accessible and implemented by means of presenting of a technical device, takes part in the educational process (fig. 5). Thus, the laboratory can also be used by university partners for training and consultations (Access Center).

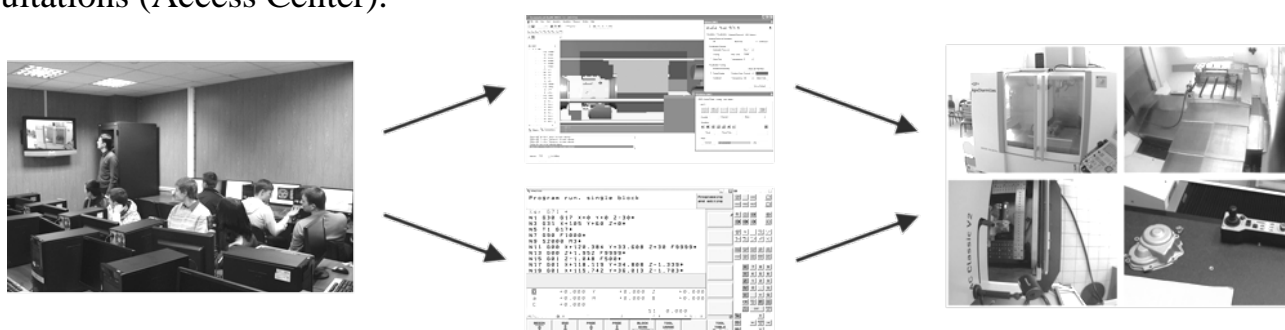


Fig. 5. «The educational process».

Using of this technical device for wireless access to the CNC machines allow solving a number of industrial and educational tasks:

1. Exemption of the enterprise from the changeover process which would use new parts under high load of the equipment (the development of new production methods).

This system allows to carry out work on the design and process technology, experimental samples under constant control of the customer (outsourcing, outer-source-using).

2. The solution of complex engineering optimization problems, preparation and testing of technical processes using scientific and technical bases of the university.

A consultation through videoconference improves qualification of engineers from enterprises.

3. Support for projects implemented in production. Consultations for specialists at distance (on-line).

4. Training of students with the technology of production in specific enterprises. Creating a database of specific details (technologies) for use in the educational process.

J21410-029

**Bondarev A, Krainev D, Ingemansson A, Oteny Y,
Polyanchikov Y, Chigirinsky J**

**MATHEMATICAL MODEL FOR PREDICTION LIFETIME OF
CUTTING TOOL IN TURNING STRUCTURAL STEELS WITH ADVANCE
PLASTIC DEFORMATION**

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Abstract. A mathematical model, which predict a lifetime of cutting tool in turning with advance plastic deformation (APD) on the workpiece surface, has been created. The regression analysis has allowed revealing the dependence of the response function and the influence of each factor on the function. The formula for calculation of the lifetime of cutting tool edge expanding possibilities of the turning with APD application in machining practice has been offered.

Key words: mathematical model, turning, wear, lifetime, cutting tool, advance plastic deformation (APD), carbide, structural steel, formula, calculation.

Structural steel alloys are widely used for the manufacture of machine parts. Turning processes are used in technological processes manufacture of shafts, which are require of high surface quality and durability. Specificity of processing of structural alloy steels is complex loading condition of the cutting wedge, which leads to high wear of the blades of the tool. Productivity growth processing turning structural alloy steels is an important aim.

Presented problem can be solved in the following ways: increasing the resource efficiency of the cutting tool, the performance of the processing and the quality of the products. Cutting with advanced plastic deformation (APD), combining the stage of preliminary surface plastic deformation and subsequent stock removal processing cutting tool is a combined method of treatment, allowing to obtain a complex result of growth efficiency on these issues. Changes in the physical and mechanical properties of the material being processed after APD responsible for the formation of such conditions of physical processes in the cutting zone, which help to reduce loads on the cutting wedge, the conditions of contact interaction.

Investigations have shown that turning of alloyed constructional steels with a APD on the treated surface can significantly reduce the amount of pad wear along the main rear surface, therefore improving the efficiency of the cutting process. In turning with APD heat-resistant alloyed structural steel CrMo 4130 been decreasing values of the wear pad on the front surface of up to 2 times as compared to traditional turning. Reserves of significant efficiency improvements of the cutting process were identified. The same value on the front pad wear surface was obtained by the traditional turning on same speeds and cutting at high speeds previously deformed metal.

Studies have been performed for rough turning (cutting depth $t = 1 \text{ mm}$) structural alloy steel CrMo 4130 (delivery status, the roll section $\sigma_s = 930 \text{ MegaPascal}$). The tool was introduced indexable carbide inserts Ti15Co6, WcO6, TiN20 form W ($\alpha = 0^\circ$ (ISO 1832-1991)); fillet radius main and auxiliary

cutting edges $r = 0,8 \text{ mm}$. Processing was carried out without lubricating technological environments. The factors that determine the value of the response function (T), were selected cutting speed, the thermal conductivity of the tool material, feed rate and APD rate.

$$R_{ADP} = \frac{h_{def}}{t} \quad (1)$$

where h_{def} - the depth of work-hardened surface layer, mm ;

t - depth of cut, mm .

The natural and dimensionless values of the factors accepted in our research are presented in Table 1.

The effect of the APD machined surface on the turning process has been discovered to change. The increase in R_{ADP} to some value is accompanied by reduction of the cutting force, reaching the minimum at a certain relation of the depth of the deformed surface layer to the cutting depth (for the maximum efficiency in the machining of steel CrMo 4130 this ratio equals 2). Further growth of the R_{ADP} reduces the efficiency of the process. The bottom level of the coefficient R_{ADP} is equal to zero (the cutting without advanced plastic deformation), but for the purpose of the model creation is accepted 0,001. It allows carrying out some additional calculations, including logarithming. At this assumption the depth of the deformed metal layer would be equal to 0,0005 mm and that is insignificant. Thus, this convention does not affect the result of the regression analysis.

Table 1

The natural values of the factors

Factors	Designation	Natural values		
Normalized value (level)	Z_i	-1	0	1
Cutting speed, <i>m. per min</i>	X_1	90	135	180
The thermal conductivity of the tool material, <i>Wt / m · K</i>	X_2	11 (TiN20)	27 (Ti15Co6)	50 (WCo6)
Feed, <i>mm / rev</i>	X_3	0,083	0,166	0,256
APD coefficient R_{ADP}	X_4	0,001	1	2

Research accepted as the most frequently viewed, mathematical models of the following specifications: additive (linear) and multiplicative (exponential and powermode).

The problem of the usage the mathematical methods of the experiment planning consists in obtaining the mathematical description of the response function in form of a mathematical model, that connects this function with various factors. The data sufficiency depends on a type of the model and on the quantity of considered factors (four in this research) and is equal to:

$$\text{– for the additive model: } k_{\min} = 2^n = 2^4 = 16; \quad (2)$$

$$\text{– for the multiplicative models: } k_{\min} = 3^n = 3^4 = 81, \quad (3)$$

where k_{\min} – the number of independent trials with full factorial experiment;

n – the number of factors.

When constructing a model initial formal assessment of the existence of

dependence of the response function of each of the factors considered were prepared based on the coefficient of pair correlation [6], which shows the probability of the existence of a linear relationship between two statistical samples of equal volume. Similarly, the approximate estimated the link between factors.

On the basis of calculations it is established that the selected factors are pairwise mutually independent and each of them has an effect on the magnitude of the response function. To assess the degree of influence of each factor was constructed multivariable regression model.

In the process of constructing a model of the following required operations.

Correct estimation of the degree of influence factors on the nature and magnitude of the response function is only possible if the values of all the comparability factors and the actual objective function. Since these factors are of a different scale, the valuation was carried out according to the rules of input data [1, 6] regression models of various specifications.

Construction of the model after normalization involves the following, independent of its specification, consistent calculations [1,6]: calculation of the regression coefficients for selected factors; calculation of the regression coefficient, which determines the influence of random factors; calculation of the normalized values of the response function; calculation of Student's t test, which determines the significance of differences between the regression coefficients from zero; assessment of the statistical significance and to determine the degree of influence of the factors considered (for linear, power and exponential models of all the analyzed factors were statistically significant); calculation of predicted normalized values of the response function, taking into account the statistical significance of factors; payment recovered (real) values of the response function for normalized series; assessment of the adequacy of the constructed models for the largest F-test.

For analysis of the constructed mathematical models reduce the most significant results of the simulation in Table 2.

The average gractional error (the difference values of tool life T , calculated by the model and obtained experimentally) the exponential model are lower than those of parameters and linear power (9.08% - linear, 8.61% - a power mode; 6.49% - exponential), which is an advantage. Level of influence on the tool life of random factors, expressed by the corresponding coefficient of regression in the exponential and power mode model is equal to the absolute value of -0.03, that is insignificant. In the linear model, the influence of random factors is characterized by the absolute value of -0.28, which is very important in the background taken in the investigation of factors. Thus, the exponential model facilitates further prediction of tool life after turning with APD, as it allows to conclude that the most significant influence on the stability of the cutting tool have exactly the cutting speed, the thermal conductivity of the tool material, feed rate, APD rate.

The regression coefficients of the exponential model show that resistance of the cutting tool during turning with APD ascending affected by the following factors: feed, the thermal conductivity of the tool, APD, speed. With the increase feed the working capacity resource of the cutting tool is growth (regression coefficient 0.04

for the exponential model). With the growth of the thermal conductivity resistance of the cutting tool in accordance with the traditionally established notions is growth (the regression coefficient is 0.08 for the exponential model). Using the APD can significantly increase the resistance of the cutting tool (regression coefficient 0.33 for the exponential model). With increasing speed, the cutting blade resistance of the cutting tool is decrease (regression coefficient -0.47 for the exponential model), which is consistent with the traditional understanding of the influence of cutting speed on the stability of the cutting tool.

Table 2**Comparison of regression models**

Parameter	Model specification		
	Linear	Power mode	Exponential
Assessing the impact of factors			
Random factors	-0.28	-0.03	-0.03
Cutting Speed	-0.40	-0.48	-0.47
The thermal conductivity of the tool material	0.14	0.08	0.08
Feed rate	0.09	0.03	0.04
APD rate (R_{APD})	0.35	0.22	0.33
The validity of an adequate model, %	99.9	99.9	99.9
Estimate of error			
Standard deviation	2,014	2,014	2,014
F-criterion	2,530	2,344	3,342
The average fractional error, %	9.08	8.61	6.49

Analysis of the data in Table 2 suggests the following conclusions.

Regression mathematical model of impact the main parameters of machining with APD on measure the resistance of the cutting tool in turning structural alloy steel CrMo 4130 is realized in the form of the following relationship:

$$T = 23.65 \times 0.995^V \times 1.0023^\lambda \times 1.3^S \times 1.212^{R_{APD}} \quad (4)$$

where V - cutting speed, m / min ;

λ - thermal conductivity of the tool material, $W / m \cdot K$;

S_r - feed, mm / rev ;

R_{APD} – APD rate.

This formula allows you to calculate the value of resistance in the traditional turning and APD, that is predict the efficiency of the cutting process and take this into account in the technological route of machining. The ranges of variation factors (for example cutting speed 90-180 m / min), and processing conditions for the practical application depending described above.

Thus, the regression analysis, which allows us to estimate the degree of influence factors on the stability of the cutting tool. The formula for calculating the

resistance of the cutting tool T , which extends the application of the method of cutting with the HPD in the practice of machining.

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J21410-030**Sokolskyi A.L., Ivitskyi I.I.****METHOD OF ACCOUNTING WALL SLIP POLYMER IN MODELING
CHANNEL PROCESSING EQUIPMENT***National Technical University of Ukraine "Kyiv Polytechnic Institute"**Kyiv, Prospekt Pobedy, 37, 03056*

Abstract. The article describes of the method of accounting the effect of wall slip in the flow of polymer extrusion molding process. Through the use of techniques, it is possible to refinement the simulation of the polymer flow in the channels forming equipment.

Keywords: polymer flow, extrusion molding, wall slip.

Production of high-quality polymer products is impossible without using the refined methods for modeling structural and technological parameters of the equipment and processes in it, and without the influence of wall effects, which have a significant influence on the processes of formation of products. Near-wall effects can greatly influence the distribution of the main parameters of the entire cross section of the melt channels and, consequently, on the performance of the products.

Statement of the Problem

The processes of polymer melt flow usually considered on condition of the adherence to the bounding surfaces of the equipment. However, as the number of experimental studies, for example [1], on certain conditions, different types of polymers show a slip on the channel walls, periodic separation from them, the formation of a low-viscosity boundary layer and other effects which affect the course of technological processes and properties of polymer products.

In mathematical modeling of polymer flow it's necessary to specify the boundary condition of the melt velocity at the channel wall. This rate depends of the properties of the polymeric material and equipment operating conditions.

Analysis of Published Data

Wall slip liquids theory on solid surfaces was developed by L. Prandtl [2].

Analytical solution of the problem of the velocity distribution in a laminar boundary layer on the plate was first obtained by Blasius [3] in 1908.

In recent years computational capabilities are expanded with the development of computer technology and numerical methods. However, in solving such problems in relation to the polymer melt we have the problems, which is connected with the difficulty in determining their stress-strain state in the wall region, the thickness of this region, the influence of fillers, the state of the wall surfaces etc.

On the issue of solving problems with the presence of the boundary layer in the flow of polymer melts in the processing equipment is indicative of the work [4], which proposes an iterative approach to determine the velocity of the polymer near the wall and the shear stress in it.

The Methods of Wall Slip Polymer

The method is based on determine the correspondence points of the following subsection:

1. Velocity on the channel wall of shear stress at the wall, which is obtained by experiment, using the method of Mooney [5].

2. Velocity on the channel wall of shear stress at the wall, obtained by means of mathematical modeling of flow with different mean integral velocity at the channel inlet.

In mathematical modeling of the process flow used dependence to the generalized Newtonian flow [6]. Flow process - isothermal. Other parameters of the material, including the dependence of viscosity on shear rate, can be taken in accordance with the properties of the test material.

For each value of the average integral velocity at the inlet of the channel of interest is carried interval of at least 5 session of the modeling with different predetermined velocities at the wall of the melt channel. For each of the sessions determined velocity and wall shear stress at the wall in full flow mode of stabilization, which is determined by achieving a difference of values between neighboring points in the wall of 0.01%.

According to the results of mathematical modeling in the same coordinate axes are constructed velocity curves on the wall shear stress on the wall for all the investigated mean integral velocity at the channel inlet.

Comparing the experimental curve and the curves obtained from the experiment, we get the dependence shown in Fig. 1.

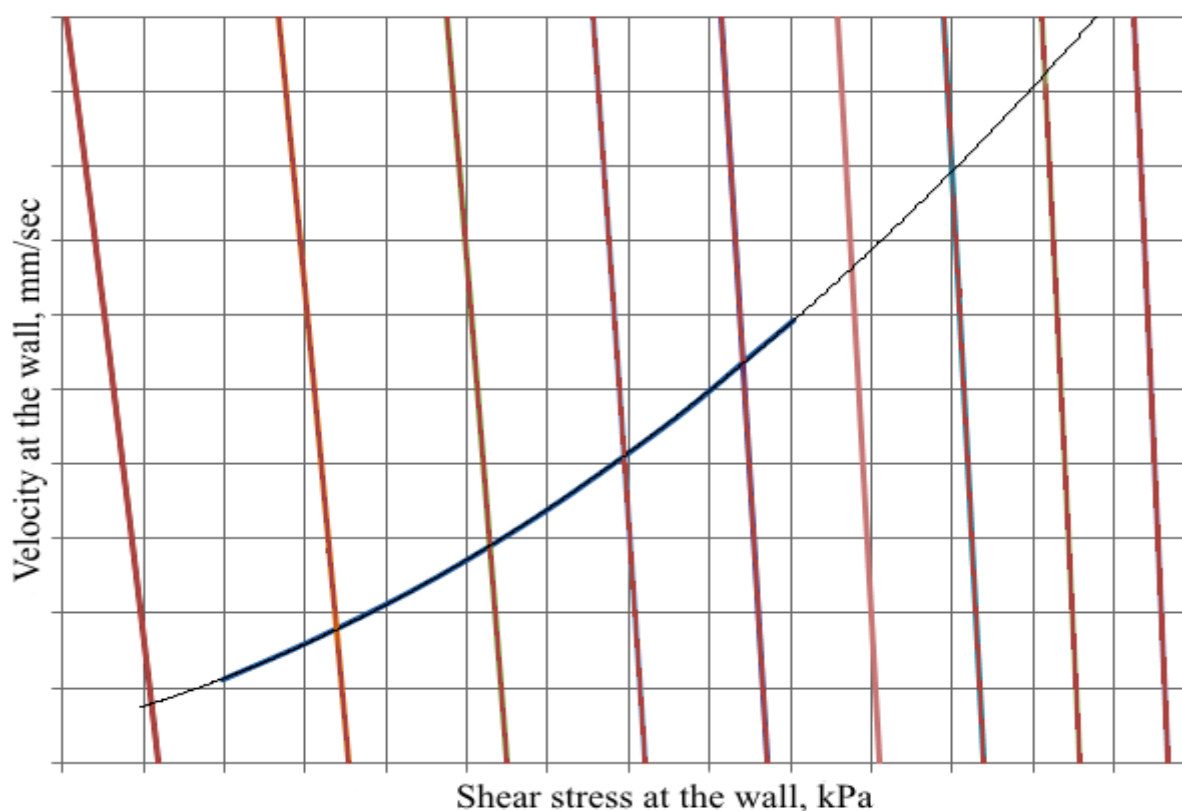


Fig. 1 The Dependence of rate of the slip on the wall shear stress for the high-density polyethylene, calculated and experimentally using mathematical modeling at different rates of entry: — experiment; — simulation results.

In terms of the correspondence points is constructed slip velocity dependence on the channel wall on the velocity of the inlet channel, Fig. 2.

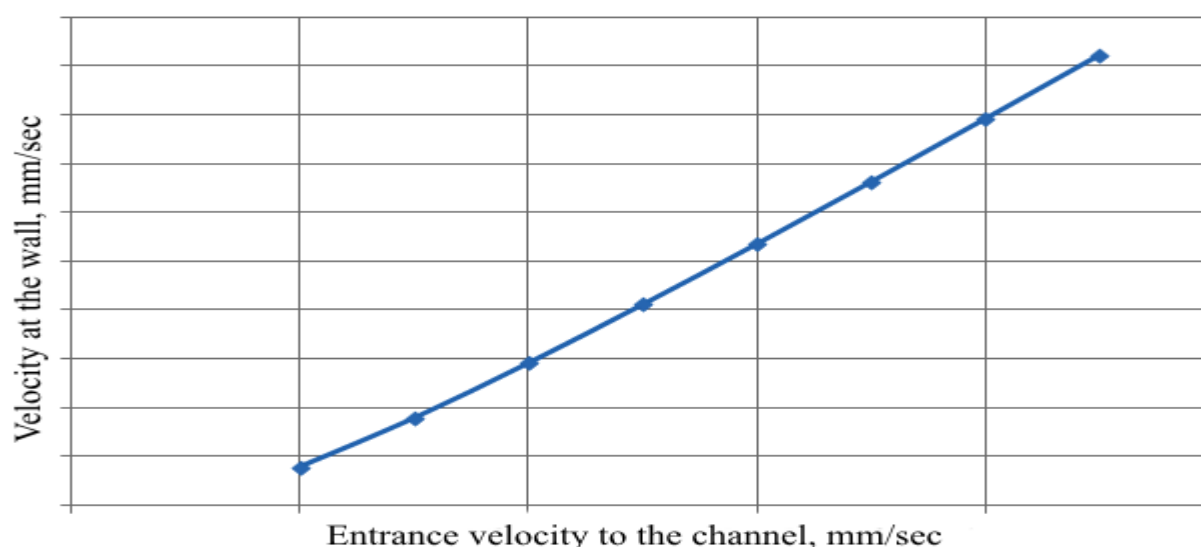


Fig. 2 The Dependence of rate on the side slip velocity of the inlet channel

The dependence, which was received can be approximated by a polynomial of n -th degree. Polynomial is chosen according to the minimum possible, in which the value of the reliability of the approximation does not change by more than 0.01.

Block diagram of determining the effect of the wall slip is shown in Fig. 3.

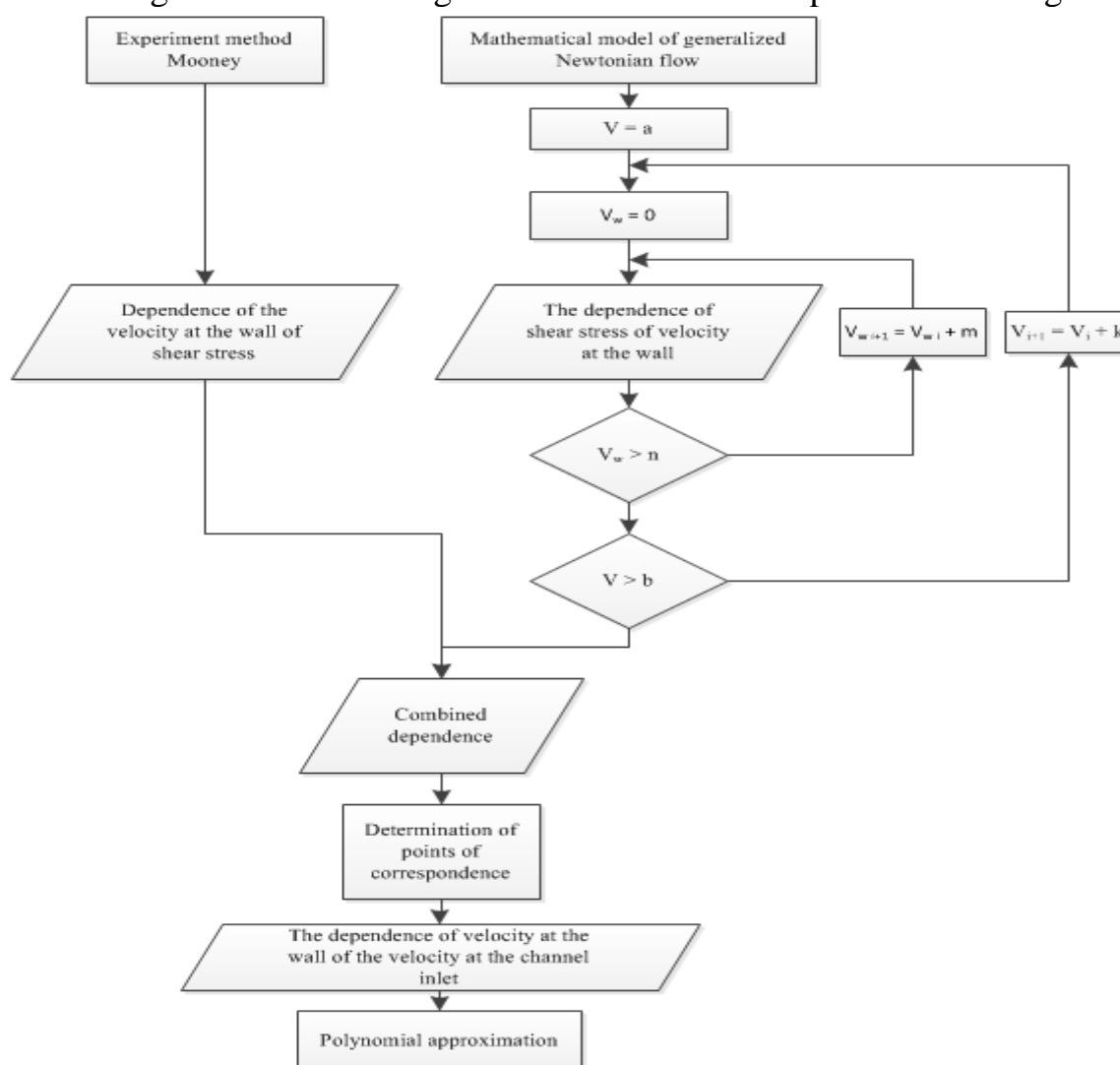


Fig. 3 Block diagram of the treatment of the wall slip of polymer

As shown in the flowchart (see Fig. 3), the dependence of the velocity of shear stress at the wall in the mathematical modeling is constructed in the desired range of velocities mean integral inlet channel (in this example from a to b with step k). For each calculation of the voltage held at the wall of the velocity on the wall at a predetermined velocity range (in this example from 0 to n in increments m).

Conclusions

The developed technique provides a polynomial dependence of the rate on the channel wall of the average integral velocity at the inlet to the channel for a wide range of polymeric materials and technological modes of processing. The technique can be used for further mathematical modeling of the polymer flow, thus obtaining the distribution of molding parameters (e.g., velocity, pressure) at a higher accuracy.

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J21410-031

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TRAJECTORY MODULATION OF 2.5 DEGREE OF FREEDOM ROBOT ARM

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Abstract. This research paper analysis this year's most developed robotics arm's – 2.5 DOF (degrees of freedom) robot arm's capabilities in trajectory modulation aspect when robot arm moves at the established speed through the settled points. 2.5 DOF manipulators design composes two links which are attached to a horizontal surface with a drawing or an engraving instrument at its end. Analysis of this paper consists mainly of two parts, i.e. the analysis of mathematical model of 2.5 DOF robot arm and analysis of trajectory modulation of real model. The mathematical design of robotic arms made using „Matlab Simulink“ program, which allows to do gear control voltages and calculate currents, momentums, links angular speed, angles and robot arms' end point position variation in time. Moreover, analysis of this research paper shows the results of research of the electromechanical and electrical time constants of the used motors and actual deviation of the trajectory of 2.5 DOF robot arm from desired trajectory.

Key Words: manipulator, robot arm, 2.5 DOF, control system, SCARA type robot.

Introduction. Robot arms are used to perform a variety of tasks such as assembly, loading, welding, polishing, painting, etc. In order to ensure the motion accuracy and quick operation of robot arms, various static and dynamic mechanics tasks are solved.

Robot mechanics tasks are specific as robots are controlled systems and they must maintain sufficient precision and quick operation pace while performing the required object manipulation actions. The operational device of a robot must move in the established trajectory in accordance with certain speed and acceleration and perform necessary orientation motions. While designing and managing robots, it is necessary to solve kinematics and dynamics tasks [1].

The paper researches a robotic arm with 2.5 degree of freedom (2.5 DOF), whose operational device moves in the horizontal plane (Fig. 1). This design is more advantageous than the robots of other designs operating in the horizontal plane as it takes up less space and is easier to manoeuvre. The purpose of this paper is to promote the capabilities of 2.5 DOF robotic arm, when such an arm draws a fragment of a picture captured by a computer camera or even the entire picture.

Material and Methods. Research object. The principal schematic diagram of a robot arm with 2.5-DOF (degree of freedom) is presented in Figure 1. The position of the robot arm's end-point (pencil) is changed by controlling the angular velocities of the two DC motors (M1 and M2); the third motor rotates the engraver (M3). Two drives (P1 and P2) are used to control the motors' speed. For the measurement of the links' turning angle, incremental optical encoders J1 and J2 are used. All these

components are connected to the control device – a microcontroller that receives commands and data from a PC.

The construction of the constructed robot arm (Fig. 1 b) consists of three 12V DC motors; two incremental optical encoders ($N = 1042$ pulses / rev); a table to which the first engine is tightly secured; two links and the arm's end position device (a pen or engraver).

Mathematical model of the robot arm dynamics. The dynamics of any robot's arm is characterized by the movement equations which describe the forces and moments that affect the mechanical links. These equations are used to simulate the movement of the robot arm, select control laws and evaluate the quality of the kinematic scheme. Therefore, it is necessary to prepare the equations appropriate to control a constructed robotic arm [1].

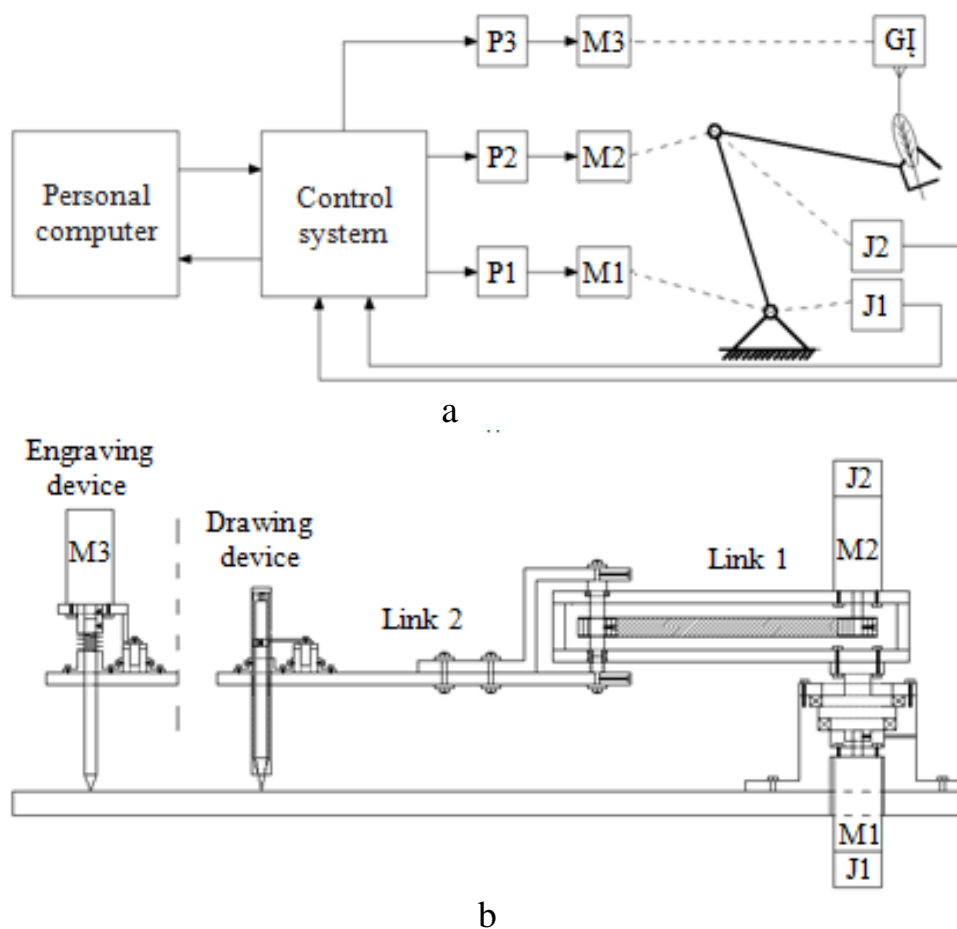


Figure 1. A robot arm with 2.5-degree of freedom: a - block diagram; b - designed structure (made by Authors).

The kinematic scheme of a robot arm with 2.5 DOF is presented in Figure 2. The robot arm operates in the horizontal plane, therefore its motion is not affected by the gravitational forces.

The dynamics of a robot arm is described by the following system of equations [2]:

$$\begin{cases} \left(J_1 + m_2 l_1^2 \right) \ddot{q}_1 + m_2 l_1 r_{2c} \ddot{q}_2 \cos(q_2 - q_1) - \\ - m_2 l_1 r_{2c} \dot{q}_2 (\dot{q}_2 - \dot{q}_1) \sin(q_2 - q_1) = T_1; \\ J_2 \ddot{q}_2 + m_2 l_1 r_{2c} \ddot{q}_1 \cos(q_2 - q_1) - \\ m_2 l_1 r_{2c} \dot{q}_1 (\dot{q}_2 - \dot{q}_1) \sin(q_2 - q_1) = T_2; \end{cases} \quad (1)$$

When: $J_1 = 1/3 l_1^2 m_1$ ir $J_2 = 1/3 l_2^2 m_2$ – link mass inertia moments, $\text{kg} \cdot \text{m}^2$; $r_{2c} = l_2/2$ – distance to the mass centre of the second link, m; $m_{1,2}$ – link mass, kg; $l_{1,2}$ – link lengths, m; $q_{1,2}$ – link turning angles, rad; $\dot{q}_{1,2}$ – link angular velocities, rad/s; $\ddot{q}_{1,2}$ – link angular acceleration, rad/s^2 ; $T_{1,2}$ – torques at the axes of the link joints, Nm.

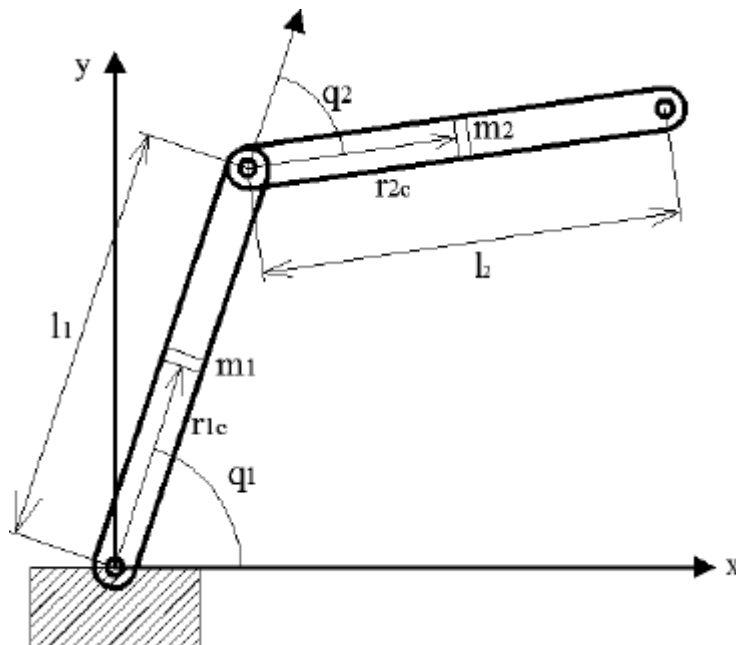


Figure 2. Kinematic scheme of a robot arm with 2.5 DOF (made by Authors).

The main operational devices of the robot arm are DC motors that generate the torque and thus move individual links of the robot arm. Therefore, the dynamics model of the arm should be complemented by a DC motor model.

A DC motor model upon assessment of the friction forces [3, 4]:

$$\begin{cases} L \frac{di}{dt} = u - i r - \omega C_E; \\ J \frac{d\omega}{dt} = i C_M - M_A - \omega f_s - [T_C \text{sign}(\omega) + (T_s - T_C) \exp(-\alpha |\omega|) \text{sign}(\omega)]; \end{cases} \quad (2)$$

When: L – motor armature circuit inductance, H; i – strength of the electric current flowing through the armature circuit, A; u – voltage connected to the armature circuit, V; r – armature circuit resistance, Ω ; ω – motor shaft angular rotation speed, rad/s; C_E – generator electromotive force constant, $\text{V} \cdot \text{s/rad}$; J – inertia moment of the motor armature, $\text{kg} \cdot \text{m}^2$; C_M – electro-mechanical transmission

coefficient, Nm/A; M_A – resistance moment, Nm; f_s – fluid friction coefficient, Nm·s/rad; T_C – dry friction torque, Nm; T_S – static friction torque, Nm; α – friction constant, s.

Thus, the entire dynamics model of a robot arm with 2.5 DOF with DC motors is shown below in the picture (Fig. 3).

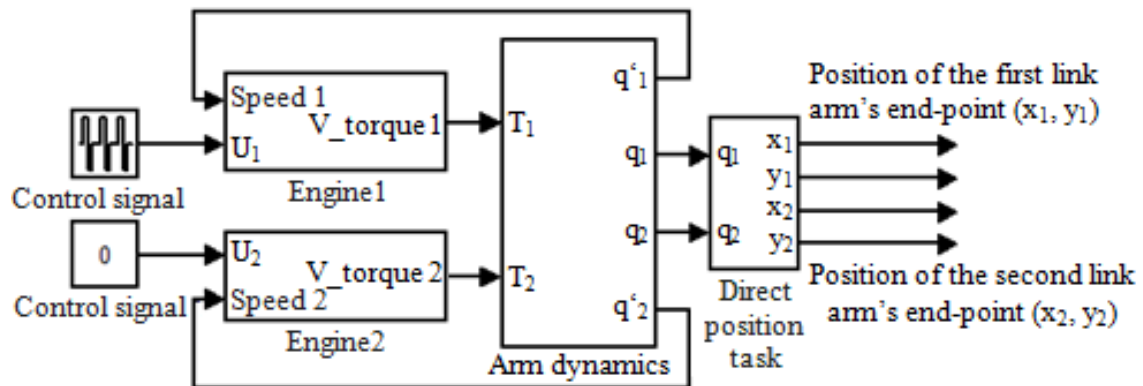


Figure 3. Model of a robot arm with 2.5 DOF (made by Authors).

The robot arm model consists of several blocks (Fig. 3):

- The blocks *Motor1* and *Motor2* are direct current motor models designed according to the formula (2);
- The block *Arm dynamics* is made in accordance with the formula (1);
- In the block *Direct position task*, the position of the entire robot arm's end point x and y in the Cartesian coordinate system is obtained from the robot arm links' relative coordinates in accordance with the following formulas [5]:

$$x = l_1 \cos(q_1) + l_2 \cos(q_1 + q_2); \quad (3)$$

$$y = l_1 \sin(q_1) + l_2 \sin(q_1 + q_2). \quad (4)$$

Trajectory planning. There is a variety of the robot arm end-point's motion trajectory planning algorithms [6]. This paper uses the algorithm when the robot arm end-point moves from point A to point B in a straight line. Its essence is that during the interpolation, the function of the straight is found between the start and end-points. After the straight is divided into segments and while addressing the reverse position tasks, the link angles in each point are calculated (Fig. 4).

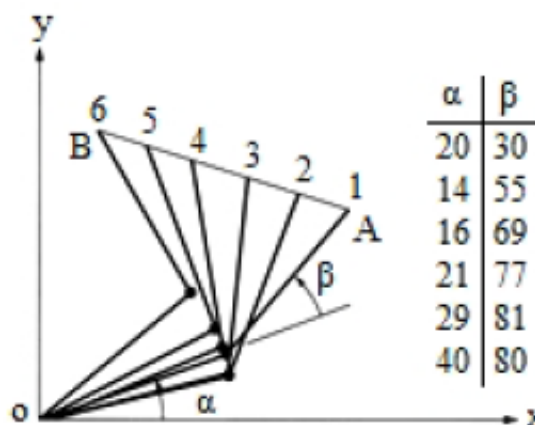


Figure 4. Trajectory planning [6].

When all rotation angles of the robot arm links in each point of the straight's trajectory are known as well as the maximum rotation speeds of the links, it is possible to calculate which link will move through each segment offset at the maximum speed within the slowest time. Then the maximum speed is established for this link in a particular segment, and the speed of the other link is reduced so both robot arms would overcome the estimated offsets within the same time.

Results. Research of the time constants. In order to prepare a mathematical model of a robot arm, it is necessary to research the dynamic characteristics of the used motors and calculate the required coefficients. Only in this case the modulation results will be adequate to the results of a real robot arm's motion.

The paper investigates the electro-mechanical time constant of the used motors. The research scheme is presented in Figure 5. While performing the research, the graphs of the motors' angular velocity variations in time were obtained. The section of the velocity graph has been taken for the analysis in which the velocity increases from zero to a stabilized value (Fig. 6, a and b).

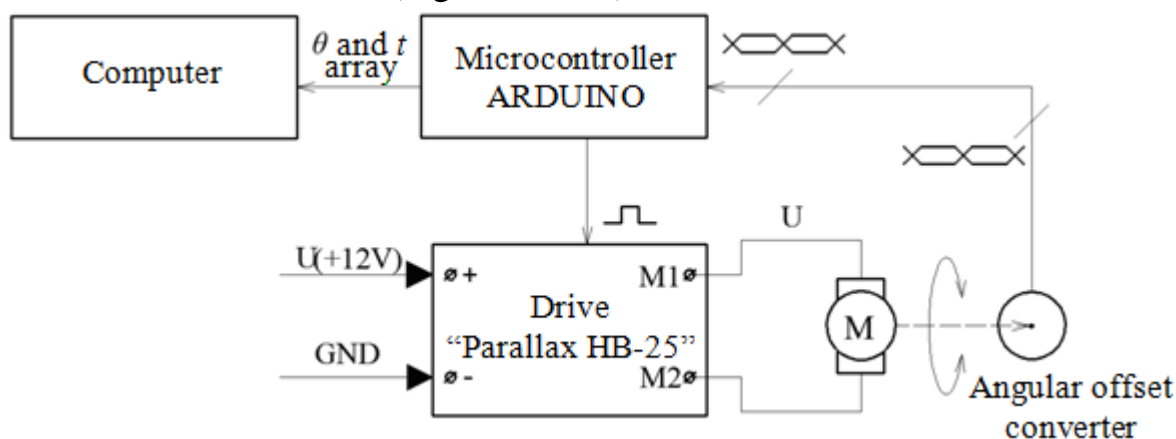


Figure 5. Research scheme of the electromechanical time constant DC motor model upon assessment of the friction forces [3, 4]:

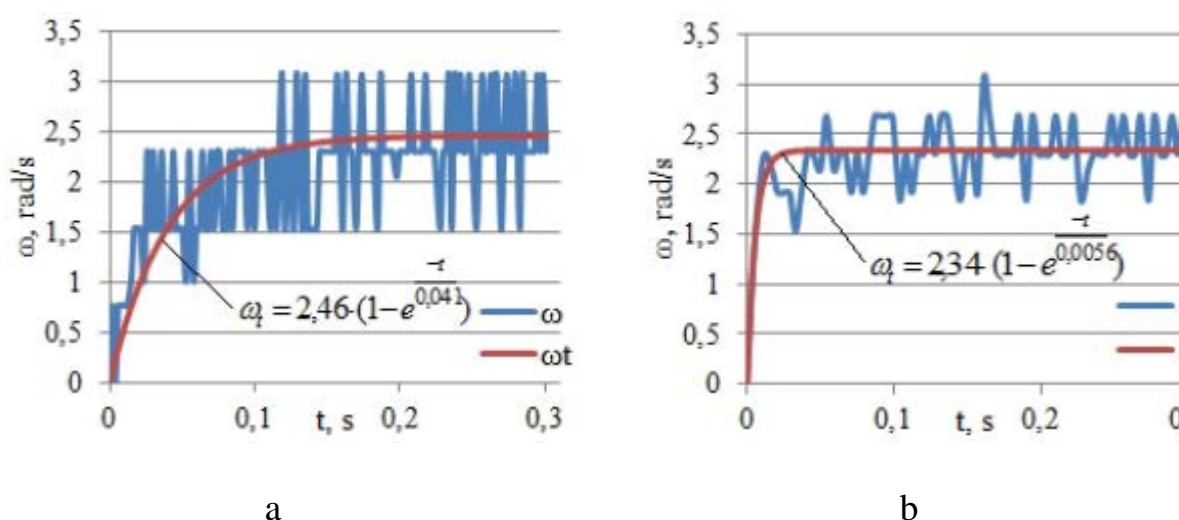


Figure 6. Graphs of the motors' angular velocity variations in time: a – of the first engine; b - of the second engine

Upon processing of the data of the change of the motors' angular velocity in time by the least squares method, the following value was obtained:

$$\omega_T = \omega_{\max} [1 - \exp(-t / T_M)] \quad (5)$$

When ω_T – motor angular velocity response function; ω_{\max} – steady angular velocity value; t – time; T_M – electromechanical time constant ($T_{M1} = 0.041$ s or $T_{M2} = 0.0056$ s).

The paper also researches the electrical time constant that can be calculated from the armature current's variation graph at the moment of the motor's start-up. The research scheme is shown in Figure 7. During the experiment, the motor voltage was turned on manually.

After the research and processing of the findings, the graphs have been prepared that are presented in Figure 8.

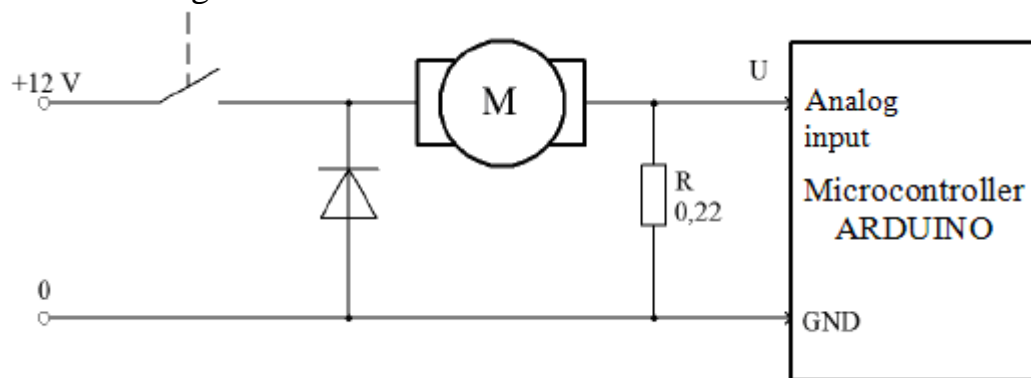


Figure 7. Electrical time constant research scheme

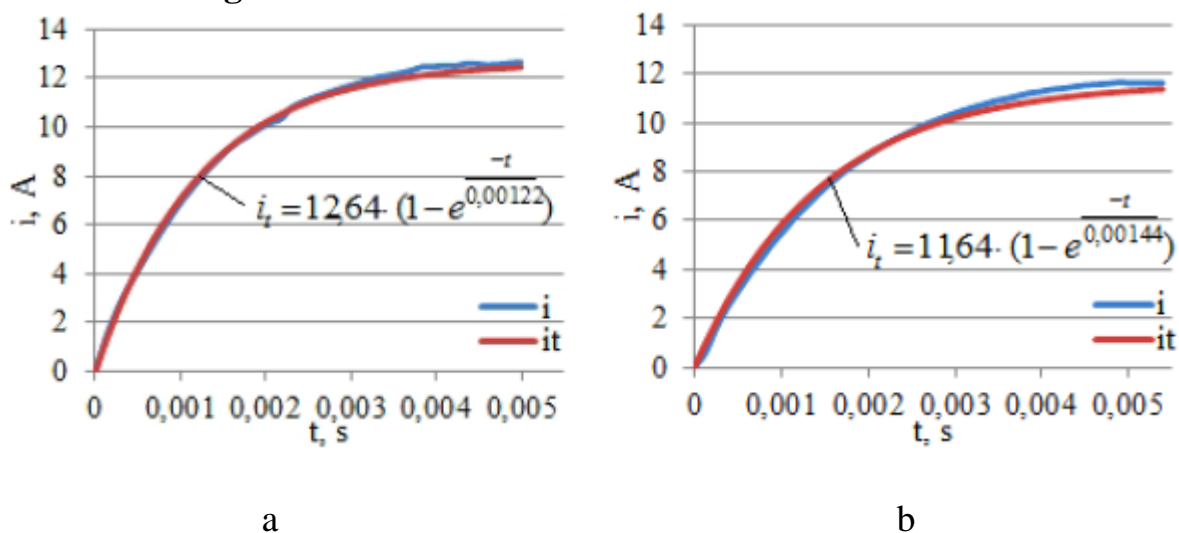


Figure 8. Graphs of current variations of the robot arm's first (a) and second (b) motor at the moment of start-up

Upon processing of the data of the robot arm's motors current variations in time by the least squares method, the following value was obtained:

$$i_T = i_{\max} [1 - \exp(-t / T_E)] \quad (6)$$

When i_T – motor current variation function; i_{\max} – settled armature current value; t – time; T_E – electrical time constant ($T_{E1} = 0.00122$ s or $T_{E2} = 0.00144$ s).

Model research. The obtained time constants of the DC motors were used to calculate all other parameters of the motor required for the construction of the model. The calculated parameters, measured during an experiment, are given in Table 1.

Table 1.**Characteristics of DC motors**

Parameter name and measurement unit	Marking	Value	
		Motor 1	Motor 2
Electrical time constant, s	T_E	0,00122	0,00144
Electromechanical time constant, s	T_M	0,0410	0,0056
Inductance, H	L	0,00183	0,00216
Resistance, Ω	R	1,5	1,5
Moment of inertia, $\text{kg} \cdot \text{m}^2$	J	0,057	0,0062
Electromechanical coefficient, $\text{N} \cdot \text{m/A}$	C_M	0,625	0,625

For the construction of the robot arm's dynamics model, link lengths and mass are still required: $l_1 = 0.2 \text{ m}$; $m_1 = 3.42 \text{ kg}$; $l_2 = 0.2 \text{ m}$; $m_2 = 0.36 \text{ kg}$.

Upon generation of the control signals of the robot arm joints for the motors (Figure 9.), under the algorithm of section 3, a trajectory of the robot arm motion was obtained that is given in Figure 9.

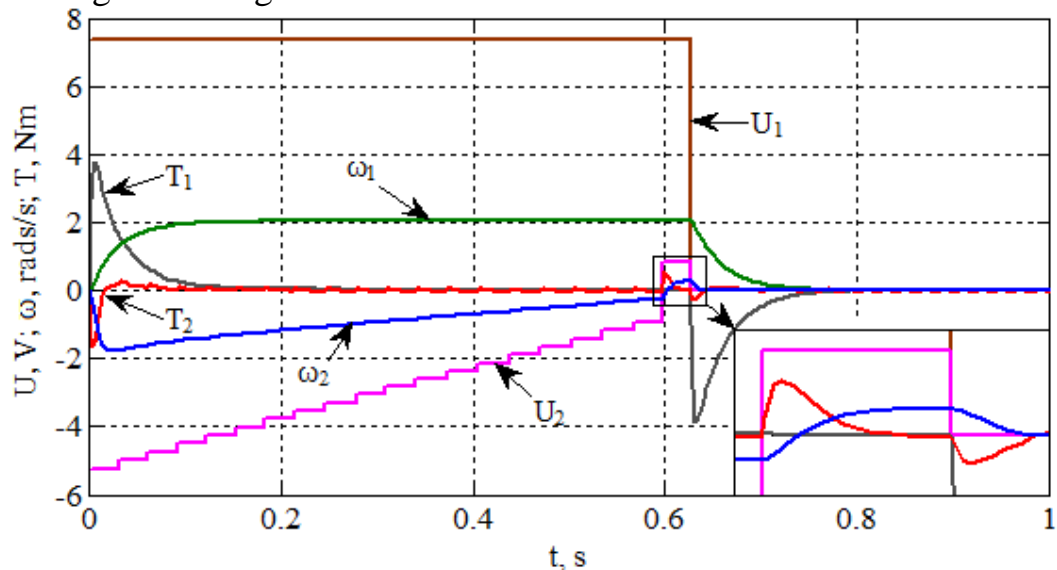


Figure 9. Results of modulation of the robot arm end-point's movement in a straight: U_1, U_2 – motor control voltage variation; T_1, T_2 – torques developed by the motors; ω_1, ω_2 – motor angular velocity variation.

Conclusions. Robot arms operating in the angular coordinate system are more advantageous than the drawing robots of other designs as they occupy less space and are easier to manoeuvre.

A mathematical model of the robot arm in the “Matlab Simulink” environment, allowing to establish the drives' management voltages and calculate the variation of the current, torque, links' angular velocity and the angle of the robot arm end-point's position in time has been prepared.

For the control of the robot arm's movement at the established speed through the settled points, the motion planning method had been selected when the trajectory is divided into segments of equal length.

After the research of the electromechanical time constant of the used motors, the time constants $T_{M1} = 0.041\text{s}$ or $T_{M2} = 0.0056\text{s}$ were obtained.

After the research of the electrical time constant of the used motors, the time constants $T_{E1} = 0.00122\text{s}$ or $T_{E2} = 0.00144\text{s}$ were obtained.

The modulation results show that the trajectory of the robot arm end-point deviates from the desired trajectory up to 3.7 mm. In order to reduce the error, it is necessary to improve the trajectory planning algorithm.

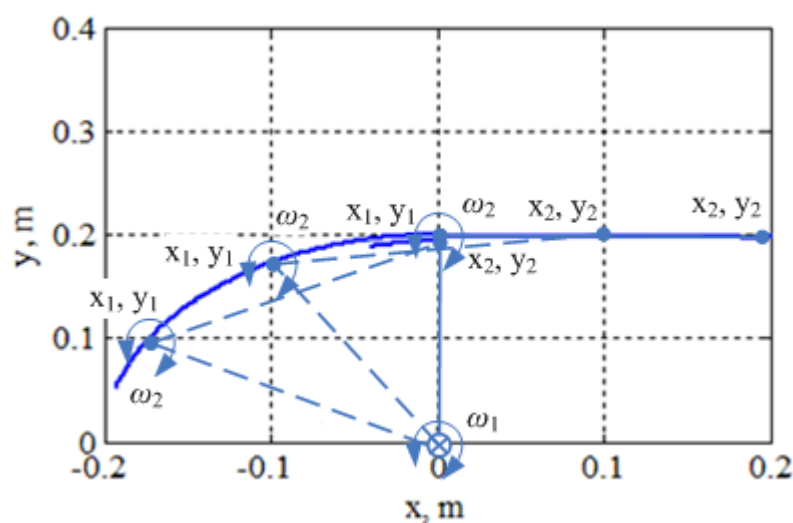


Figure 10. Trajectories of the end-point of the robot arm's first and second links in the Cartesian coordinate system.

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J21410-032**Lavrov Yu.A., Petrova N.F.****PROTECTION OF CABLES WITH XLPE INSULATION FROM HIGH-FREQUENCY OVERVOLTAGES***Department of High Voltage Engineering and Electrophysics Novosibirsk State Technical University, Russia, Novosibirsk, K.Marks-street 20, 630087*

Abstract. The report presents results of numerical researches of the effectiveness of commercially produced devices can be used to protect high voltage cables with XLPE insulation from the effects of high-frequency (HF) overvoltages. Used now traditional protective devices as nonlinear surge arresters (SA) is not effective in reducing the slope of lightning impulses incoming from the overhead transmission line (OTL). Is known, the XLPE insulation system is very sensitive to HF overvoltages. To suppress high-frequency overvoltages in report have been proposed commercially produced devices: power reactor (PR), coupling capacitor (CC), used for the organization HF communication by wires of OTL, and their combination. Note that these devices are now commercially produced and do not require special fabrication.

Key words: overvoltages, cables with XLPE insulation, power reactor, coupling capacitor.

During the operation, XLPE-cables rated voltage from 110 to 500 kV subjected by overvoltages with different amplitude and duration. It is now quite acute problem limiting of HF-overvoltages, caused by lightning destruction of OTL. Frequency range and level of lightning overvoltages affecting on XLPE-cables depend on the parameters of the lightning current, results of lightning destruction of OTL, length of cable-link between OTL and substation (SS), scheme, rated voltage of OTL and other factors. Frequency range of lightning overvoltages, depending on the rated voltage of OTL and waveforms lightning impulses, coming from OTL, can obtain from 300 Hz to 1 MHz.

Nonlinear surge arresters successfully cope with limited amplitude of lightning overvoltages. The correct choice of parameters and their mutual arrangement with the protected equipment at the design stage ensures operational reliability of XLPE-cables. However, SA can not affect the slope of the front affecting lightning overvoltages, they only limit the amplitude of the overvoltages, which depends on the residual voltage on arrester.

Use in a new generation of cables XLPE insulation provides a number of advantages over oil-filled cables. However, the presence in a solid XLPE insulation electrical or water treeing causes the "sensitivity" of the XLPE-cables to HF overvoltages, repeated exposure of which decreases dielectric strength of the insulation system cable.

The supramolecular structure of XLPE insulation is inherently heterogeneous and consists of a plurality of spherulites that determine the existence locally distributed areas of high tension electric field, which creates favorable conditions for the emergence and rapid development of electrical treeing (ET). When voltage

pulses with steep fronts expose to a solid dielectric input energy proportional to the current density, strength of electric field and the time of forcing the voltage pulse

$$W = j \cdot E \cdot t.$$

On the edge of the ET (Fig. 1) the strength of electric field is increased ten times, with a sharp input pulse energy by a shock wave cracking of the solid dielectric occur. As a result, at the boundaries of spherulites microinclusions air with high electric field formed. The formation of these air microinclusions size tens and hundreds of microns lead to development within their cavity partial discharges and, as a consequence, to further increase the length of the ET. Thus, the impact of each HF overvoltage initiates ET germination and reduces resource exploitation XLPE insulation system. To increase the life of the XLPE insulation is necessary to prevent exposure of HF overvoltage (slope of overvoltage).

To tighten the front of pulse overvoltage to improve the reliability and operational life of the XLPE insulation can be offered reactive elements used for the organization of high-frequency communication by wire of OTL - the coupling capacitors and HF reactors, as well as their combination.

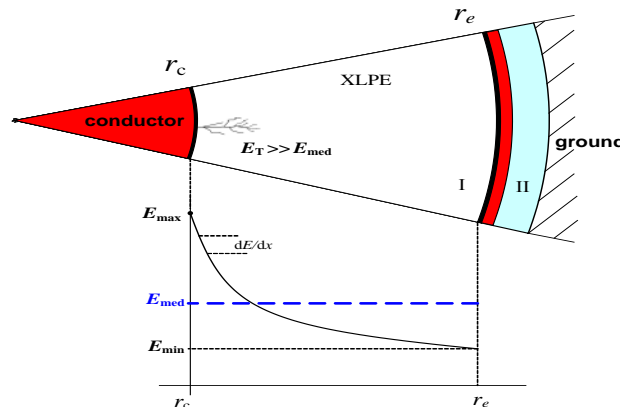


Fig. 1. To analyze the influence of electrical treeing on the dielectric strength of the XLPE insulation system

In this power reactors used in high-frequency rejectors HF channels of communication on transmission lines are connected to the crosscuts between wire of OTL and cable insert, additional capacity on the basis of the coupling capacitor can be connected to the busbar substation.

At present recommendations to limit lightning overvoltages affecting XLPE insulation and insulation of substation equipment were developed, but there are no clearly defined measures to protect equipment from the XLPE insulation from HF overvoltages. For example, the existence of ground wire in the immediate vicinity of substation or decreasing the lightning protection angle does not affect the steepness of the pulse overvoltage, lightning defeat at the OTL in this case do not contribute to the damping the front of coming from OTL lightning overvoltages. This problem especially actual for substation located in areas with high soil resistivity. To increase the SS lightning-proof and reliability of power transmission lines in certain circumstances forced to shoot a ground wire on the approaches to the substations.

Analysis of the implementation of XLPE-cables rated voltages of 110, 220 and 500 kV possible to distinguish the following basic scheme of their application in terms of typing conditions (Fig.2):

- using XLPE-cables rated voltages 110 and 220 kV as insertion between OTL and complete distribution device with gas-insulated switchgear (GIS) with length from hundreds of meters to a few kilometers with followed electricity supply of consumers through distribution cable network (DKN) medium voltage (MV). This scheme is used in cases where the application of OTL is impossible for technical, aesthetic or environmental reasons (fig.2,a);

- XLPE-cables rated voltages 220 and 500 kV with length units of kilometers for deep input power in the city with followed electricity supply of consumers through DKN HV and MV (fig.2,b);

- XLPE-cables rated voltages 220 and 500 kV with length 0,5-1,0 km for input power from the dam in lower step of the hydro power plant (HPP) to GIS 220-500 kV, located on the top step of the HPP. (fig.2,c);

- at the place of crossing OTL of 500 kV tracks of OTL rated voltages 110 kV and 220 kV, in this case, instead of using high transient towers at the crossing used cable of length 0.3 - 0.5 km (fig.2,d).

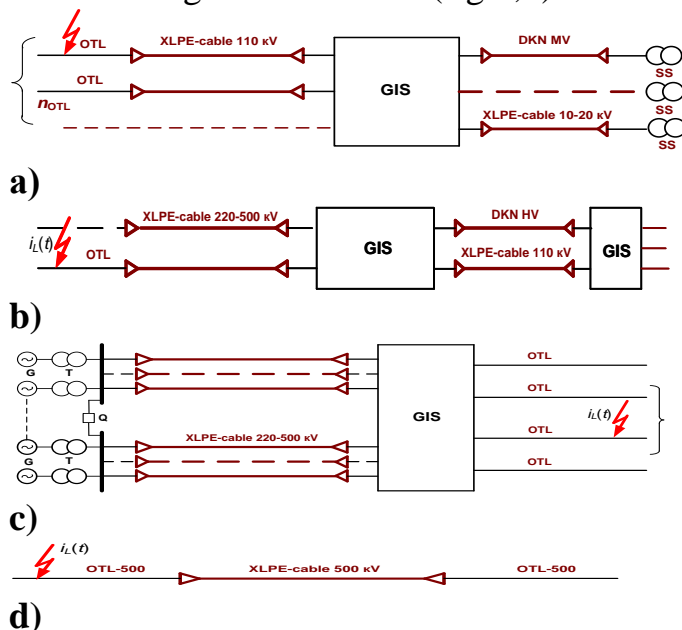


Fig. 2. Typical application schemes XLPE-cables rated voltages 110-500 kV

A distinctive feature of the first three schemes use XLPE-cables rated voltages 110, 220 and 500 kV is the presence of cables and overhead lines connected to buses of GIS that may, under certain conditions, to make the scheme "self-secure" in terms of their lightning-proof. But in terms of the number of HF overvoltages air-cable connections to buses GIS has little effect on the rate of voltage rise on the wave front.

All lightning waveforms running from OTL to substation have different steepness and energy potential described by waveform amplitude U_w and duration τ_w . Amplitude-time parameters of impulses running from OTL depend on lightning damage kind such as lightning strike to a tower or lightning protection wire or lightning break to a cable through protection wire, lightning current amplitude (I_L)

and steepness (A_L), OTL linear insulation impulse strength $U_{LI}(t)$, tower grounding resistance R_G , tower construction and OTL wire damage distance from a substation or cable insertion. Thus lightning waveform shape and parameters acting on XLPE-cables are random and caused by some random factors [1,2].

The considered waveforms can be divided into three groups:

- *full waves* are generated by lightning break through the OTL wire protection. They do not cause OTL linear insulation overlay with amplitude not exceeding 50% pulse discharge voltage;
- *trimmed waves* are formed by lightning break through the OTL wire protection with following OTL linear insulation overlay;
- *short waves* caused by inverse overlays between tower body and a wire if lightning strikes a tower or protecting wire overlay.

Obviously, the most dangerous for XLPE-cables are lightning waves, formed by the overlap of OTL insulation in the vicinity of the substation. In this case, almost rectangular front voltage pulse comes down on cable insertion.

Taking into account typical application circuits using XLPE-cables rated voltages 110, 220 and 500 kV, described in section II, we take universal design scheme of substitution according to Fig. 3.

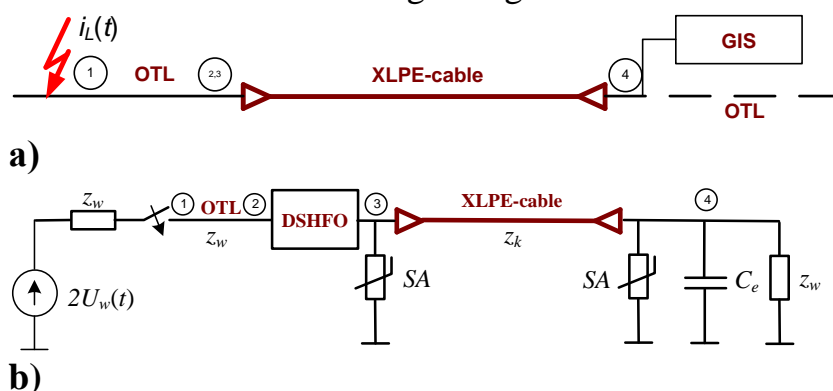


Fig. 3. Schematic (a) and calculated (b) equivalent circuit for numerical research to suppress high frequency component of lightning overvoltages in application circuits XLPE-cables

The following notation use in calculation scheme:

z_w , z_k – wave impedances of air and cable lines, respectively;

C_e – equivalent capacitance of substation equipment (GIS);

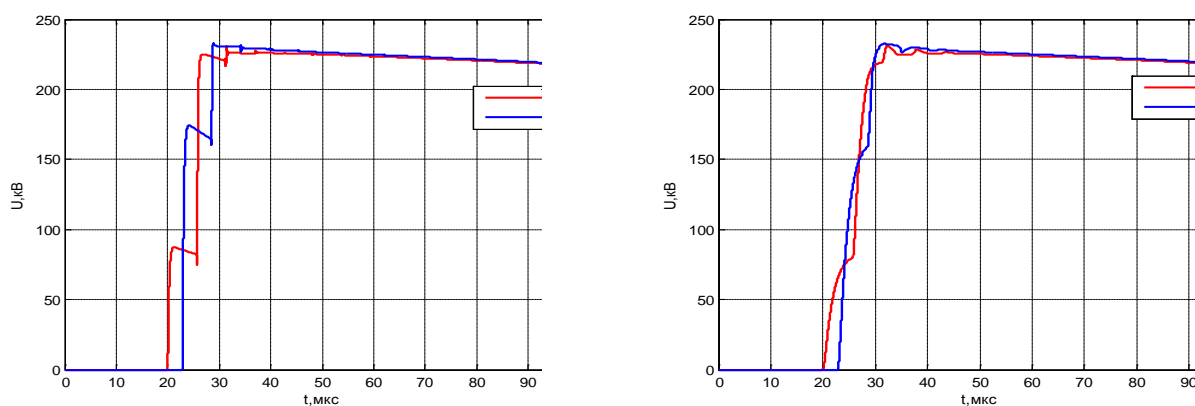
$U_w(t)$ – voltage impulse, oncoming from OTL to the cable insert;

DSHFO block – devices for suppression HF overvoltages (there are various devices in this block: PR are connected to the crosscuts between wire of OTL and cable insert, CC at the interface between OTL and XLPE-cable, combination of PR and CC).

Design scheme was implemented in the application Matlab Simulink. For 110 kV network parameter values for XLPE-cables with section 1000 mm^2 conductor assumed to be equal: $C_1 = 2,3841 \cdot 10^{-10} \text{ F/m}$, $L = 1,3228 \cdot 10^{-7} \text{ H/m}$, $Z_k = 23,5 \text{ Ohm}$, $v = 178 \text{ m/us}$.

As an example, fig.4 and 5 illustrate simulated plots of overvoltages caused by full and cut waves running from OTL and affecting to the cable insert 110 kV. The

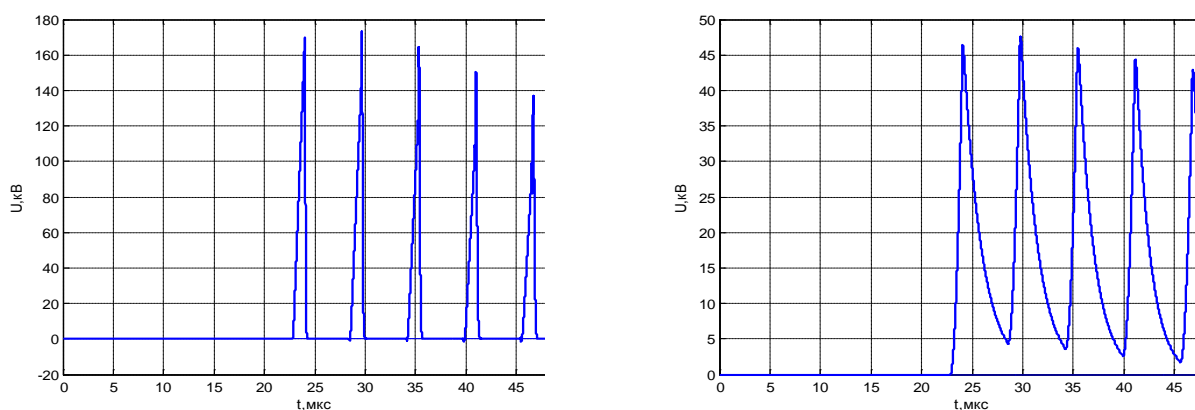
plots in fig. 4-5 show that PR with inductance 1,2 mH as well as CC presence reduce steepness of impulse overvoltages acting XLPE-cable insulation.



a)

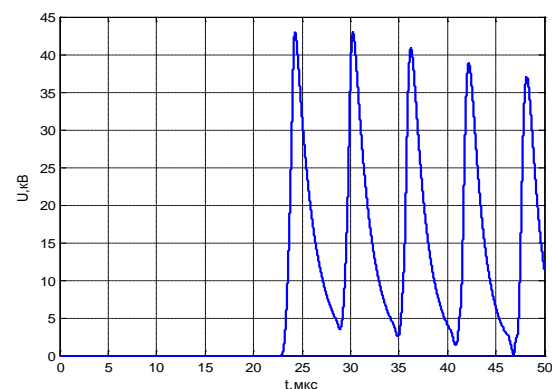
b)

Fig. 4. Simulated plots of overvoltages at the beginning and end of the 500 m cable insert caused by full wave ($U_w = 1000$ kV, $\tau_f/\tau_w = 1,2/50$ us), running from 110 kV OTL without devices for suppression HF overvoltages (a) and with PR (b)



a)

b)



c)

Fig.5 Simulated plots of overvoltages at the beginning and end of the 500 m cable insert caused by cut wave ($U_w = 1050$ kV, $\tau_f/\tau_w = 1,2/0$ us), running from 110 kV OTL without devices for suppression HF overvoltages (a), with PR (b) and CC (c)

Application of commercially available hardware devices to suppress high-frequency overvoltage affecting XLPE insulation system leads to the following positive factors.

Steepness of pulse overvoltage affecting XLPE insulation decreases, which leads to increased resource exploitation XLPE-cables.

1. Decreasing steepness of pulse overvoltage leads to more uniform current load through the protective devices installed on the substation.

2. Reduced steepness of pulse overvoltage promotes more "effective work" SA by damping the dynamic properties of the current-voltage characteristics of the arrester when exposed to current pulses with steep fronts.

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Piganov M.N., Tyulevin S.V., Erantseva E.S., Mishanov R.O.
DIAGNOSTIC METHOD FOR NON-DESTRUCTIVE CONTROL CHIP
CMOS -TYPE

Samara State Aerospace University named after academician S.P. Korolyov
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The article deals with a new method of diagnostic testing and culling of potentially unreliable chip CMOS structure. The influence of defects on the dynamic parameters of the circuits. Shows the equivalent circuit and the basic element of the structure. Proposed setting for rejection circuits. The values of the response time for the sample chip.

Key words: diagnosis, control, chip, CMOS structure, equivalent circuit, the basic element, the apparatus for culling., informative parameter.

Introduction

Element base defining way affects on the properties, characteristics and capabilities of radioelectronic means. In modern devices use a wide range of active and passive discrete electric components, hybrid microcircuits and semiconductor, micro assembly, functional electronics devices and other items. Due to the complication of functions, performed by the hardware, growing it's complexity that is estimated by the number of its elements. This can be clearly seen in the case of equipment used in space vehicles (SV). Increase in the complexity of electronic equipment dramatically increases the demands on the reliability of components. Severe operating conditions of equipment on board the spacecraft are aiming to select the most reliable elements.

Selecting electrical radio products (ERP) of high quality is usually carried out on the basis of methods electrophysical diagnostics or diagnostically nondestructive control (DNC). The basis of the principle of identifying the electrophysical parameters (informative parameters) characterizing the state of ERP and determining workability of electrical radio products on selected criteria by comparing the measured informative parameters with their thresholds. While rejecting subject is ERP that are related to potentially unreliable. Their main characteristics correspond to the requirements of technical conditions. However, this ERP have hidden defects that may eventually lead to failure.

At this stage developed various methods and means for DNC components. Which is used in the respective devices [1-9]. However, the ever growing range of ERP of different functional purposes, the use of new materials, structures, manufacturing processes is require a new informative parameters, more precise criteria of rejection, the development of new means of control. Particularly acute this issue is in connection with the creation of spacecraft having a large period of active functioning. Increasing demands for reliability, accuracy and efficiency of DNC, it's automation increases the complexity of the diagnostic tools and rejection. Therefore, the development of such means is necessary to take additional measures to improve the reliability of their functioning.

The main role in providing high quality electronic products and electronic equipment belongs to stage production on which implemented the potential of reliability built into the product by developers. High quality of technical process, timely detection and elimination of deviations from the process, leading to the failure of the product, the development of the constructive and technological solutions, unthinkable without introducing of considered automatically quality control system. One of the major subsystems of quality control in the production and use of electronics products recognized physical and technical methods of nondestructive control and failure forecasting.

Introduction of such methods in manufacture allows us to solve the following technical and economic objectives: quality control of original materials and components; correcting of modes of technological process; percentage increase of valid products; reduction in long-term tests; increasing productivity.

Development a method DNC of IMC

Preliminary research have shown a lack of efficacy of the known methods of DNC chip based on CMOS structures. At the same time revealed a deviation of some dynamic parameters, in particular fronts duration of impulse at the output of "defectives" IMC, from the average values in the series at extreme low supply voltages. The mechanism of influence of defects on the dynamic parameters in the MOS chips can be explained in the presentation of its basic element in the form of RC - structures with distributed parameters. Equivalent circuit of such a structure is shown in Fig. 1.

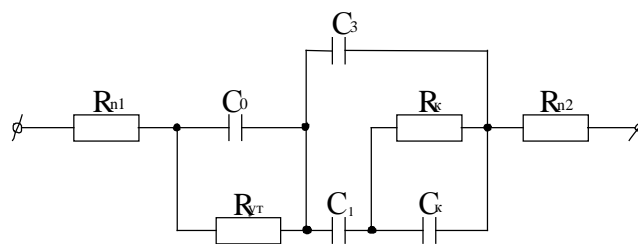


Fig. 1. Equivalent circuit of MOS - structure

In the equivalent circuit used following notations: R_{n1} – resistance of contact and metallization; C_0 – capacitance gate dielectric; C_3 - capacity of the space charge region; $R_K C_K$ – circuit, taking into account the spreading of the bias current through the dielectric to nearby highly conductive area of channel; C_1 - edged capacity; R_{n2} – resistance of contact and metallization runoff. These parameters are determined by the condition of respective areas of MOS - structures and the applied voltages. Transient processes caused by them, determine the signal propagation delay and "tightening of fronts".

Another mechanism of emergence of distortion of pulse edges can be defined recombination of carriers in the potential well in the gate area of the open transistor complementary pair (Fig. 2) on the defects and impurities, as well as recharging of defects in the channel in arrival moments of rise and fall of the front, thereby increasing the saturation and resorption time of space charge. This leads to a deviation of dynamic parameters from the norm. Lowering the voltage to thresholds

levels is reduce the drift current component to extent, comparable to recombination, which increases the influence of defects on the CMOS deviation dynamic parameters.

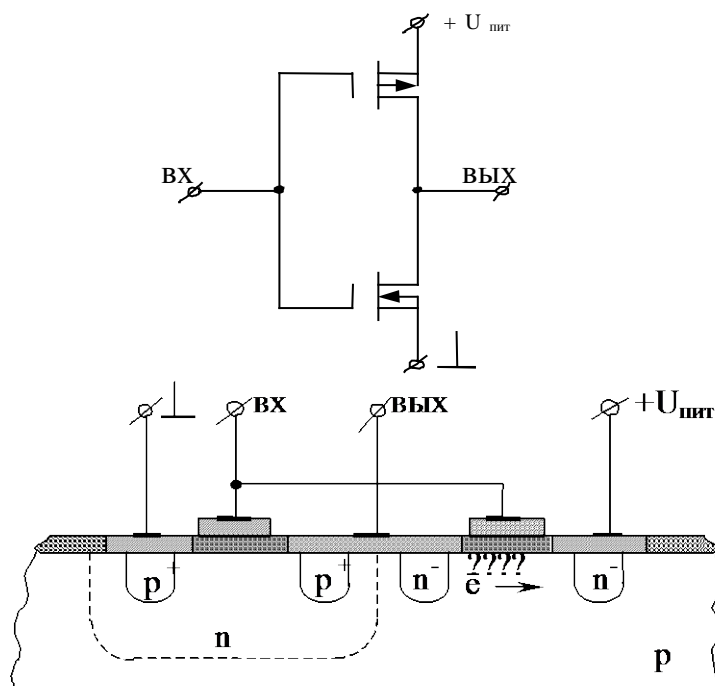


Fig. 2. Basic Element CMOS IMC

Was developed a new method of culling of CMOS - microschemas with reduced reliability, that will improve the accuracy of assessing the quality of IMC compared with known methods.

The method consists in the following.

On the test chip served supply voltage close to critical, and input test sequence of impulses with an amplitude limited supply voltage of tested IMC to prevent false alarms, and the breakdown of the chip.

As an informative parameter for culling IMC use the delay time when turn on and turn off. This option allows you to take into account to a greater extent IMC defects than the measurement of static parameters, and at the same time is an early stage of defects detection than the unstable signature. Produce culling of microcircuits by comparing the difference in values when the trigger on (off), between the mean value of the delay of samples and delay value of trigger of IMC with etalon value.

On Fig. 3 shown a scheme of device, implementing this method.

It comprises a power source 1, the output of which is connected to the power supply pins of tested IMC 2 and block 3 of the test sequence generator, connected to the inputs of IMC 2. Outputs IMC 2 are connected through a switch 4 to the input of block 5 measuring propagation delays when starting and stopping.

Method of culling IMC is as follows. On one power source 1 set the voltage of test IMC, close to critical supply voltage. From block 3 of test sequence generator to the test IMC 2 send a test impulse sequence with an amplitude equal to the supply voltage of testing IMC. By switch 4 is selected preset output of microcircuit. Propagation delay times when turning on/off is determined by block 5. Specific value

of low supply voltages is set empirically in depending on the type of IMC and requirements in terms of reliability. The closer it is to the critical value, the stronger the IMC defects appears and therefore the accuracy of the culling.

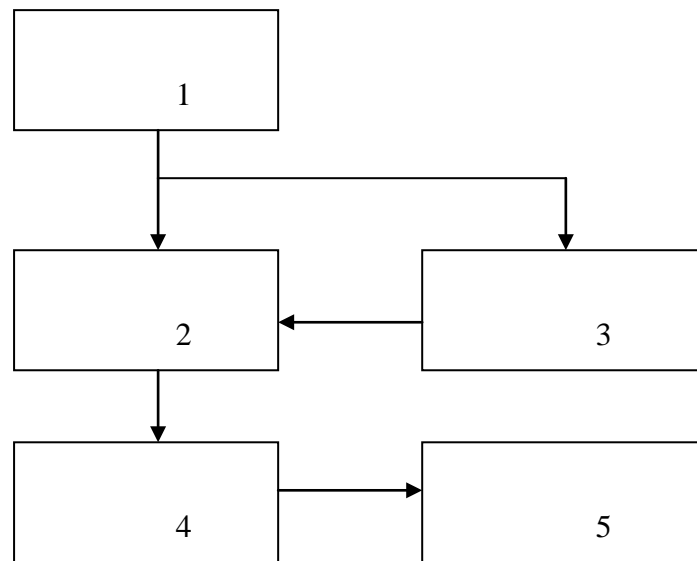


Fig. 3. Scheme of apparatus for culling

For each testing microcircuit is measured propagation delay time, when turning on/off $t_{0,1i}$ and $t_{1,0i}$. Find the average delay values $t_{0,1cp}$ and $t_{1,0cp}$, then cull the microcircuit by criteria:

$$(t_{0,1cp} - t_{0,1i}) < \delta_{0,1}, \quad (1)$$

$$(t_{1,0cp} - t_{1,0i}) < \delta_{1,0}, \quad (2)$$

$t_{0,1cp}$ - average value of the propagation delay when the turning on;

$t_{0,1i}$ - propagation delay value when turn on the i -th microcircuit;

$\delta_{0,1}$ - parameter that determines the quality level of IMC by propagation delay when the microcircuit turning on;

$t_{1,0cp}$, $t_{1,0i}$, $\delta_{1,0}$ - same, when turning off IMC.

Depending on the requirements for reliability can be used criteria (1) and (2) together or just one of the criteria.

The IMC culling method described above can be illustrated by following example. In table 1 shown dwell(ing) time are in microseconds when turn on (BF) and turn off (CF) for a sample of ($N = 50$ pcs.) IMC series 564JII2. Power supply IMC was 1.9 V, frequency of clock input sequence - 10 kHz. For output 4 of IMC time $t_{0,1cp}$ was $6,4 \mu S$, $t_{1,0cp}$ - $4,9 \mu S$. If take dispersion as a determining quality parameter of IMC, the value $\delta_{0,1} = 5,1 \mu S$ and $\delta_{1,0} = 1,1 \mu S$.

Using the criterion (1), culling a less reliable IMC with numbers 9, 10, 11, 18, 19, 22, 23, 25, 29, 38, 41, 43, 44, 48. By the criterion (2) culling IMC with numbers 8, 9, 10, 18, 19, 21, 23, 25, 27, 28, 29, 32, 33, 38, 39, 41, 42, 43, 44, 46, 48, 50. Experimentally established that the delay times of trigger when turning on/off for one output of IMC have a strong correlation link, the correlation coefficient $r > 0,6$, so you can use IMC culling criteria (1) and (2), both jointly and separately. In addition, the correlation coefficients between of delay times of the trigger when turn on(off) for functionally identical outputs of IMC (for IMC 564JII2 pins 10 and 4) also have

a strong correlation link. In this regard, diagnostics of IMC sufficient to perform according to any one output of microcircuit. Specific values $\delta_{0,1}$ and $\delta_{1,0}$ are determined for each type of IMC depending on the hardness of reliability requirements imposed to the microcircuits.

In report is given analysis of the influence of temperature regime of external adapter with cord on U_n , t_p^+ , t_p^- , and also shows the values t_p^+ и t_p^- and for other part types of IMC of this series.

Table 1

Number of testing IMC	Dwell(ing) time of IMC 564JII2 10 pin		4 pin	
	BF(t_p^+)	CF(t_p^-)	BF(t_p^+)	CF(t_p^-)
1	10,1	5,0	9,1	5,7
2	8,8	4,2	6,9	4,6
3	7,0	5,3	6,7	5,9
4	3,0	2,7	2,8	3,3
5	14,0	5,5	9,8	5,6
6	7,8	4,2	7,4	4,7
7	8,4	5,0	7,6	5,3
8	7,7	5,2	8,0	6,1
9	13,2	6,4	13,5	6,2
10	16,0	6,1	13,9	6,0
11	8,9	5,7	11,6	5,7
12	6,2	4,2	5,5	4,5
13	7,4	4,5	7,3	4,8
14	9,8	4,9	9,2	5,5
15	10,5	5,3	8,3	5,8
16	6,3	5,9	6,0	5,9
17	6,9	4,1	7,0	4,7
18	12,8	5,5	12,0	6,5
19	14,2	6,6	12,8	7,2
20	7,6	4,2	6,6	4,7
21	11,6	6,2	11,4	7,0
22	12,9	5,0	13,0	5,6
23	14,0	6,4	12,8	6,6
24	7,9	4,9	7,0	5,5
25	15,9	6,2	15,3	7,0
26	6,2	4,9	6,1	5,5
27	14,3	7,1	11,2	6,8
28	10,1	5,1	11,2	6,3

Table 1. Ending

29	12,8	5,0	12,3	6,2
30	7,2	4,9	5,6	5,9
31	8,6	4,5	8,1	5,4
32	11,2	5,8	10,5	6,6
33	9,1	6,1	8,1	6,7
34	5,5	4,3	4,7	4,8
35	8,6	4,7	8,5	5,8
36	6,6	3,9	6,1	5,1
37	4,7	4,2	4,5	4,9
38	19,0	7,9	18,3	8,8
39	7,4	5,9	7,3	6,6
40	6,6	5,2	6,2	5,3
41	10,4	6,7	12,5	7,6
42	8,9	5,8	9,5	6,6
43	11,8	5,5	11,5	6,2
44	11,6	5,3	11,7	6,3
45	9,6	5,2	10,1	5,9
46	9,6	5,0	8,6	6,8
47	11,3	5,3	10,8	5,3
48	12,0	5,3	12,8	6,2
49	8,0	5,3	7,9	5,9
50	11,1	5,7	11,1	6,2

Conclusion

Performed researches allow to make the following conclusions:

1. Due to equally informativity of parameters t_p^+ , t_p^- and U_n at $t_p^+ = \text{const}$ or $t_p^- = \text{const}$, their choice for culling CMOS - microcircuits is determined only by the efficiency of technological implementation and metrological characteristics of means of control.

2. Presence in the distribution of the parameters t_p^+ , t_p^- and U_n at $t_p^+ = \text{const}$ or $t_p^- = \text{const}$ coincide and saving at an elevated temperature of several maximums indicates the presence in the researched samples corresponding quality groups.

3. When implementing this method, control of informative parameters of multiple-output IMC enough to make by one of the outputs.

4. Increasing of temperature not causes increase informativity of considered parameters.

5. Working with external adapter contributes a small error (2...2,5% by BF and below 15% by CF), which can be easily taken into account.

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Mikhalevskiy D., Naugolnykh E., Melnykh V.
TRAFFIC TRANSFER IN WI-FI NETWORKS WHILE SWITCHING
BETWEEN ACCESS POINTS

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Abstract. The paper considers the conducted research on the process of automatic switching of movable network subscribers between access points in wireless Wi-Fi networks.

Key words: traffic, wireless network, roaming, Wi-Fi.

The possibility of lossless transferring of the modern types of multimedia traffic is the one of the topical issues in wireless networks investigations [1]. Such a traffic requires transferring of large amounts of data together with maintaining of its quality. The researches had proven that the modern Wi-Fi networks have a number of disadvantages while transferring the new types of multimedia traffic [2]. Thus, the development of new method on optimization of wireless networks require an investigation on the factors effecting the bitrate. In this paper, we consider the features of roaming in Wi-Fi standard networks.

Roaming is the process of automatic switch between access points while moving the subscriber's transmit-receiving equipment. In our case, the main criterion in deployment of network with more than one access point or retranslation is the availability of a stable signal throughout the network coverage area. In this case, the following conditions must be satisfied: the network coverage zones overlap each other, the access points belong to the same network with a unique identifier (SSID), usage of the same transmission channel. During the switching between access points the packet losses must be either minimal or nonexistent. Let's create a wireless Wi-Fi network to study the process of movable subscribers' switching between the access points, as it is shown on Fig.1.

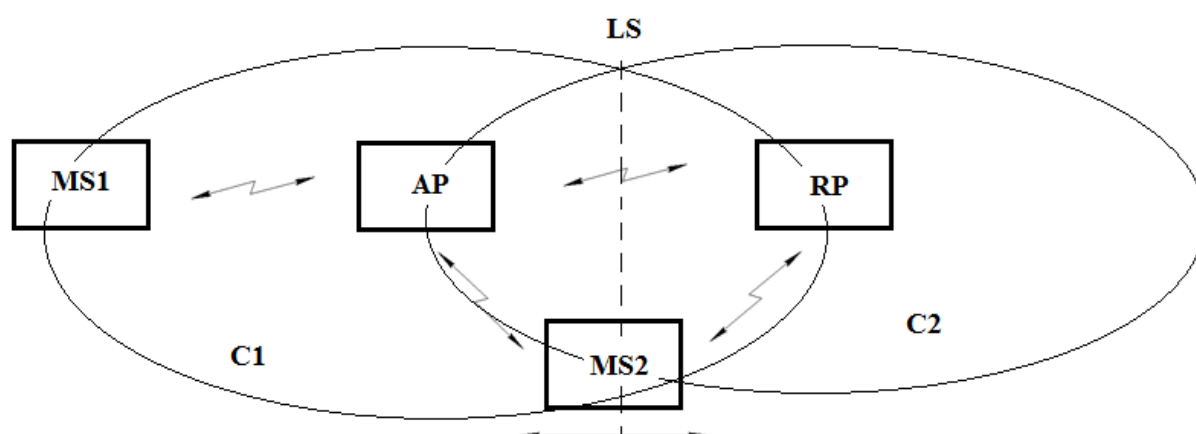


Fig.1. The researched network scheme

This scheme provides a network access point (AP) with network coverage C1, the retranslation point (RP) with network coverage C2 to provide the network coverage expansion, two movable subscribers MS1 and MS2.

The main parameter while transferring data is the bitrate speed that is directly related to the signal power at the movable subscribers' input and is a random value. Fig. 2 shows the time dependencies of the received signal's level while moving MS2 through the imaginary line of automatic switching (LS) between points AP and RP.

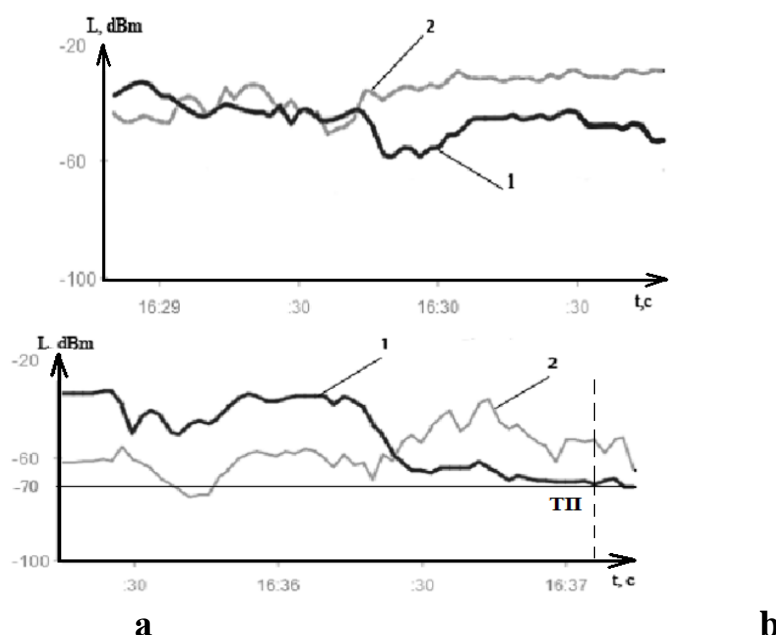


Fig. 2. The distribution of signal power in network: a) while moving between access points; b) at the moment of switching.

As it can be seen from Fig.2, while moving between access and retranslation points there occurs the dependence between the power of the received signal and the distance that has been considered in [2]. However, if the access point's signal level is lower than -70 dBm, the switching of a movable subscriber over the retranslation point becomes automatic. This phenomenon is shown on Fig.2 b and is named as a retranslation point (RP). The data transmission delays and even data losses must occur while proceeding the switching between the access points. For considering this during studying the switching moment the data has been transferred from one movable subscriber 1 to movable subscriber 2 and the multimedia data has been transferred backwards. Fig. 3 and 4 describe the time dependencies of transferring bitrate of the given data between the subscribers.

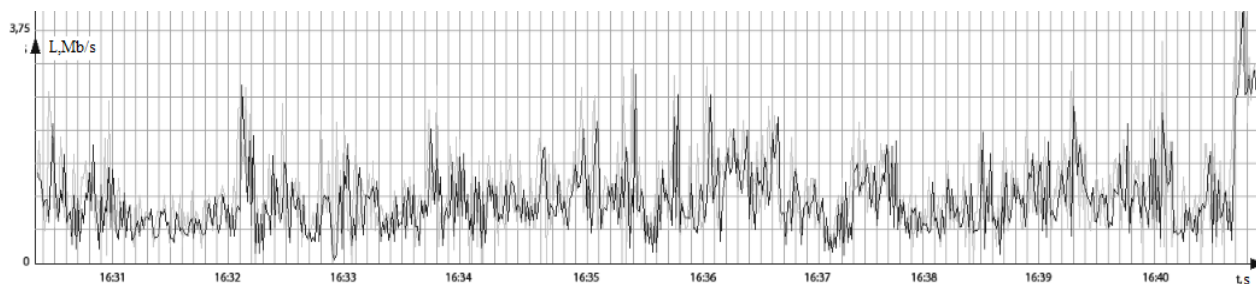


Fig. 3. Data transferring between subscribers

The diagrams above prove that during switching after 37 sec the bitrate has significantly decreased that is caused due to the algorithm of subscriber's identity to

the RP. A critical situation of multimedia traffic, which clearly show the gap flow, appearance and loss of useful information and the emergence of visual distortion. The situation with the multimedia traffic is even more critical, when the flow gap is clearly seen, the losses of useful data and visual distortion take place.

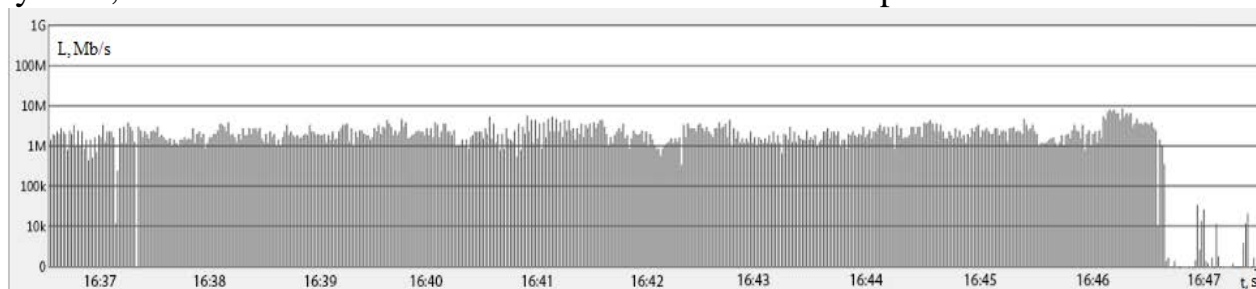


Fig. 4. Multimedia data transferring between the subscribers

Since there may be lots of movable subscribers in the wireless Wi-Fi networks, let's consider more typical case of roaming: the subscribers move side-by-side, the subscribers move towards each other. The time diagrams of data transferring between the subscribers are shown on Fig. 5 and 6.

Analyzing the obtained results, we should mention that the side-by-side movement is the most critical for data transferring. In this situation the connection may be lost for the period up to 0,5 sec. In the case of moving the subscribers towards each other the results are similar to the previous researches with one subscriber.

Thus, the automatic switching between access points in Wi-Fi networks has a number of disadvantages, which present themselves online during multimedia data transferring. This disadvantage is nonsignificant for transferring little amount of data, but the data losses can be rather significant during transferring big data amounts, especially of new modern multimedia formats, also taking into account the number of drawbacks such as external electromagnetic disturbances, lack of duplex transmission, which leads to the division of bandwidth between the number of subscribers and characteristics of traffic flow, which is characterized by irregularity and self-similarity effects arising from accidental changes of the transmission medium.

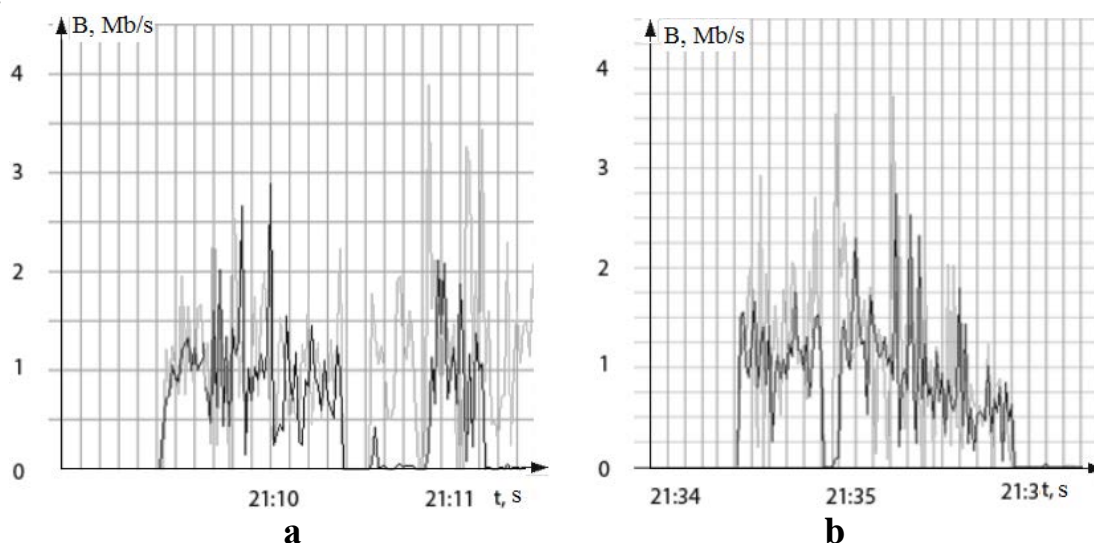


Fig. 5. Data transferring between the subscribers for the side-by-side (a) and towards (b) movements

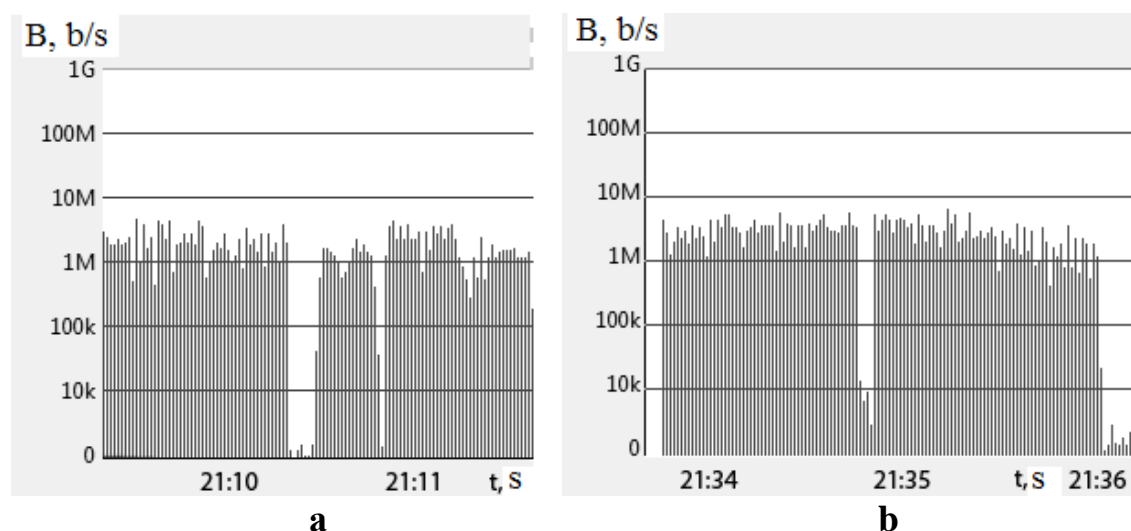


Fig. 6. Multimedia traffic transferring between the subscribers the side-by-side (a) and towards (b) movements

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Tolbatov S.V., Tolbatov A.V., Tolbatov V.A.
INFORMATION TECHNOLOGY ARCHITECTURE DEVELOPMENT
FOR WORK COMPLEXITY ASSESSMENT ALGORITHM
IMPLEMENTATION

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Abstract. Business logic and database resources access logic are being considered herein as a base for software development and representation logic implementation.

Key words: information system, software, database, work complexity assessment and design.

Information technology analysis within work complexity assessment framework allows determining the main approaches of the system design which is going to be developed. Especially two-level architecture should be designed for the system and software in order to be widely used by medium business enterprises.

Let's consider business logic and database resources access logic as a base for software development and representation logic implementation.

Physical data structure and its attributes are depicted on the figures 1-4. They are used for software development which is targeted to implement mathematical model of the work complexity assessment. The data structure and its relationship are represented by the ERM (entity-relationship model) which is designed to describe the conceptual scheme of the domain [1]. It helps to determine the key entities and relationship. Later on the ERM transforms into a certain database scheme during the design and implementation phases based on the chosen data model.

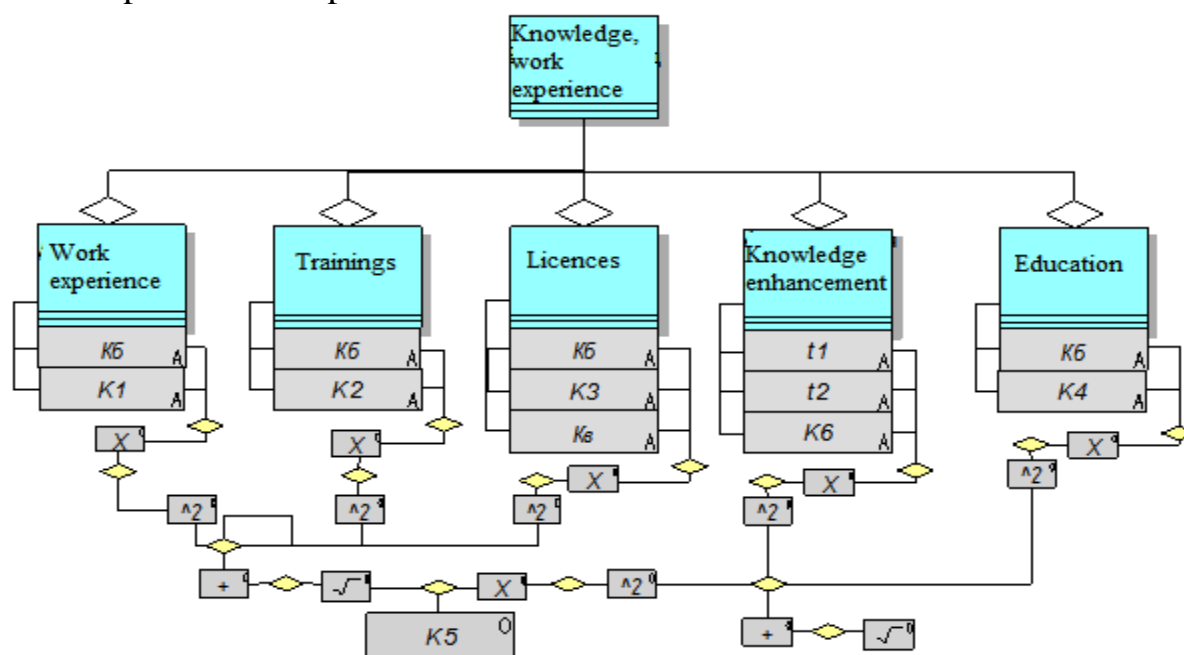


Figure 1. Aspect 'Knowledge, work experience'

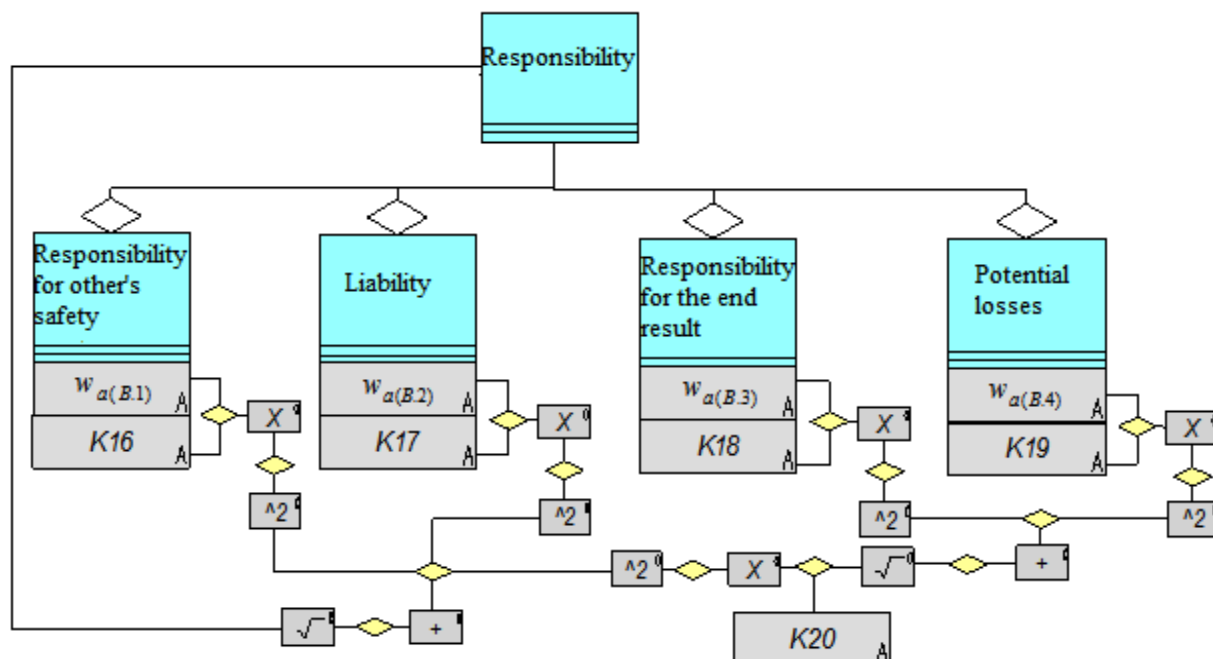


Figure 2. Aspect 'Responsibility'

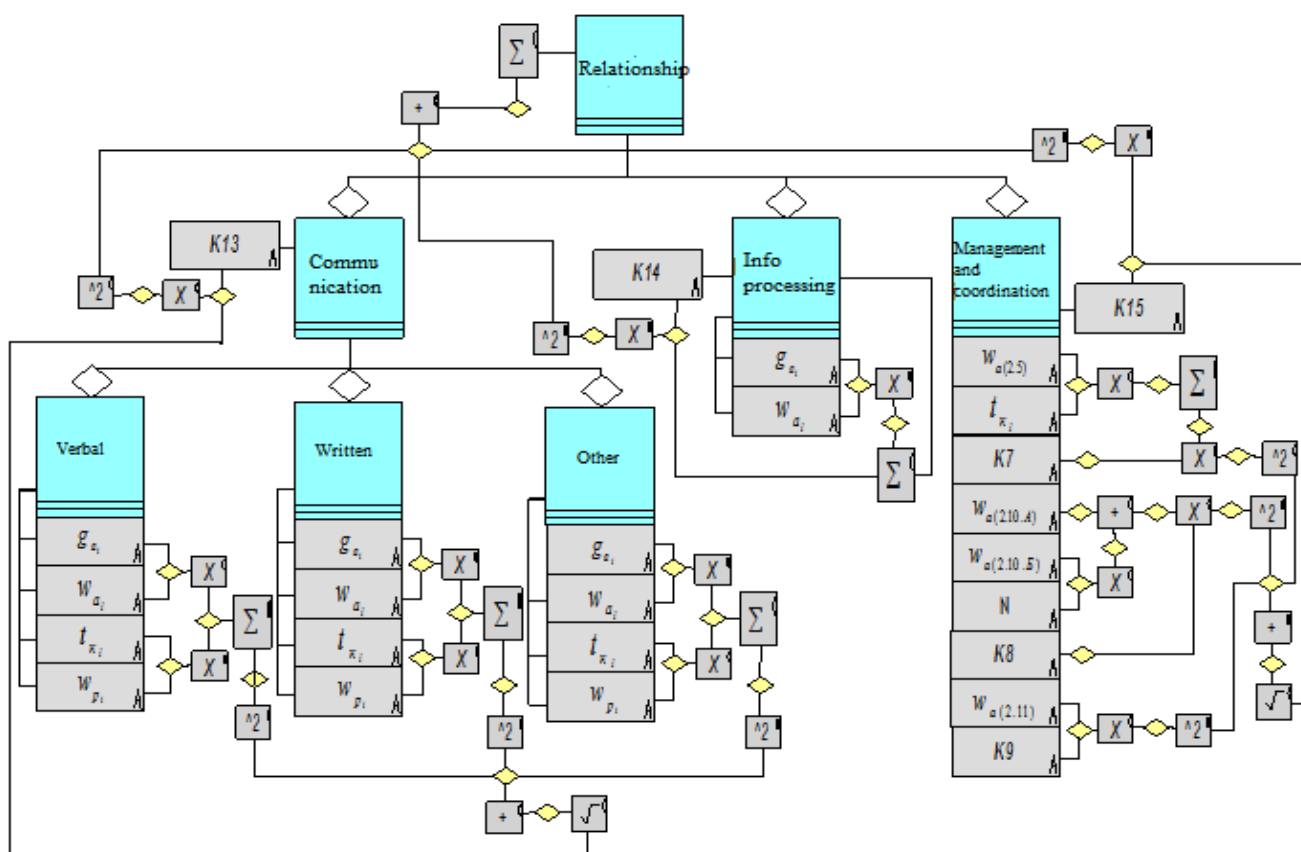


Figure 3. Aspect 'Relationship'

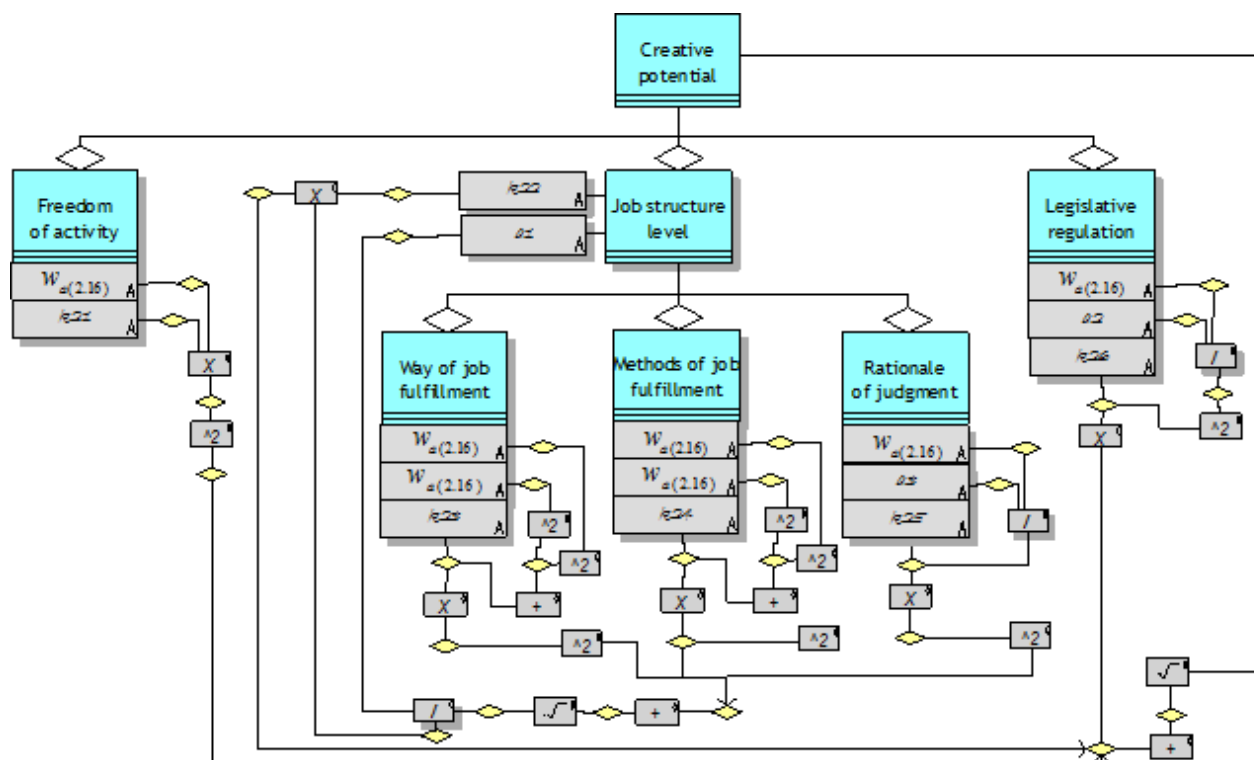


Figure 4. Aspect ‘Creative potential’

In order to design information system architecture, all input and output data, which will be used for processing and further outcomes for end users, should be thoroughly determined [2].

Current variety of data formats due to different measures used for work complexity assessment leads to necessity of data integration and transfer to unified database as well as processing and calculation system.

Information system could be represented by the following modules:

1. Data input module. It is used for variable data input. These data characterize every single aspect of the certain work model which is required for calculations. Basically this is the main item of the presentation logic (PL) implementation.

2. Aspects calculation module. Basically this is the main module for calculations. It is responsible for the quantitative assessment of the every single aspect of the work model. Business logic (BS) is implemented in this module. It is responsible for the relationship between all system's modules and implementation of the calculation algorithms.

3. Weight coefficients calculation module. This is a BL layer calculation module with pairwise comparison algorithms for weight coefficients calculation. It is considered as separate module due to necessity of calculations according to the chosen methodology which is assumed to be relevantly constant and not dependent on the work types. Such approach should simplify development process as well as operations and improvements of the module.

4. Memory table. These tables serve to store intermediately input data as well as calculations. Tables could be implemented in the appropriate areas of the RAM

devices. Basically information exchange between the calculation modules and the database is performed by the mentioned tables. Database resource to the access logic (AL) is implemented based on this mechanism.

5. Databases. Wide range of databases is incorporated in this group of modules. They are responsible for the storage of constant values, various legal directories which are required for calculations and data input.

6. Report. Report module works with report visualization and formation. Reports could be programmed or prepared by software users in advance.

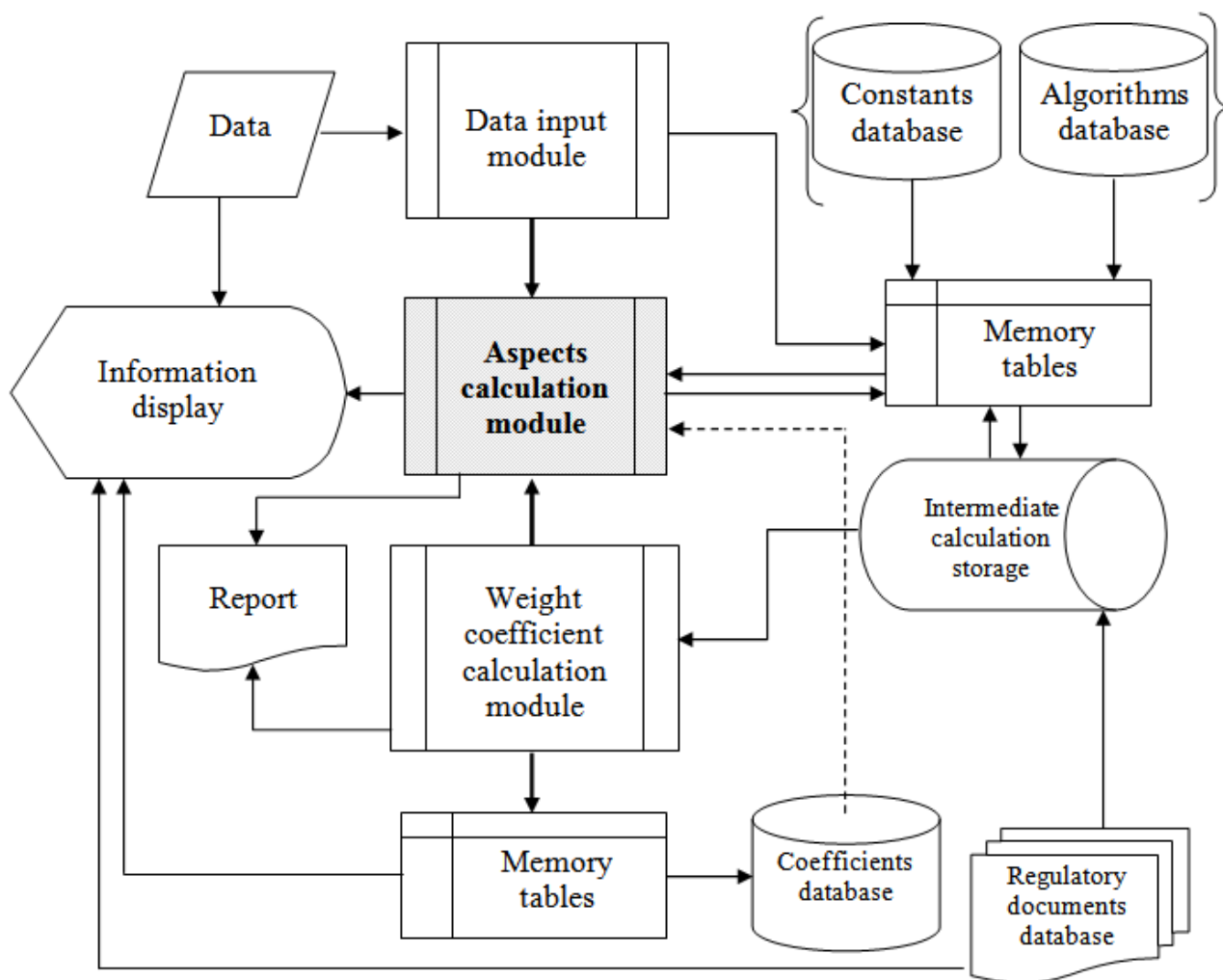


Figure 5. Flowchart of the information system

Information system reliability questions remain essential similarly to PL and BL ones. Reliability aspect consideration is suggested from the point of view that some memory areas could be duplicated and intermediate storages creation in the hard drives with further backups.

The security system of database resource access should be considered during the access allocation between system users. Usually these functions are assigned to IT departments of the organization or consulting companies which provide services of the work complexity assessment based on the own resources.

Information technology architecture for the design algorithms implementation and work complexity assessment could be used for salary level determination,

budgeting questions as well as financial analysis of the business process of the enterprises.

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Kuznetsov A. A., Kuznetsova M. A., Gorbunkov V. I.
THE WAYS OF VIRTUAL STANDARDS IMPLEMENTATION IN
SPECTRAL ANALYSIS OF MATERIALS.

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Abstract. In paper discusses ways of building a new class of measuring instruments - virtual standards in different parts of measurement and control, including the spectral analysis of materials. The aim is to improve the veracity and reproducibility of the measurement results under the influence of interfering factors.

Keywords: Means of measuring, spectral analysis of materials, influencing factors, computer processing, virtual standards.

Virtual instruments are widely used in technique and practice of measurements. Virtual instruments are a class of measurement that uses a personal computer (PC). The PC processes and displays the measurement results. Virtual instruments cannot perform measurements without the use of external software that has been installed on the PC.

There are various examples of the use of virtual instruments in different parts of the measuring technique and technical control. In the laboratories of electrical and radio measurements virtual instruments became widespread, which have the function of an oscilloscope, a generator, a multimeter and other devices. Measurement of signals of remote modules and signal processing using a microcontroller or computer allowed to increase the accuracy of output result [1].

In paper [2], was proposed the idea of virtual standards electrical quantities implementation. The technology of virtual standards used in the calibration of measuring instruments working. In installation structure that implements virtual standards are a measuring unit and software, which acts as the conversion of physical units.

The measuring unit can be a lower accuracy class than calibrated measuring instrument. After a series of measurements and data processing it was enable to receive individual correction values for compensate of measurement errors and to determine a more accurate value of the physical quantity.

For the control of rolling bearings state in paper [3] proposed a new class of test vibration signals - virtual standards defects of bearing assemblies have been described possible ways of implementing such signals. It was justified by receiving vibration test signal by reduction of the time signal of the three kinds of spectra measured signal.

In the implementation of virtual standards it is possible to solving two kinds of tasks, the first of the tasks associated with the stabilization of the measurements conditions, finding the most significant factors by regression analysis. Another task associated with finding more information in measured signal by purpose of constructing the mathematical relationship invariant to changes in the conditions of the experiment.

We consider the both tasks of virtual standards realization in the spectral analysis of materials. Real standards used in the spectral analysis for the construction of the calibration characteristics of the transformation of the measured value - the emission intensity of spectral lines to the output value - the quantitative content of elements in a sample.

For control of changing the factors which influencing for spectral analysis results, we were proposed an apparatus and a data processing unit that increase the stability and reproducibility of output results. When conducting atomic emission spectral analysis influencing factors are measured, it was adjusted intensities and as a result - improved stability of the calibration dependence of the device.

To spectral analysis device connects seven sensors that transmit data to the processing unit, and predicting of results. The device will be work as follows. After installing the test sample, on the PC screen is transferred its image by sensor D7. At the same time, in the case of incorrect installation or the presence of surface defects (spots of previous firings, etc.), a warning will be issued appropriate, the by analyzing the images obtained from the probe D7. When starts the electric discharge, a sensor D6 measures the distance between the analyzing probe and the electrode and the size of the cloud recorded.

Pressure sensor D1 is located inside a sealed optical block 1, which are also a diffraction grating 6 and radiation detectors CCD1 – CCD6. The emission from the sample is flagged in the block through the optical pickup (OP). The flow sensor D2 is installed on the line of supply argon in the chamber discharge 2 of the device. The temperature sensors D3 and wetness D4 mounted on the outside of the spectrometer. Sensor of electrical discharge parameters D5 is located in a circuit current flowing from the electric generator (EG) to the tungsten electrode 3 Sensors D6 and D7 represent a technical endoscopes, and arranged so as to provide the desired review surface of test sample installed on the table 4 and in the discharge chamber 5 [4, 5].

Where all measured parameters are normal, the final measurement result is considered significant. If the values of some parameters are outside the limits, it is necessary to make adjustments dependence the calibration by means of standard samples.

Another way of create the virtual standards is to create a mathematical model that compensates for the influence of factors on the measurement result, and its application in the software of the automated measurement system.

In order to obtain invariant model measured the intensity of the spectral lines at different experimental conditions. For obtain a positive result it is necessary to obtain the most significant deviation of the measured parameters. For construct the model selected spectral lines with different power characteristics (have different reaction to change factors) [6].

For account of the different energy characteristics of the spectral lines was proposed use of generalized functions of the type (1):

$$F_j = \frac{\sum_{i=1}^N a_i I_{\text{ah}ij}}{\sum_{i=1}^M b_i I_{\text{cp}ij}} = \frac{a_0 I_{\text{ah}0j} + a_1 I_{\text{ah}1j} + \dots + a_N I_{\text{ah}Nj}}{b_0 I_{\text{cp}0j} + b_1 I_{\text{cp}1j} + \dots + b_M I_{\text{cp}Mj}}, \quad (1)$$

I_{an} – the intensity of the spectral lines of analyte; I_{cp} – intensity of comparison line with different energy characteristic; a_i , b_i – stable calibration weight coefficients; N – number of lines of the analyte; M – number of the comparison lines.

Calibration characteristics constructed by the proposed model are stable when external conditions change, or can be transferred to different devices of the same type without loss of accuracy due to the individual calibration parameters.

Virtual standards can be regarded as the real standard models with the software that processes the output signal from these samples using the additional information from the recorded spectrum for compensate of error components due to changes in the external conditions of the experiment.

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Filippova A.G., Galiakbarov V.F., Filippov V.N.
DATABASE POSSIBLE COMPLICATIONS DURING HIGH-SPEED
DRILLING OF WELLS

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Abstract. The paper presents the possible causes complications that may hinder speedy and efficient drilling of oil wells.

In order to identify the most significant causes of complications arising during drilling, the authors were aiming to develop an electronic database of information on the oil producing facilities in the territory of the Republic of Bashkortostan.

Key words: database, drilling, oil wells, drilling complications.

Oil production in the Republic of Bashkortostan is conducted since 1932. For 80 years the cumulative production amounted to more than 1.66 billion tons. In the late 40's - early 50's was discovered a number of large deposits - Tuimazinskoye, Arlan, Shkapovskoye, Chekmagushevskoye, Mancharovskoye commissioning which allowed Bashkiria come out on top in terms of crude oil of the oil producing regions of the USSR. Peak production rate - 47,850,000 tons - was achieved in 1967.

After a "plateau" at the level of 40 million tons per year average rate of decline in production levels from 1984 to 1999 accounted for an average of 6% per year. Stabilize production was only in 2001, at around 12 million tonnes. Despite the high rates of drilling - from 1999 to 2008, "Bashneft" has introduced an average of 16 new wells at 1 million. Tons of production - a priority in those years was not the intensification of production and stabilization of water production. Therefore, up to 2008 production remained at a level of 12 million tons per year [1].

Optimization of the existing wells in the second half of 2009, the improvement of flooding, the use of a number of geological and technical measures, including cutting off flooded intervals, the removal of the skin effect, and EMG yielded good results.

Following 2012, Bashneft has kept oil fields under development at an optimal level, and continued to increase the volume of production, having produced 15.4 million tons. Average daily production in 2012 was 42.2 thousand tons/day.

Oil production growth was achieved mainly by increasing the efficiency of geological *tehnicheskikh* *meropriyaty*, the application of modern technology, as well as the commissioning of new fields located in the Republic of Bashkortostan - deposit them. V.S. Afanasiev, Opal and Barsukovskoye.

In 2012, Bashneft has commissioned 42 new wells, 32 of them from drilling. In this case, due to the geological model of the existing space and the adjustment program, drilling volumes decreased as compared with 2011.

New approaches to the selection of sites for drilling and seismic 3D- allowed to avoid drilling inefficient in terms of geology wells. By modeling the operational object and to optimize the design of the well on the basis of three-dimensional geological and technological model in March 2012, during the drilling of wells in the

field was obtained Ilishevskom record inflow of oil, amounting to 503 tons/day (capacity - 900 tons/day) [2].

The drilling process consists of the following: round-lifting work. These operations are interrupted periodically for descent pipes into the well to prevent the wall of the hole from landslides and divide the oil (gas) and water horizons.

Simultaneously in the process of drilling a number of runs of an auxiliary work: coring preparing flushing fluid (mud), logging, measurement of curvature, the development well to the call flow of oil (gas) into the wellbore and so forth. In case of accident or complication arises the need for additional work [3].

Even when using the latest advances in design and construction technology of wells is often not possible to avoid complications that hinder speedy and efficient drilling. Most often develop complications such as:

- absorption of drilling and grouting solutions;
- oil, water and gas show;
- debris avalanches and the borehole wall;
- tightening and landing drill tool during tripping operations [4].

The authors set out to compile statistics on complications in drilling oil wells in the territory of the Republic of Bashkortostan, on their basis to develop an information electronic database.

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© Filippova A.G.

J21410-038**M.Ye. Chernova, Ya.V. Kuntsyak****STUDY OF THE STRESS STRAIN OF ROCK MASSIF IN THE CROOKED WELLBORE***Ivano-Frankivsk National Technical University of Oil and Gas (IFNTUOG),
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Abstract. We investigated the stressed-deformed state of rock mass in a deviated borehole. There were received the analytical dependencies for determination of circular and radial stress that allow a science-based approach to the design of a borehole profile during the drilling process in uneven horizon of rock mass of such reservoirs as Dnipro-Donetsk Depression and Black Sea Shelf and construction of hydroacoustic directional energy devices with controlled parameters.

Key words: borehole, stress, drilling, rock.

The main task, which is facing Ukraine, is to increase hydrocarbon production on its own fields. One of the most effective methods of oil and gas production is the construction of a directional (DW) and horizontal wells (HW), and side-hole jamming. In recent years both domestic and foreign scientists are working on developing the methods of controlling the dynamics of BHA operation on the bottom well by applying the fluctuations generators of directed actions, with the purpose of increasing the mechanical drilling speed, improving the quality of treatment of the buttonhole and the withdrawal of the rocks extracted onto the day surface [1]. To determine the effects of energy hydro-acoustic oscillations on the properties of the rock and its strength characteristics it is necessary to carry out theoretical, experimental and industrial research.

The successful construction of DW and HW depends on the completeness of the information on the structure and properties of rocks that are being developed. One of the important data in this direction is the characteristics of the stress-strain state of rock and information on the disturbances, which arise in the process of the dynamic loads.

Rocks are able to destroy the strength in conditions that are close to the one-axial tension (compression), but while approaching the hydrostatic conditions this ability is lost, since in the course of drilling a well its walls are in a complex stress state. Therefore, the assessment of the sustainability of the rock is the most complete in volumetric strain, characteristic of which is the by-pass of maximum Mohr's circles (passport strength), built in the coordinates of the normal and maximum tangential stresses. Using the passport sustainability and Mohr's circles, you can define hour resistance (tensile strength) of rocks to one-axial stretching-compression, to torsion, to the cut with the compression, to the volumetric compression.

By-pass circles of stress have a different shape, in particular, for loose rock it is an inclined line, which starts in the beginning of the coordinates, and for the plastic rocks it is the line which is parallel to the axis of the normal stresses. For the rocks, which are characterized by fragile destruction and significant difference destructive stress in compression and tension, as a by-pas shape we take part of the circle with a line, a parabola, a cycloid, an exponential curve, etc. [2,3].

The rock, which is being drilled both in DW and in the HW, is not an isotropic medium, therefore the stress-strain state of rocks around the bottom-hole should be taken into account with a view of considering the fissure zone being formed, the task of whose calculation is different from the normal tasks by the fact that the limit of dividing the range of elastic deformations and fissuring zones is unknown beforehand. It has to be determined in the decision process. Thus, during the construction of the algorithm for calculating the ranges of elastic stresses and deformations it is expedient to use the methods that are suitable for the ranges of arbitrary shapes. This implies, in particular, the technique which is based on the application of the potential expression of the desired solutions [4,5,6]. This enables to build a definition of the desired circuit elastic zone using the iteration scheme. Under this condition the optimal satisfaction of all the necessary conditions is gradually achieved. A sufficient number of experiments made enables to detect the presence of the monotonous nature of the operators of the task in question, which provides the convergence of the iteration process over a wide range.

Taking into consideration that the extinction of the disturbances in the bottom hole in the direction perpendicular to its walls corresponds with the exponential law, the zone of stress can be considered as two-dimensional circular area Ω , consisting of the areas of plastic and elastic deformations accordingly Ω_1 and Ω_2 . We assume that in the area Ω_1 the Saint-Venant plasticity condition will be satisfied,

$$(\sigma_r - \sigma_\theta)^2 + 4\tau_{r\theta}^2 = \sigma_T^2, \quad (1)$$

where $\sigma_r, \sigma_\theta, \tau_{r\theta}$ - are the relevant elements of the stress tensor.

To determine the stress-strain state in Ω_2 we use the system of differential equations:

$$\left. \begin{aligned} (\lambda + \mu) \frac{\partial \tilde{\epsilon}}{\partial r} - \mu \left(\frac{U}{r^2} + \frac{2}{r^2} \frac{\partial V}{\partial \theta} \right) + \mu \Delta U + X &= 0; \\ (1 + \mu) \frac{1}{r} \frac{\partial \tilde{\epsilon}}{\partial \theta} - \mu \left(\frac{V}{r^2} - \frac{2}{r^2} \frac{\partial U}{\partial \theta} \right) + \mu \Delta U + Y &= 0, \end{aligned} \right\} \quad (2)$$

Where

$$\Delta = \frac{\partial^2}{\partial r^2} + \frac{1}{r} \frac{\partial}{\partial r} + \frac{1}{r^2} \frac{\partial^2}{\partial \theta^2};$$

$$\tilde{\epsilon} = \frac{\partial U}{\partial r} + \frac{U}{r} + \frac{1}{r} \frac{\partial V}{\partial \theta};$$

$U = U(r, \theta)$ and $V = V(r, \theta)$ - are the radial and tangential displacement respectively;

$X = X(r, \theta)$ and $Y = Y(r, \theta)$ - are the components of the load volume vector;

λ and μ - Lame elastic constants.

On the internal L_1 and external L_2 borders of the area under consideration Ω (being concentric circles radii $R_1 < R_2$) we assume the following:

$$\sigma_r|_{L_1} = \varphi_1(\theta); \quad \tau_{r\theta}|_{L_1} = \varphi_1(\theta); \quad (3)$$

$$U|_{L_2} = \psi_1(\theta); \quad V|_{L_2} = \psi_2(\theta). \quad (4)$$

Along the border L of the section of areas Ω_1 and Ω_2 the following conditions should be observed:

$$\sigma_r^{(1)}|_L = \sigma_r^{(2)}|_L; \quad \tau_{r\theta}^{(1)}|_L = \tau_{r\theta}^{(2)}|_L; \quad \sigma_\theta^{(1)}|_L = \sigma_\theta^{(2)}|_L, \quad (5)$$

were $\sigma_r^{(1)}, \sigma_\theta^{(1)}, \tau_{r\theta}^{(1)}$ and $\sigma_r^{(2)}, \sigma_\theta^{(2)}, \tau_{r\theta}^{(2)}$ - the voltage in the areas Ω_1 and Ω_2 respectively.

In the plastic zone using the voltage function $\Phi = \Phi(r, \theta)$, which is determined by the following formulae:

$$\sigma_r = \frac{1}{r} \frac{\partial \Phi}{\partial r} + \frac{1}{r^2} \frac{\partial^2 \Phi}{\partial \theta^2}; \quad \sigma_\theta = \frac{\partial^2 \Phi}{\partial r \partial \theta}; \quad \tau_{r\theta} = \frac{1}{r^2} \frac{\partial \Phi}{\partial \theta} - \frac{1}{r} \frac{\partial^2 \Phi}{\partial r \partial \theta},$$

satisfying the equilibrium conditions:

$$\frac{\partial \sigma_r}{\partial r} + \frac{1}{r} \frac{\partial \tau_{r\theta}}{\partial \theta} + \frac{\sigma_r - \sigma_\theta}{r} = 0; \quad \frac{\partial \sigma_\theta}{\partial r} + \frac{1}{r} \frac{\partial \sigma_\theta}{\partial \theta} + \frac{2\tau_{r\theta}}{r} = 0.$$

Then the plasticity condition (1) will have the form:

$$\left(\frac{1}{r} \frac{\partial \Phi}{\partial r} + \frac{1}{r^2} \frac{\partial^2 \Phi}{\partial \theta^2} - \frac{\partial^2 \Phi}{\partial r^2} \right)^2 + 4 \left(\frac{1}{r^2} \frac{\partial \Phi}{\partial \theta} - \frac{1}{r} \frac{\partial^2 \Phi}{\partial r \partial \theta} \right)^2 = \sigma_T^2. \quad (6)$$

Thus, taking into account the conditions (3) on the circuit L_1 should be as follows:

$$\left. \begin{aligned} \left(\frac{1}{r} \frac{\partial \Phi}{\partial r} + \frac{1}{r^2} \frac{\partial^2 \Phi}{\partial \theta^2} \right) \Big|_{r=R_1} &= \varphi_1(\theta); \\ \left(\frac{1}{r^2} \frac{\partial \Phi}{\partial \theta} - \frac{1}{r} \frac{\partial^2 \Phi}{\partial r \partial \theta} \right) \Big|_{r=R_1} &= \varphi_2(\theta). \end{aligned} \right\} \quad (7)$$

Thus, the function $\Phi(r, \theta)$, which is determined by Cauchy problem (7) for equation (6) can be found regardless of the other terms and conditions.

The following conditions (4) in the external circuit L_2 are regular boundary conditions. Along the border L it is necessary to perform a large number of conditions, than in the uniquely solvable boundary problems. This fact is used to determine the form of the border L which is being determined in the course of solution L .

In accordance with the principles on the use of the potential of expressions [4, 5], the solution of the problem

$$\left. \begin{aligned} \left(\lambda \epsilon + 2\mu \frac{\partial U}{\partial r} \right) \Big|_L &= \sigma_r^{(1)}|_L; \\ \mu \left(\frac{1}{r} \frac{\partial U}{\partial \theta} + \frac{\partial V}{\partial r} - \frac{V}{r} \right) \Big|_L &= \tau_{r\theta}^{(1)}|_L \end{aligned} \right\} \quad (12)$$

$$U|_{L_2} = 0; \quad V|_{L_2} = 0, \quad (13)$$

for the system of equations (2) it is appropriate to be sought in the form of contour capacity

$$\begin{pmatrix} U(r, \theta) \\ V(r, \theta) \end{pmatrix} = \int_{\tilde{L}} G(r, \theta, \rho, \varphi) \mu(\rho, \varphi) d_{\rho, \varphi} \tilde{L}. \quad (14)$$

Taking into account the experience of work [6] as the contour \tilde{L} as the contour $\tilde{R} > R_1$] of with the idea that it will completely belong to the plastic zone.

Taking into account that $r = r(\theta)$ - contour equation L , and substituting the expression (14) in the condition (12), we obtain (15)

$$\int_{\tilde{L}} G[r(\theta), \theta, \rho, \varphi] \mu(\rho, \varphi) d_{\rho, \varphi} \tilde{L} = q(\theta), \quad (15)$$

where

$$q(\theta) = \begin{pmatrix} \sigma_{\theta}^{(1)} |_L \\ \tau_{r\theta}^{(1)} |_L \end{pmatrix}, \quad \mu(\rho, \varphi) = \begin{pmatrix} \mu_1(\rho, \varphi) \\ \mu_2(\rho, \varphi) \end{pmatrix}.$$

To solve the equations (2), (4), (5) the following condition should be satisfied (at the expense of the proper choice of a loop L):

$$\left[\lambda \epsilon + 2\mu \left(\frac{U}{r} + \frac{1}{r} \frac{\partial V}{\partial \theta} \right) \right] |_L = \sigma_{\theta}^{(1)}(r) |_L. \quad (16)$$

For this purpose, it is convenient to use the iteration scheme.

Such a mathematical model gives the opportunity to get a picture of the distribution of stresses in the bottom-hole zone when drilling in depending on the direction of layers of rocks. The solution of the system of equations for this task was carried out on an advanced computer with the help of the program «MathCAD Prime 2.0».

The results of theoretical investigations of stress-strain state of a rock for the Donetsk-Dnieper basin (DRS) in the bottom-hole zone of the wells with the specified values of the characteristics of the breed are shown in Fig.1 (solid lines).

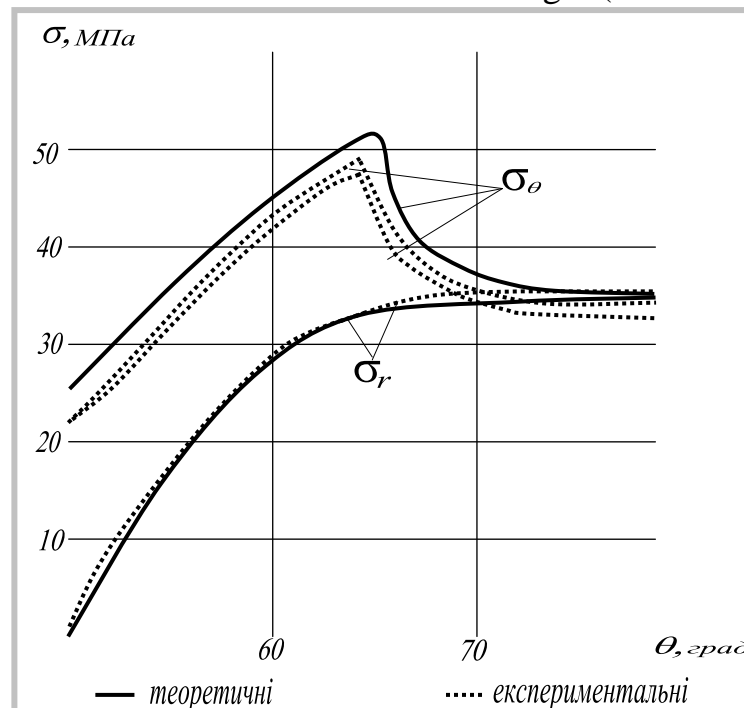


Fig.1. The distribution of the circular and radial stresses in the wellbore depending on the angle between the direction of layers of rocks and direction of action of the load from the rock cutting tool.

According to the figures, we can conclude that within a certain angle the circular stress reaches the maximum value, and the radial voltages, and at the same values of the angle, do not show any sort of abrupt changes. Consequently, at certain values of the angle of the meeting of rock cutting tool and layers of rocks reaches the maximum values of the circular stresses that can cause the destruction of the rock. The convergence of iterative method corresponds quite well with the experimental results which were carried out on the test stands with the use of stabilometrical device. The results of the experimental investigations of stress-strain state of the rock are shown in Fig.1 (dotted lines).

Used for the experimental studies were the cylindrical samples, carved out of the core, at various angles of rocks layers. Three-axial stress state under the influence of volumetric compression was studied by the method of S.I. Alekseyev [7] in stabilometrical device, but the transformer oil was used as a working fluid. Strain-gage sensor glued according to the known method, gave the opportunity to receive at the same time the value of radial and circular stresses that arise in the samples under the pressure, created in the system. During the experiment every three samples with the same direction of the rock layers were studied. The first of them was subjected to the load of up to the moment of destruction, which took place either in the form of «chipped», or in the form of the «barrel». The following two samples were run under the loads less than the maximum of 10 and 15%, respectively, as the important thing was not the process of destruction but the distribution of stresses, which appeared in the rock under the load. The slope of the graph characterizes the average value of the voltage, resulting in the samples according to the load cell, which in each sample was fixed, on the well-known scheme of 12 pieces.

The obtained picture of the distribution of stresses depending on the angle between the direction of load and the direction of rock layers, made it possible to estimate the value of the critical angle, at which the tensions that arise in the rock under the influence of the load, and for the real conditions of the contact angle of the rock cutting tool with the rock, are the highest. This, in its turn, gives the possibility to foresee at what contact angles of the rock cutting tool with rock, with the given direction of the rock layer, rock scree or rock fall in the unsustainable formations may become possible. In the light of the above mentioned, it is possible, taking into account the critical area when drilling the DW and HW, it is possible to formulate a scientific and reasonable approach to the well profile design during drilling in the unstable horizons of the mountain massif in the fields of the Dnieper-Donetsk Depression and on the Black sea shelf and to use the directional sonar power generators with adjustable modes parameters, and thereby to prevent emergency situations, which arise in the unstable horizons.

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GRAVITY DISTRIBUTION OF COMPONENTS OF HYDROCARBON STRATAL SYSTEMS*SRDI PJSC "Ukrnafta", Ivano-Frankivsk, Pivnichniy Bulvar 2*

Abstract. The article studies evaluation features of initial hydrocarbon saturated stratal systems such as oil deposits with a "gas cap" and gas deposits with oil fringe. It also highlights the distribution of hydrocarbon components in the cut of productive stratum in gravity field and its effect on the accuracy of volume method of reserves estimation. Examples of the use of software packages developed by authors are given and main key points of reserves calculation and further development of deposits are analysed.

Key words: field, deposit, oil, gas, condensate, reserves, development, gravity distribution, phase equilibrium

Mathematical modeling of saturated hydrocarbon deposits such as oil deposits with a gas "cap" and gas deposits with oil fringe is connected with the difficulty of concurrence of physical properties of formation fluids and divergence in the results of subsurface samples of wells. The same problems concern significant oil and gas saturated layers while the densities of fluid components significantly differ in the cut of deposits.

The authors consider the case that is quite common in oilfield practice, when gas-saturated deposit is developed by the first well, oil deposit – by the second one and gas-oil contact is undercut by any well and the layer is several meters high, the deposit is disclosed in the extreme upper and lower points. In this case, according to the results of subsurface studies, difference in saturation pressure is noted, fluids are not completely saturated, gas-and-condensate rates are also different. These differences and poorly drilled wells, i.e. exploration maturity of deposit, may lead to attempts to make two separate hydro-gas-dynamic systems by simulated breakdown or other methods of their isolation to link research results considering complex multicomponent systems. The idea of saturated phases on the verge of contact is generally accepted, so saturation pressures should be equal to current (production) formation pressure.

This problem can be solved by application of new state equations. Calculations carried out with the help of state equations show the following: with saturated gas that is in equilibrium, on the verge of gas-oil-contact in any small height of it, pressure decreases due to hydrostatic pressure column and the loss of heavy hydrocarbons that would have flown down to contact boundary changing component composition and balance system. Thus there is a closed-loop system without physical meaning. The same difference in physical properties is also peculiar to oil gas content and density of which varies with depth. So it is impossible to apply classical approach, i.e the use of average value fluid parameters measured or calculated at one point followed by extrapolation to the entire volume.

Obligatory condition of adequate adaptation of such a mathematical deposit model is the need to consider redistribution of components in gravitation field. It is

well known that warm air always tries to take the highest position, i.e. to rise up and for example, the oxygen content in the air in mountain areas is significantly lower than at sea level. The basic idea of these phenomena is the principle that any closed system or a single body tries to take position with the lowest possible potential energy

At one time, this perspective was publicized by various scholars. [1] The first attempts to take into account the gravitational redistribution were carried out in 1939 by Sage and Lacey, who noted that the distribution of mixture components is in proportion to their molecular masses. Namiot in 1954 performed calculations for multicomponent systems modeling oil of different compositions. It was concluded that the force of gravity significantly influenced the composition of oil that contained a significant amount of asphalt-resinous substances and dissolved gas. The method of gravitational distribution calculation considering its necessity for deposits with the mixtures in a state close to thermodynamic equilibrium was offered by Brusilovskiy in 2002. [2].

The authors of this work implement software solution for phase equilibrium calculation and gravity distribution of components that provides modeling of multicomponent systems and is used as one of the modules in gas-hydro-dynamic simulator [3].

So back to the case that we have consider, model of hydrocarbon saturated deposit with oil and gas layer up to 400 m (Fig.1) and formation temperature - 100 °C was developed. Component composition of hydrocarbon mixtures are given in Tab.1. The considered mixture is oil: density at surface conditions is 804 kg/m³, saturation pressure – 24,6 MPa, gas content - 775 m³/t. Formation pressure in the middle layer is taken to be equal to saturation pressure and pressure changes at deposit section, gravitation redistribution of components of oil and gas equilibrium to it are calculated.

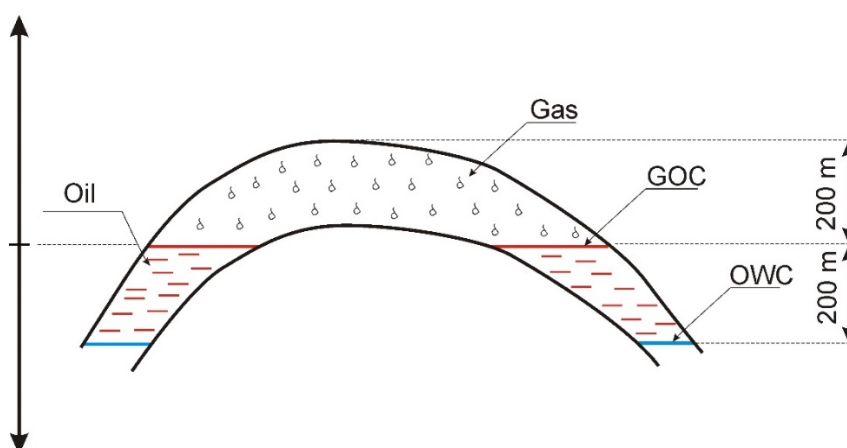


Fig.1 Scheme of hydrocarbon saturated deposit

Table 1

Initial composition of formation fluid

component	Mole part, %	M, g/mol
methane	60,000	16,043
ethane	10,000	30,070
propane	10,000	44,097

I-butane	10,000	58,124
F1	1,798	89,219
F2	1,381	104,400
F3	0,830	116,964
F4	0,614	127,772
F5	0,547	136,413
F6	0,401	148,775
F7	0,513	162,225
F8	0,383	176,865
F9	0,321	192,745
F10	0,242	209,859
F11	0,270	228,159
F12	2,700	257,669

The change of formation pressure and saturation pressure at cut formation is shown in Fig.2. Graphs are constructed according to the distance to gas-oil-contact.

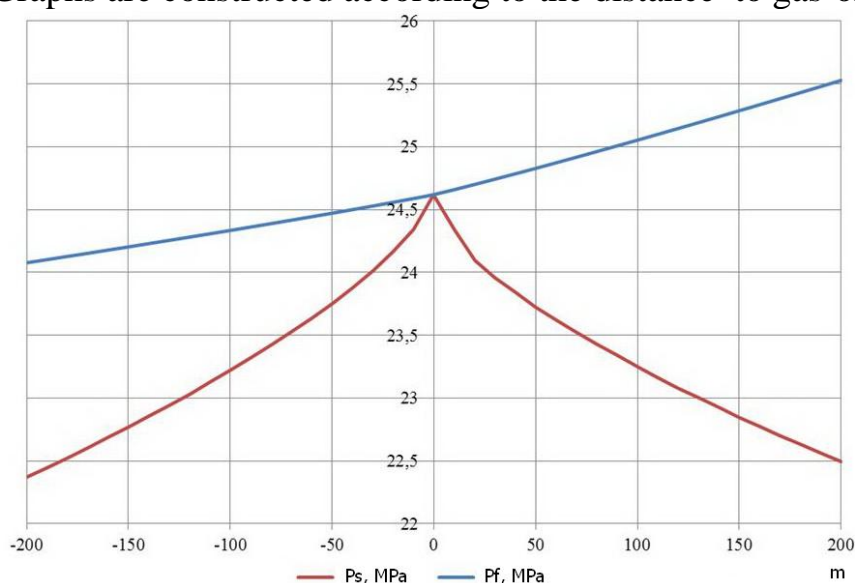


Fig.2 Change of formation pressure and saturation pressure at deposit cut

Thus, as seen in Fig.2, gas and oil saturated on the verge of contact at the distance from it immediately become poorly saturated. When lifted up relatively to gas-oil-contact, formation pressure is reduced according to the column of gas, but gas saturated by heavy hydrocarbons, and thus saturation pressure have a greater rate of decline. So, gas will always be poorly saturated that prevents phase transitions and condensate dropout. Saturation pressure is equal to formation pressure on the edge of gas-oil-contact, saturation pressure at the distance of 200 m from gas-oil-contact decreases to 22,36 MPa, while formation pressure drops to 24,08 MPa. Pressure difference is 1,71 MPa. As for oil part - at deepening under the level of gas-oil-contact, formation pressure is rising faster than in gas part due to higher density of the mixture and saturation pressure is decreasing. At the distance of 200 m from gas-oil-contact saturation pressure decreases to 22,49 MPa, formation pressure rises to 25,53 MPa, pressure difference in this case is 3,04 MPa.

Fig.3 shows the change in the content of heavy hydrocarbons in gas and gas in oil, for oil and gas parts of deposit and for convenience their content is signified respectively for condensate - in g/m^3 , for gas - in m^3/t

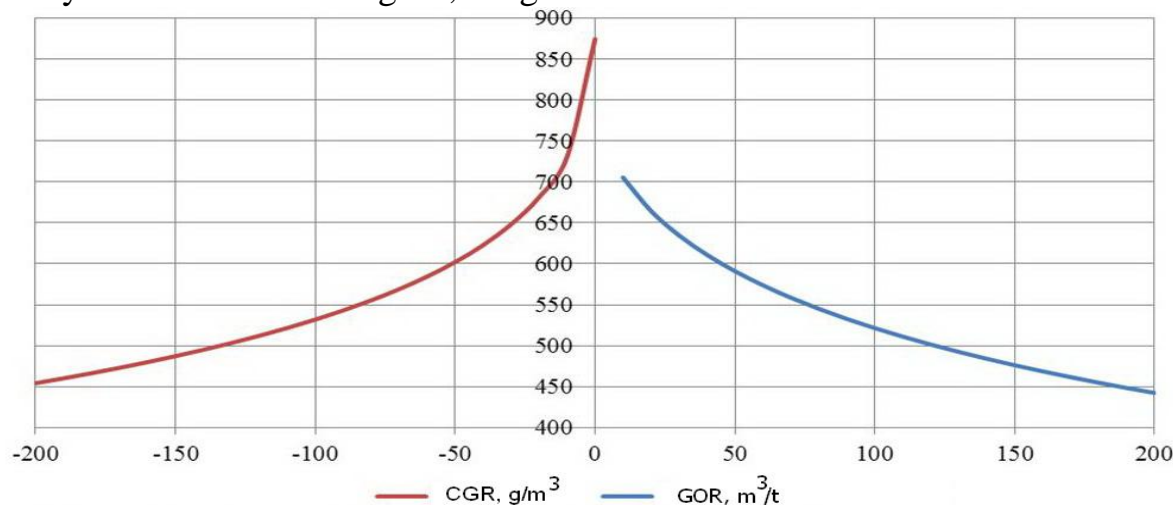


Fig.3 Change of condensate- and gas-content at deposit cut

As you can see from the above Fig.3 gas part of deposit is characterized by significant change of condensate content at cut. The value of content drops from 874 g/m^3 to 454 g/m^3 at the distance of 200 m from gas-oil-contact. Reduction of condensate factor (CF) in this case is 48%, or 420 g/m^3 . The same trend to decrease is observed in respect to gas in oil part: its content from the original $775 \text{ m}^3/\text{t}$ is reduced to $442 \text{ m}^3/\text{t}$, the difference is 43%, or $333 \text{ m}^3/\text{t}$.

As part of this work the calculation to estimate the influence of the gravitation distribution of hydrocarbon components on the value of calculated reserves by classical method is performed. The value of specific hydrocarbon reserves per unit volume of deposits is estimated. Two options of calculation are considered:

- Option 1. Reserves are estimated by average parameters of mixture composition in the middle of oil-and-gas saturated part of the deposit.
- Option 2. Reserves are estimated by parameters of mixture composition in the extreme top and bottom parts of gas-and-oil saturated part of the deposit.

The values obtained by options 1 and 2 were compared with reserves obtained by integrating component composition changes with depth by the following formulas:

$$Q_0 = \sum_{i=1}^n Q_i; \quad (1)$$

$$Q_i = F(h_i, b_i, \rho_i). \quad (2)$$

Where Q_0 , Q_i –total reserves of hydrocarbon and reserves of i-n sublayer correspondingly, m^3 ;

h_i – thickness of i-n sublayer, m;

b_i – volume rate of i-n sublayer, part of unit;

ρ_i – density of formation fluid of i-n sublayer, kg/m^3 .

The results of this comparison for the gas part is shown in Tab.2, for the oil part - in Tab.3.

Table 2**Relative difference of reserves calculation for the gas part of the deposit**

Option component	1		2	
	gas	condensate	gas	condensate
Relative difference of calculation, %	-0,25	5,03	-4,67	19,29

Table 3**Relative difference of reserves calculation for the oil part**

Option component	1		2	
	oil	gas	oil	gas
Relative difference of calculation, %	-0,83	0,26	-12,6	5,53

In the process of reserves calculation for the first option for gas and for oil parts there is a small part of the error in the calculation. Thus, reserves for the gas part calculated for average composition of mixture will be a quarter percent higher, and condensate – 5.03% lower than in the calculation by integral method. The difference for oil part is for oil -0.83%, for dissolved gas - 0.26%. Thus, the use of mixtures parameters corresponding to the middle part of the deposit in the process of calculation does not lead to significant errors and can be used in daily practice.

Quite converse situation happens to the method of calculation for option 2. As for the gas part, calculated gas reserves are 4.67% higher and condensate – 19.29% lower than reserves calculated by integral method. In the oil part the difference in oil and dissolved gas will be accordingly -12.6% and -5.53%. Obviously, these values of reserves and errors are unacceptable and cannot be used in calculations.

Conclusions

In summary, we can conclude there is a mandatory need to consider the influence of gravitation field on distribution of in situ mixtures components and the need for integration method of calculation that includes the change in physical parameters of fluids with the depth of deposits with high oil and gas layers. We should add the fact that ignoring these factors lead to incorrect assessment of mode of development because of a significant change in gas and condensate factor in the development process that in turn can lead to irrational development of the object.

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MANAGEMENT BASICITY OF SINTERING MIXTURE

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Abstract. The results of introduction of technology and control system are Considered for the receipt of high-quality agglomerate. On the agglfactory of company ThyssenKrupp in Duysburg (Germany) the system "CB Omni" (company "Intertech Corporation", USA) is inculcated on the basis of method of gamut-neutron-activating analysis (PGNAA) for determination of element composition of agglburden and optimization of process of agglomeration due to automatic control basicity. On the basis of data, got by means of analyzer real-time there is adjustment of dosage of limestone. It allowed to increase the productivity and improve quality of agglomerate, reduce expenses on his production, that resulted in an economy 0,11€ on the ton of agglomerate. Work on optimization is executed within the framework of the European program of researches (European Research Fund for Coal and Steel).

Keywords: agglomerate, isotope, control, management, basicity

Introduction. Determination of reliable values of the quality characteristics of raw materials and the ability to manage a complicated task especially for materials in metallurgical, with significant volumes and a large number of controlled items. Particular difficulties in determining the quality characteristics arise in the analysis of raw materials, in which the components are unequally distributed in the volume considered, i.e. are not subject to the normal law. Competition in the market of ferrous metallurgy puts manufacturers in a rigid framework to achieve or maintain which is only possible through the modernization and optimization of the production at all its stages.

The main raw material in blast furnaces of Ukraine is agglomerate, and the requirements for its quality in blast furnace are one of the most important parameter. Stabilization of the sintering process and getting quality sinter results further in the stabilization blast furnace and converter processes.

Aims and objectives. All over the world sinter specialists again find each other in the field of tension regarding productivity, costs and sinter quality. In many cases a process optimization of one parameter leads to the negative influence on one or both others. In addition, the influence of control variables like raw material composition and man power, levels off, as a result of the transition into the direction of a captive market at the raw material supplement and the continuous reduction of staff. The mutual influence of various parameters in the management of the production process is shown in Figure 1.

For today there are different methods of elemental analysis instrumentation materials in the flow: X-ray, laser, infrared, gamma neutron activation et al. [1, 2, 3].

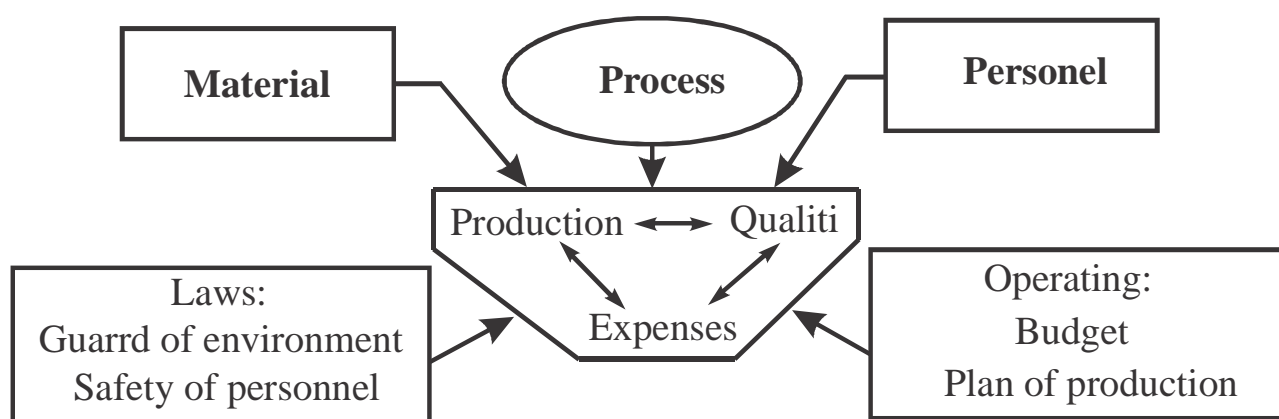


Figure 1. Schematic diagram of influence control of different process parameters on each other.

Therefore at ThyssenKrupp Steel Europe (Duisburg, Germany) sinter plant a new method for measuring the raw mix composition in site CB Omni was tested by prompt gamma neutron activation analysis (PGNAA), which has the innovative potential to optimize the sinter process concerning all three parameters at the same time [4]. The results of 4 years of operation have shown that it is possible to determine the composition of the sinter mix in the flow with accuracy comparable to laboratory data. Based on the data obtained by the analyzer in real time corrects the limestone dosing. It is known that one of the important indicators of the quality of sinter is determined by its basicity (basicity) - the ratio of the content of basic oxides (Ca, Fe, Mn, Mg, etc.) to the content of acidic oxides (Si, P) or the simplified $\text{CaO}:\text{SiO}_2$.

Sinter mix intended for sinter production is dozen on the basis of the calculation, the initial parameters for which are the chemical composition of the initial mix of components required by the iron content and basicity sinter. According to the calculation results establish necessary baseline weight of all components and supported their respective costs.

However, due to disturbances often arise from the instability of the chemical composition of the starting components, the intervals between the data obtained from the laboratory (usually every 4 hours) - basicity sinter produced may significantly deviate from a predetermined value. In such cases it is necessary to perform a full recalculation of the charge and the establishment of new relations values of expenditure components. In practice, the implementation of these requirements requires a fairly frequent sampling for chemical analysis of components, which is very difficult when dosing a multi-component mix. Furthermore, operational changes in flow components affect the physical properties of the charge (particle size distribution, humidity, pelletizing ability), that have a negative impact on the process of mixing and pelletizing the mix.

Practically, when dozen sinter mix basicity sinter quickly stabilized by adjusting the content of the charge flux (limestone). However, this method provides individual adjustment, but does not provide sufficiently high quality and precision stabilization basicity sinter.

Important elements of the sinter mix, affecting the principal - Ca, Si, Mg, Al and Fe can be analyzed by analyzer «CB Omni» with the required accuracy. Thanks to the peculiarities of the method PGNAA, it is possible to analyze other elements / components that have a significant impact on performance and / or quality of sinter: Ag, Au, Cd, Cl, C, Cr, Cu, Hg, K, Mn, Na, Ni, P, S, Ti, V, Zn, moisture.

Analyzer «CB Omni» can also perform the calculation of the relations defined by the user, for example: $\text{CaO}:\text{MgO}$; $\text{SiO}_2:\text{MgO}$; $\text{Ni}:\text{Fe}$; $\text{CaO}:\text{SiO}_2$, etc.

The determination of these parameters is used to improve economic performance and a better understanding of the agglomeration process in general and the development of the control algorithm basically. Optimization of the sintering process by managing mainly using the analyzer «CB Omni» increased productivity with improved sinter quality and lower costs, resulting in a saving 0,11 € per ton of sinter (in the calculation did not include savings that came out at the same time in the blast-furnace process stage).

Execution studies. The main raw material for the blast furnace at the plant ThyssenKrupp is agglomerate. TKSE is running three sinter stands with a total suction area of 844 m² at the sinter plant located in Duisburg-Schwegeln. The annual production of this sinter plant is, depending on production planning and economic situation, approximately 12.5 Mio t/a.

Specialists of ThyssenKrupp pay much attention to the optimization of the sintering process, and in particular the fact that never before used automatic elemental composition of the sinter mix **in real time**. The best option - when the process is controlled automatically and there is no human factor, i.e. operator influence.

The work was carried out within the framework of the European research programme of the “Research Fund for Coal and Steel” The aim of this research project was the optimization of sinter raw mix homogeneity based on inline-monitoring test devices CB Omni.

CB Omni System allows stabilizing basicity and controlling the process of preparing the sinter mix. The analytical data was used to install a limestone dosing control system (LDCS) in sinter facility to control the basicity of the raw mix and to minimize the fluctuations on site.

The PGNAA is a sensitive and non-destructive analytical technique. The principle of the method is that thermal neutrons (<1 electron volts), emitted by the isotope Cf^{252} bombard the entire flow of the charge located on the conveyor belt. The core of each of the elements in the sinter composition moves temporarily into an excited state. After returning to a stable state, each nucleus emits gamma rays which are fixed four sodium iodide detectors. Allocated to the specific energy of gamma rays is unique to each of the elements of the Periodic Mendeleev Table.

As a result of the gamma spectrum collected for 1-minute period - this is actually a histogram of all incoming gamma radiation, ranging from zero to 10 MeV (million electron volts). Typical range of more than one minute, collecting a few million pulses.

Detectors located in the analyzer unit, registers spectra (intensity spectrum characteristic element concentration in the analyzed material), and the converter converts analog signal values from the detector into a digital value.

For many elements PGNAA method shows the sensitivity and accuracy which greatly exceeds the existing analogues. This method has a very important advantage - thanks to the good penetration of gamma rays in the material, and the size of the pieces and the uniformity of the material does not affect the accuracy of the analysis, in contrast to X-ray or laser method. The measuring principle is shown in Figure 2, and Figure 3 shows the installation of the analyzer «CB OMNI» production of company «Thermo Fisher Scientific».

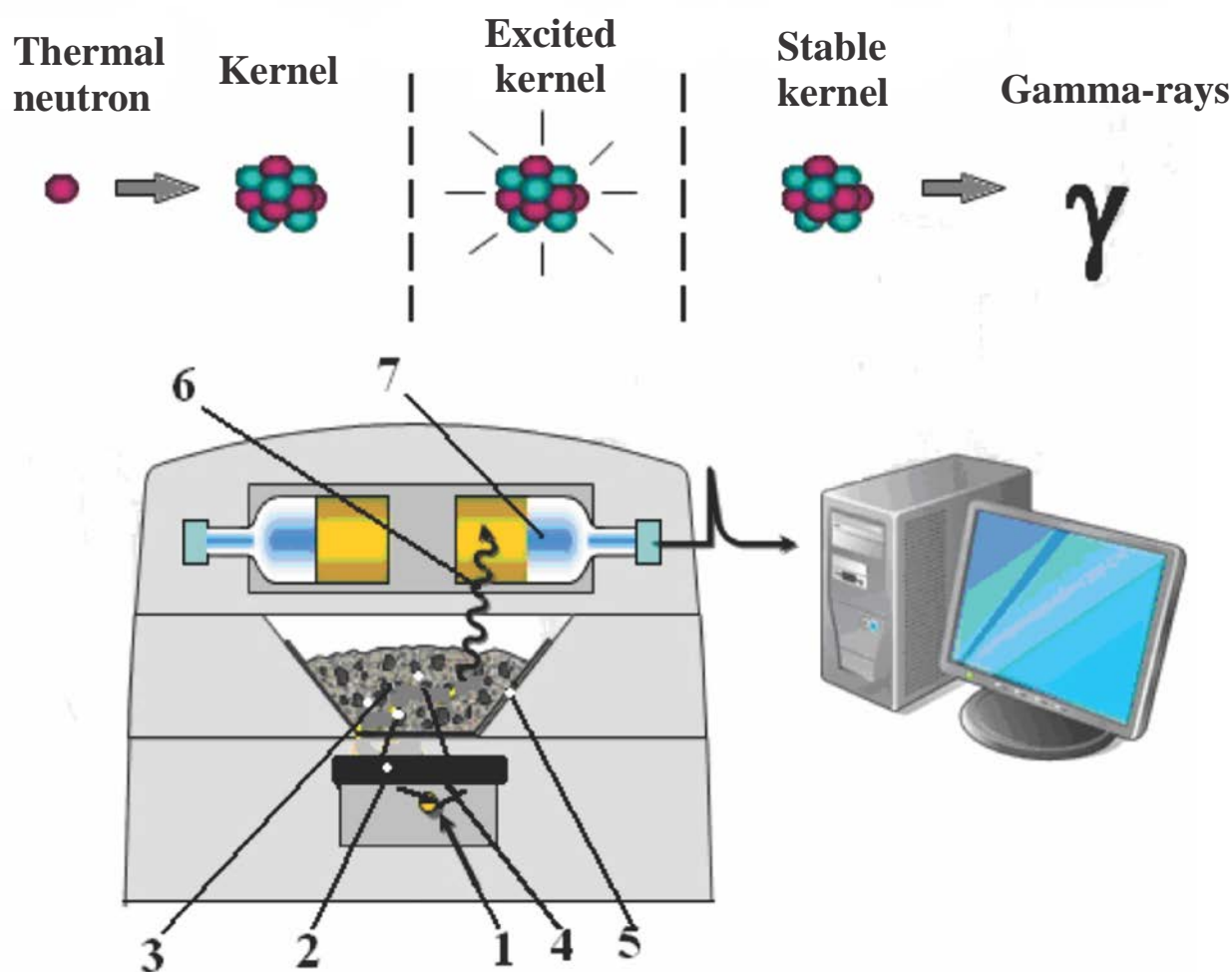


Figure 2. Measuring principle of the PGNAA technique

1 - source of fast neutrons (^{252}Cf); 2 - graphite plate; 3 - material; 4 - thermal neutrons; 5 - conveyor; 6 - the secondary radiation; 7 - sodium iodide detector

Limestone dosing control system LDCS. At the sinter plant in Duisburg only limestone (LS) and burnt lime can be added to influence the basicity. This makes the controlling schema easier. CB Omni only has to deliver the actual data on basicity and SiO_2 content of the raw mix to calculate the amount of added limestone if there are no changes of the burnt lime concentration. If there are changes the amount has to

be corrected by a controlled variable. The relative amount of limestone which the operator has to add during process to hold the basicity constant on the level “basicity aim”.

Start-up of LDCS The start-up of the limestone dosing control system (LDCS) at the sinter plant was in October 2009. To compare the influence of different time periods with and without PGNAA-based LDCS it is necessary to investigate time periods when the main raw mix components are approximately the same. In addition the investigated periods must be very close to each other. To guarantee these requirements it was decided to investigate the period from the beginning of September 2009 until mid November 2009.



Figure 3. General view of the analyzer «CB OMNI»

1 – analyzer «CB OMNI»; 2 – conveyor; 3 – material

In Figure 4 the basicity development of sinter strand no. 3 in September 2009 is illustrated. In September 2009 the LDCS was switched off. The green line is the basicity target that the operator has to hit. During this time period the operator has set for the sinter process only by the analysis of sampled sinter, as he had always done in previous years. Therefore in Figure 4 high divergences between measured basicity and targeted basicity are observable. However, a nearly constant divergence between PGNAA and sinter analysis is also illustrated.

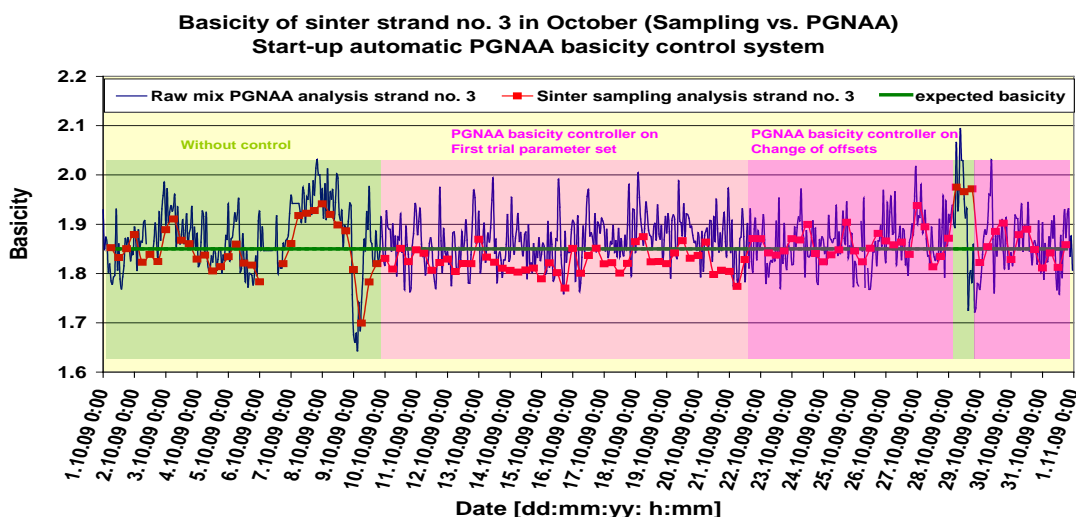


Figure 4. Fluctuations of basicity with manual control

In Figure 5 the start-up of the LSD is shown in October 2009.

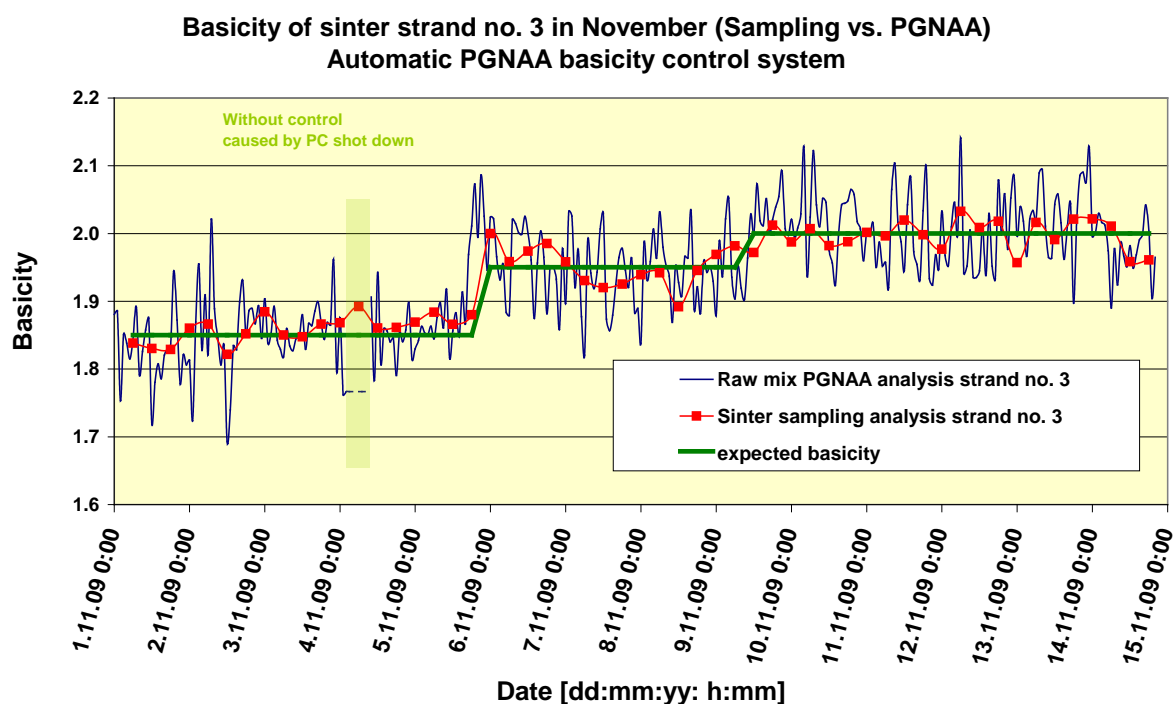


Figure 5. Fluctuations of basicity using «CB Omni»

Until the 10th of October, the process was uncontrolled by LDCS. Then the LDCS was switched on and in comparison the divergences of raw mix and sinter were from the beginning much smoother, but also the nearly constant divergence between PGNAA raw mix and sinter analysis was observable. Therefore it was decided to change the offsets of the basicity elements (CaO and SiO_2) on October, the 21st. Since then the basicity averages of sinter analysis and PGNAA have been the same. With one exception caused by a computer failure, divergence was eradicated. Determination of basicity PGNAA method reduces vibrations basicity, and will open eyes to a lot of factors that affect the fluctuations of this parameter. In November the real basicity analysed twice by PGNAA and sinter analysis was very close to the basicity target. Until now it was additionally possible to decrease the basicity fluctuations in further steps, and will provide full control of the dosage of limestone. All cases any problems were related to computer (PC) link failures between the PGNAA computer and the control system of the sinter plant [5-7]. Maintenance of the PGNAA itself has not been required since August 2009. Re-calibration which has to be done in the case of a conveyor belt or neutron source change can be realized during the normal stoppage of the sinter strand no. 3. In November the basicity target was also changed twice. The LDCS had no problems dealing with these changes.

As desired, the analytical information was used to develop a LDCS for the TKSE sinter plant. In *table 3* the divergences of the basicity during start-up of LDCS at strand no. 3 are compared with data from strands no. 2 and no. 4 (automatic sinter sampling and analysis at TKSE lab).

Table 1.

Standard deviations of the sinter basicity depending on strand and month during start-up 2009

Month	Strand no. 2	Strand no. 3 (analyzer)	Strand no. 4
September	0,04105	0,04382	0,04925
October	0,04120	0,04226	0,04969
1st - 15th November	0,04387	0,02333	0,04650

Conclusions. The results have shown that it is possible to analyze raw mix with a high accuracy in-situ on site. All the main basicity elements such as calcium, silicon, magnesium, aluminum and iron of the sinter raw mix produced can be analyzed in the expected range or even better for blast furnace.

As a result of using the «CB Omni» analyzer and develop a system of control to the main set:

- founded that index RDI (resistance when restoring) influence by the content of Al_2O_3 . This index has a great importance to the stability of blast furnace process;

- Using the analyzer «CB Omni» allows you to open your eyes to the maintenance and management of the entire process of agglomeration;

- PGNAА analysis method allows to determine the elemental composition of the total volume of material in the conveyor belt and is the most accurate in-line analysis system to date;

- The methods that define a thin layer of the surface material (IR, X-ray, laser) is performed only on the content of the forecast of the elemental composition;

- optimization process leads to an increase in moisture permeability by 3% and 1.7% productivity.

Savings only in the sinter plant were about 0,11 € per ton of sinter, which is mainly due to lower dosing of limestone, coke breeze, return. Possible additional factors savings in production lines more potent and / or subsequent use in agglomerate blast furnaces have not been considered.

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EXTRACTION OF RARE EARTH METALS BY ISOOCTYL ALCOHOL*National mineral-resources university «Mining»**Saint-Petersburg, line 21st, h. 2, 199106*

Abstract. The process of solvent extraction of desired components from aqueous solutions of their salts by isooctyl alcohol was researched. Sodium dodecylsulfate was used as solvate. Values of the distribution coefficients in the pH range 3 ÷ 6 were calculated. Conditions for the most efficient removing of samarium cations were identified.

Key words: extraction, rare earth metals, distribution coefficients, removing.

The most profitable deposits of rare earth metals in the Russian Federation are Kovdorskoye, Khibinskoye, Lovozerskoye, Katuginskoye, Verkhnekamskoye, Central and others. They are rich bastnaesite - $\text{Ln}(\text{CO}_3)\text{F}$, monazite - LnPO_4 , loparites - $\text{NaCaLn}(\text{TiO}_3)_2(\text{NbO}_3)_2$, xenotime - $(\text{Y}, \text{Eu}, \text{Gd})\text{PO}_4$. Complex process of the extraction of the rare earth metals, harsh climatic conditions, multicomponent composition of raw materials and the proximity of the physical and chemical properties of the rare earth metals complicate and sometimes make impossible to obtain rare metal products.

Total needs of Russia's in rare earth metals in the beginning of the XXI century is 10-11 thousand tons annually and modern mineral resources are not able to satisfy them [1]. Therefore, the «rare-earth problem» can be solved by imports, the development of new sources of raw materials or recycling of industrial waste. The world's largest monopoly of rare raw materials is China. As of 2008, the country has been concentrated more than 40% of the world's reserves of rare earth metals.

Currently being modernized hydrochloric and sulfuric acid processing technology of eudialyte feedstock in order to climb removing rare earth metals in concentrate, in which as extractants are used naphthenic and oleic acids [2, 3].

Innovative aspect offered by the authors when removing the rare earth metals by liquid extraction from solutions of their salts, is the using of surfactant - sodium dodecyl sulfate to obtain solvates and their subsequent extraction. Sodium dodecyl sulfate was added to the aqueous phase and as extractant was used isooctyl alcohol ($\text{C}_8\text{H}_{18}\text{O}$, 2-ethyl-1-hexanol).

In experiments on the basis of material balance found that cation samarium and sodium dodecyl sulfate went into the organic phase in a molar ratio of 1: 3, i.e. as solvates $\text{Sm}(\text{C}_{12}\text{H}_{25}\text{OSO}_3)_3$. Their solubility in alcohol can be explained by the orientation of the polar groups to the metal cation and the shielding of the outer side solvate by nonpolar hydrocarbon radicals.

The experiments proved that the removing of the rare earth metals by use isooctyl alcohol in the absence of sodium dodecyl sulfate is the lowest. For example, extraction of cations of holmium (III) when the pH value of the aqueous phase is 6.0 then coefficient of distribution was 4.5, whereas in the presence of sodium dodecyl sulfate it equals 360. Based on these results, we can conclude that the extractant is isooctyl alcohol, and sodium dodecyl sulfate plays a role of the transport agent.

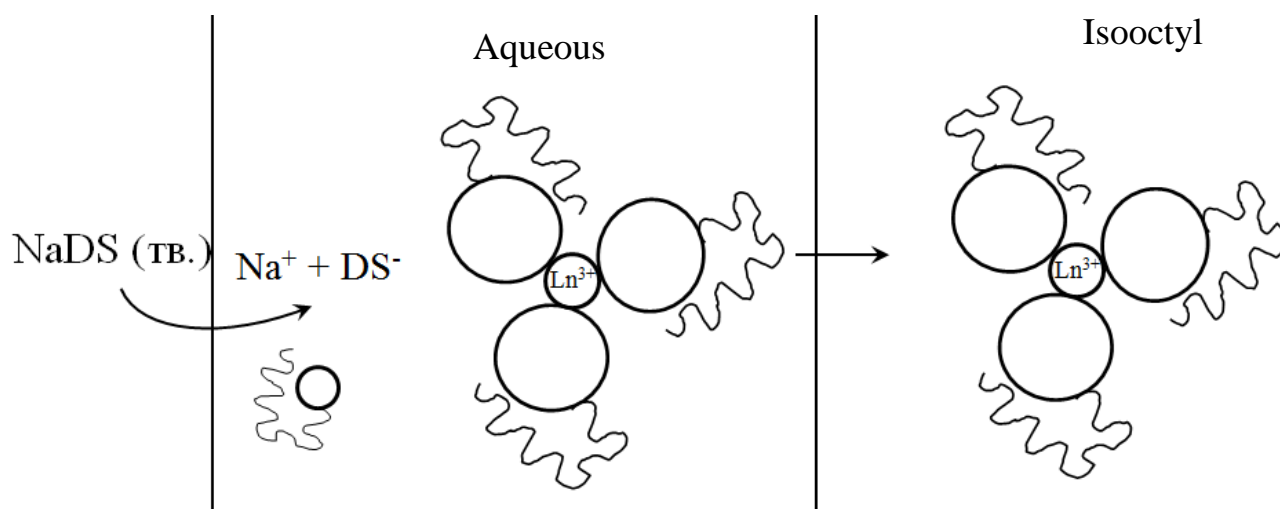


Fig. 1. Mechanism extraction of samarium (III) from solutions of its salts

Fig. 2 and table 1 show the results of an experimental study of the removing of samarium (III) from solutions of its salts. The experiment was conducted in the laboratory model of extractor. The volume of an aqueous solution of samarium (V_{aq}) is 0.2 liters. The initial concentration of the target component is 0.001 mol/L, the concentration of sodium dodecyl sulfate corresponds to the stoichiometry of the reaction is 0.003 M. The volume of the organic phase (V_{org}) is 0.005 L, i.e. ratio $V_{org}:V_{aq} = 1:40$. Extraction was conducted for 30 minutes. The aqueous and organic phases were separated by separatory funnel 0.25 or 0.5 liter. Delamination phase occurred over a period of 1 to 3 days. The aqueous phase was analyzed by the photometric method for the cation content of the rare earth metals on photocolormeter KFK-3 [4] and the maintenance of dodecyl sulfate ions by potentiometric titration by 0.002 M solution of chloride cetyl trimethyl ammonium with ion selective electrode consisting of silver chloride EVL-1MZ placed in a solution NaDS and NaCl, and membranes, ion-selective DS^- . The membrane was made in the laboratory ionometry of the department of Physical Chemistry St. Petersburg State University [5]. ICS method determines the shape of the removed salt in the organic phase on the spectrometer Nicolet 6700.

Rare earth metals content in the organic phase were determined by the difference in concentrations in the initial and in the equilibrium aqueous phases, taking into account the difference in phase volume and density of the organic phase:

$$C_{org} = \frac{(C_0 - C_{aq}) \cdot V_{aq}}{V_{org} \cdot \rho_{org}} \quad (1)$$

where C_{org} and C_{aq} – concentration of the rare earth metals in organic and aqueous phases, respectively, mol/L; C_0 – original content of the rare earth metals in the aqueous phase, mol/L; V_{org} – volume of organic phase; V_{aq} – volume of aqueous phase.

The distribution coefficient was calculated according to the equation:

$$D = \frac{C_{org}}{C_{aq}} \quad (2)$$

Extraction degree was calculated according to the equation:

$$\alpha = \frac{C_{org} \cdot V_{org}}{C_{aq} \cdot V_{aq} + C_{org} \cdot V_{org}} \cdot 100\% \quad (3)$$

Table 1

Experimental results on the extraction of cations of samarium (III).

pH	$[\text{Sm}^{3+}]_{\text{aq}} \cdot 10^4$ mol/kg	$[\text{Sm}^{3+}]_{\text{org}} \cdot 10^2$ mol/kg	C_{distr}
2.5	1.42	4.13	291.4
3.0	1.35	4.16	306.8
3.5	1.33	4.17	313.8
4.0	1.28	4.19	326.1
4.5	1.14	4.26	375.0
5.0	1.01	4.32	426.1
5.5	1.04	4.31	414.1
6.0	1.08	4.29	395.5
6.5	1.06	4.30	406.5
7.0	1.09	4.28	391.9

During extraction the most efficient recovery of the target component is observed at pH 4.0, and reaches its maximum at pH = 5.0. Partition coefficient of cations samarium Sm^{3+} between the organic and aqueous phases is significantly higher than when the extraction is with carboxylic acids. Removing is possible in a wide pH range.

As can be seen from Fig. 2, the removing of cations samarium by use liquid extraction from solutions of its salts in the presence of a surfactant is effective in the pH range 2.5-7.0 and reaches a maximum at pH 5.0.

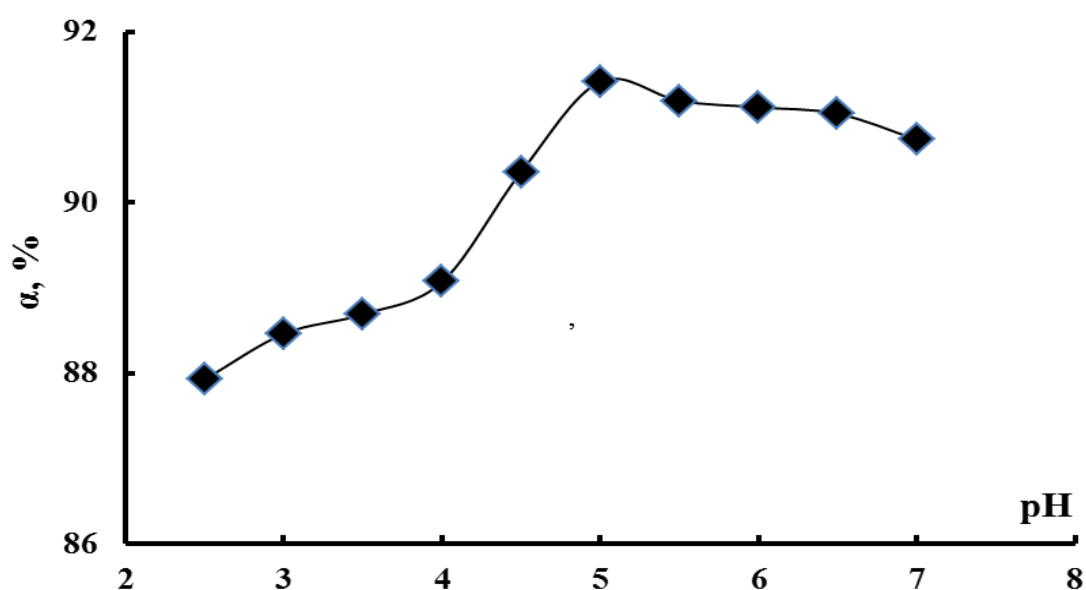


Fig. 2. The dependence of the degree of extraction of samarium (III) from the equilibrium solution pH values

The extraction of samarium in the proposed system: sodium dodecyl sulfate - aqueous solution of salt samarium (III) - isooctanol. Sodium dodecyl sulfate acts as solvate formed. The distribution coefficient varies from 290 to 430 at $\text{pH} = 2.5 \div 7.0$. Efficient recovery of samarium in acidic and in alkaline environments proved possible.

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J21410-042**Yermagambet B.T., Nurgaliyev N.U., Kassenov B.K., Kassenova Zh.M.,
Bizhanova L.N., Zikirina Aynur Mukhametzhanovna****RESEARCH OF KINETICS OF PROCESS of THERMAL
DESTRUCTION of COAL of SARYADYR DEPOSIT***"Institute of coal chemistry and technology" LLP**Kazakhstan, 010000, Astana, Orlykol st., building 10, VP-3*

Abstract. The effect of temperature, heating rate and fractional composition of coal of Saryadyr deposit on kinetic parameters of thermal degradation process was studied using thermal analysis in this work. It is found that the rate of heating of the coal samples significantly affects on the process temperature and speed.

Key words: derivatographic analysis, coal, thermal degradation, the kinetic parameters, stages of decomposition, heating rate.

Introduction

The study of the processes taking place in the temperature range of the main decomposition of organic matter of coal (OMC), allows us to understand as the general laws, as the specifics of the decomposition of solid fuels. This temperature range is used to calculate the kinetic parameters of the process, which carry important information about the nature of the structural and chemical transformations, as well as about the structure and direction of the thermal destruction of OMC. Thus, the composition and properties of the products of thermal processing of coal not only depend on their structural and chemical characteristics, the nature of the various chemical additives, temperature, pressure, composition of the medium, but also on the size of the coal particles and the nature of the heating (slow, speed) [1].

Formulation of the problem: Identification of dependences of the kinetic parameters of thermal degradation of organic matter of coal of "Saryadyr" deposit (five-meter layer) on the velocity and temperature of heating, fractional composition, as well as between the kinetic parameters at different stages of the primary decomposition of coal by derivatographic method.

Methods

Experiments were performed on Thermostep Eltra derivatographic analyzer (Germany) at different heating rates in the range of 3-15 dg / min and coal fractions with grain size of $d = 0,2-5$ mm. Heating of the samples was carried out in ceramic crucibles in the temperature range of 30-900 °C in an inert atmosphere of nitrogen. The sample mass was 1 g.

The following indicators were selected to characterize the process: the loss of mass of the samples in different temperature ranges; temperature T_{\max} , speed v_{\max} , the rate constant k_{\max} , corresponding to the greatest mass loss rate (i.e. to the maxima of the main decomposition on DTG curves at the inflection points); pre-exponential factor k_0 and the activation energy $E_{\text{акт}}$ related to the main stages of the thermal decomposition of coal. These kinetic parameters describe not the certain reactions but the total processes of thermal decomposition of OMC, because of the variety and complexity of physical and chemical transformations. So they are considered as "effective parameters" of the formal kinetics [1].

Mathematical processing of derivatograms was performed by the following algorithm. Kinetic parameters of the thermal decomposition of the main thermal destruction of OMC were determined based on the equations of non-isothermal formal kinetics [2].

The following equation was selected as basic:

$$v = d\alpha / dt = f(\alpha)k_0 e^{-E/RT} \quad (1)$$

where v - speed of the process, α - the conversion level of OMC, $f(\alpha)$ - a function of the conversion level, k_0 - pre-exponential factor; E - activation energy; T - absolute temperature.

According to experimental data [3], the basic processes of thermal decomposition of coal flow in the first order, so the function is $f(\alpha) = 1 - \alpha$. Then, using logarithms, equation (1) takes the form:

$$\ln \left[\frac{1}{1-\alpha} \cdot \frac{d\alpha}{d\tau} \right] = \ln k_0 - \frac{E}{RT} \quad (2)$$

Equation (2) represents a linear equation $y = b + a \cdot x$, wherein, $y = \ln \left[\frac{1}{1-\alpha} \cdot \frac{d\alpha}{d\tau} \right]$, $b = \ln k_0$, $a = -E$, $x = 1/RT$, which allows to put the experimental points on the line. It is possible to calculate the activation energy of the process by slope ratio of the line to axis of abscissas, and using segment cut off on the ordinate axis to determine pre-exponential.

For obtaining of reliable results, the experimental data is calculated by the least squares method, according to which the coefficients a and b are:

$$a = \frac{n \sum_{i=1}^n x_i y_i - \sum_{i=1}^n x_i \sum_{i=1}^n y_i}{n \sum_{i=1}^n x_i^2 - \left(\sum_{i=1}^n x_i \right)^2}, \quad b = \frac{\sum_{i=1}^n y_i - a \sum_{i=1}^n x_i}{n} \quad (3)$$

Root-mean-square errors in determining a and b (and the activation energy and pre-exponential factor) are calculated as:

$$S_a = \sqrt{\frac{\sum_{i=1}^n (y_i - ax_i - b)^2}{(n-2) \sum_{i=1}^n (x_i - x_{cp})^2}}, \quad S_b = \sqrt{\left(\frac{\sum_{i=1}^n (y_i - ax_i - b)^2}{(n-2)} - x_i \right) \left(\frac{1}{n} + \frac{x_{cp}^2}{\sum_{i=1}^n (x_i - x_{cp})^2} \right)} \quad (4)$$

Starting from (3) the activation energy and pre-exponential factor are determined:

$$E = \frac{\sum_{i=1}^n \ln \left(\frac{1}{1-\alpha} \cdot \frac{d\alpha}{d\tau} \right) \cdot \sum_{i=1}^n \frac{1}{RT} - n \sum_{i=1}^n \ln \left(\frac{1}{1-\alpha} \cdot \frac{d\alpha}{d\tau} \right) \cdot \frac{1}{RT}}{n \sum_{i=1}^n \left(\frac{1}{RT} \right)^2 - \left(\sum_{i=1}^n \frac{1}{RT} \right)^2} \quad (5)$$

$$k_0 = \exp \left[\frac{\sum_{i=1}^n \ln \left(\frac{1}{1-\alpha} \cdot \frac{d\alpha}{d\tau} \right) - a \sum_{i=1}^n \ln \frac{1}{RT}}{n} \right] \quad (6)$$

Authors of this article developed a computer program on Fortran Algorithmic Language (using the compiler «Compaq Visual Fortran) to calculate the kinetic parameters of the thermal degradation of OMC using the above mentioned equations (1-6), in which the original data are arrays of values mass (weighed portions of decomposed coal), time, temperature, and values of sequence numbers of start and end points of decomposition stages on DTG kinetic curves and quantity of these points.

Results and discussions

When analyzing derivatograms three main stages of decomposition of OMC of Saryadyr deposit (five-meter layer) were identified on the differential curves of DTG and DTA, where peaks are observed with maxima in the rate of mass loss (inflection point).

The first stage where the endothermic effect is fixed on DTA curve with a maximum at temperatures T_{\max} in the range of 134-226 °C, associated with the evaporation of water, release of oxygen-containing gases by decomposing the side groups of macromolecules (as carbon-oxygen bonds are less stable in thermal relation). At this stage, mainly breaking links of the main structural units, splitting off and partial decomposition of the side chains take place, O₂, N, S are partly being removed [4]. Volatile matter in this temperature range is small. In the 2nd stage, the exothermic peak with a maximum at 357-453 °C is observed, which is responsible for the increase in the intensity of the group of thermosynthesis reactions due to increasing of the reactivity of the substances of heated OMC. This may cause decomposition reaction of hydroxyaromatic and heterocyclic moieties, as well as thermochemical conversion of the humic substances and synthesis of new more thermally stable compounds on their base, increasing of the number of unsaturated bonds, the rate of formation of volatile matters increases. [5] Thermal decomposition reactions of the most thermally stable organic and mineral complexes develop in the third stage with the endothermic peak with a maximum at 462-553 °C. Release of the bulk of the tar and gaseous hydrocarbons takes place by the end of this stage, the process ends with the formation of char. Upon further temperature increasing reactions of aromatization and polycyclisation intensify (with elimination of gaseous products, mainly H₂ and less of CH₄, CO, N₂); the formation of higher molecular polycyclic systems of reticulated structure takes place [6].

Peaks with a maximum rate of mass loss are slightly expressed, that is associated with the superposition of several processes at heating rate β from 6 to 15 °C / min of the stage of OMC decomposition at temperatures in the range of T_{\max} 462-553 °C, and the inability of their separate assessment for calculation of kinetic parameters (Fig. 1).

Results of derivatograms processing and calculating by above mentioned method using this computer programme are shown in Tables 1 and 2.

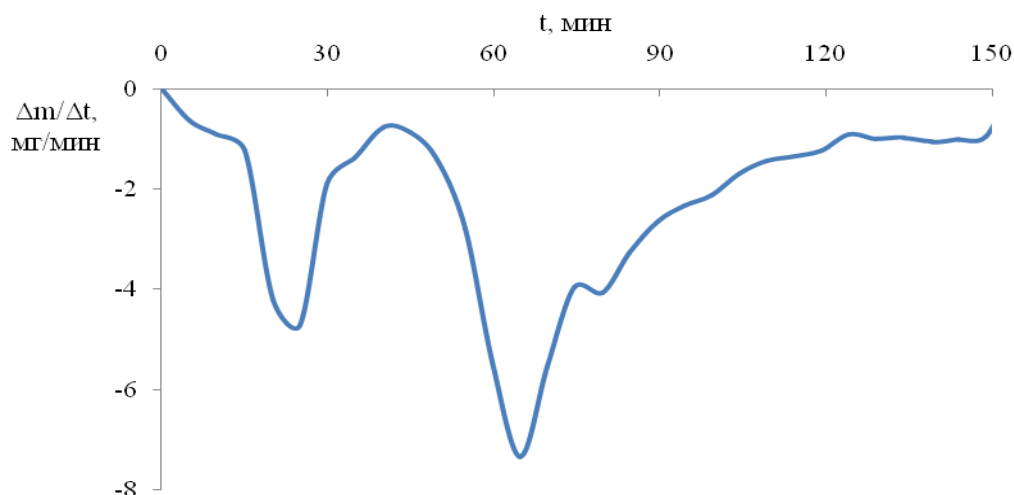


Fig. 1. DTG curve of coal of Saryadyr deposit

Table 1

Mass loss of coal samples at different temperature intervals and values of T_{nep} at decomposition stages

Heating rate, °C / min	Mass loss of samples, %				$T_{\text{max}}, ^\circ\text{C}$		
	30- 300°C	300-600°C	600-900°C	30-900°C	Decomposition stages		
					1	2	3
3	12,03	24,12	11,43	47,88	134	357	462
6	11,23	25,75	10,24	47,42	178	394	501
9	12,18	25,47	10,56	49,38	201	416	522
12	11,21	26,86	11,37	48,12	218	438	540
15	11,78	24,94	10,15	46,26	226	453	553

Table 2

Kinetic parameters of thermal decomposition of OMC

Heating rate, °C / min	Decomposition stages					
	1 stage			2 stage		
	$k_{\text{max}}, 10^{-3} \text{ c}^{-1}$	$k_0, 10^2 \text{ c}^{-1}$	$E_{\text{акт}}, \text{ kJ / mol}$	$k_{\text{max}}, 10^{-3} \text{ c}^{-1}$	$k_0, 10^4 \text{ c}^{-1}$	$E_{\text{акт}}, \text{ kJ / mol}$
3	1,35	2,72±0,13	43,7±0,92	1,23	1,45±0,03	98,2±3,7
6	1,65	7,42±0,64	46,3±2,76	1,19	1,94±0,12	93,3±2,9
9	1,47	1,89±0,11	40,3±2,61	1,34	0,71±0,03	86,8±3,6
12	1,69	2,78±0,18	44,8±2,23	1,52	0,54±0,06	82,6±3,4
15	1,39	1,65±0,06	38,3±1,75	1,32	0,47±0,02	80,1±4,8

Analysis of the data shows that the mass loss of OMC is almost identical for all the samples within the temperature range of 30-300 °C and 600-900 °C (Table 1). However, in the temperature range of 300-600 °C where there is second and third maximums it is observed higher weight loss of OMC. Apparently, this is due to the release of the bulk of the tar vapors and gaseous hydrocarbons with simultaneous formation of vapor of the so-called pyrogenetic water.

Increase in the size of the coal particles to $d = 0,2-5 \text{ mm}$ leads to a small increase in the degree of decomposition of OMC (9-10%), and does not significantly

affect on the kinetics of the studying process. However, during the transition from one stage of decomposition to other at elevated temperatures and different heating rates significant increase in $E_{\text{акт}}$ takes place, as exemplified by the heating rate of 3 deg / min: $E_{\text{акт}1} = 43,7 \text{ kJ / mol} = 98,2 \rightarrow E_{\text{акт}2} = 98,2 \text{ kJ / mol} \rightarrow E_{\text{акт}3} = 124,1 \text{ kJ / mol}$. The difference between the activation barriers of the 1st and 2nd stages within the same heating rates of 38-54 kJ / mol (see Table 2). In this case, the probability of rupture of certain types of bonds in the process of degradation increases significantly, as the differences between the values of k_0 on the 1st and 2nd stages show (1-2 orders, i.e., $k_{01} \sim 10^2 \text{ c}^{-1}$, $k_{02} \sim 10^3\text{-}10^4 \text{ c}^{-1}$).

Increasing of the heating rate β from 3 to 15 dg / min at all stages of OMC decomposition shifts temperature values T_{max} (corresponding to the maximum decomposition) towards higher values ($\Delta T_{\text{max}} \approx 100^\circ \text{C}$) and increasing of the velocity of OMC degradation process v_{max} (see Fig. 2 and 3). In this case, the approximation of points by straight line allows obtaining approximate dependences between v_{max} and β , as shown in Figure 2 (R^2 - the accuracy of the approximation). However, the difference between the velocity values at the inflection points Δv_{max} on the 1st and 2nd stages also increases with increasing of heating rate β and the relationship between Δv_{max} and β is described by similar function, close to linear ($y = 0,011 \cdot x - 0,026$, $R^2 = 0,967$).

Thus, the increase in the heating rate has more significant impact on the process velocity with a higher activation barrier, as well as contributes to a slight decrease in the quantities of $E_{\text{акт}}$ on the 2nd stage of decomposition (98,2-80,1 kJ / mol). However, it has no significant influence on the overall degree of decomposition of coal, which is likely due to compensation of shorter duration of thermolysis process by the higher speed (and vice versa).

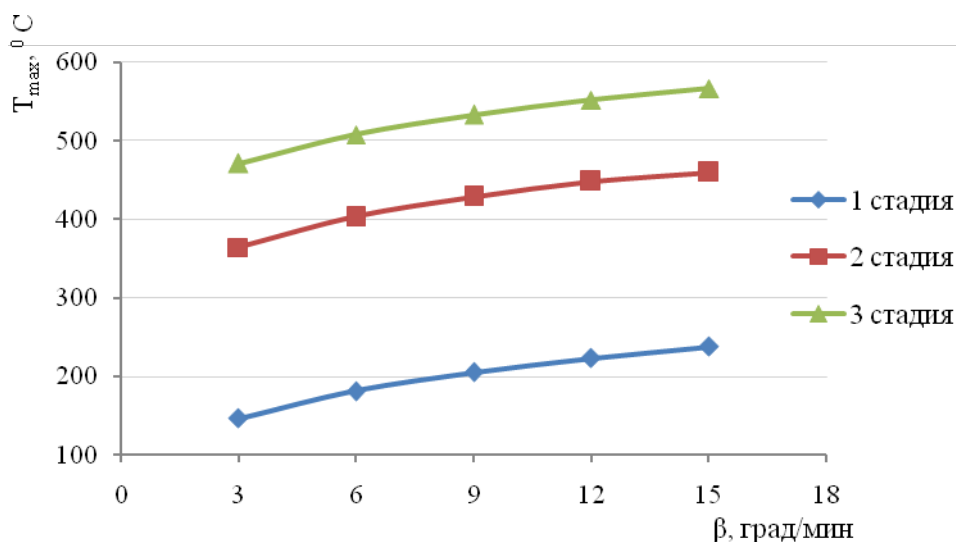


Fig. 2 The temperature dependence at the inflection points on the heating rate of coal at different stages of decomposition

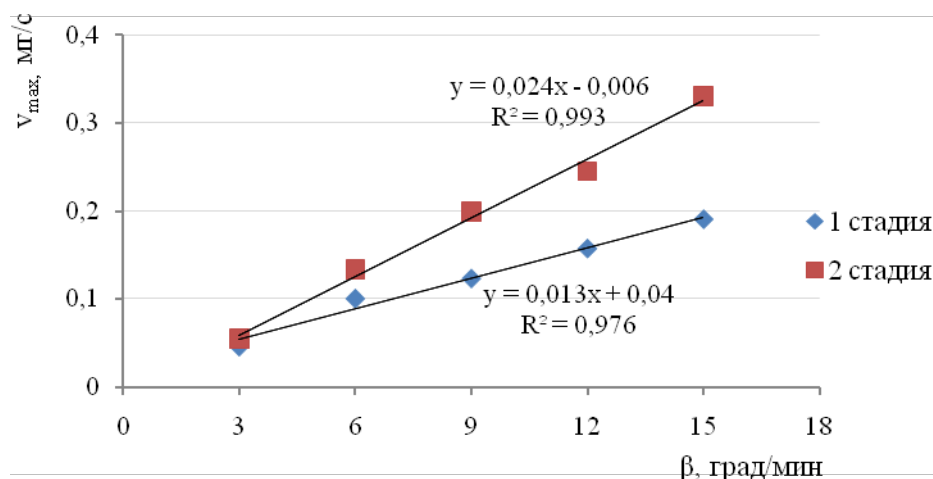


Fig. 3 The dependence of the degradation rate at the inflection points on the heating rate of coal at different stages of decomposition

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FLEXIBILITY IN THE CALCULATION OF AGRICULTURAL MACHINES

National University of Life and Environmental Sciences of Ukraine

The article shows the method of calculating the stress-strain state of a thin infinite tape stretching in considering when a large plane bending deformities.

Keywords: working bodies of agricultural machines, tape, large deformation, bending, stretching.

In agricultural machines used for cleaning flexible beat heads roots, endless belt for cutting material cutting machines, flexible shafts and belts in drives work of [1, 2]. When stretching saws (belt) form its elastic line changes significantly. There longitudinal force and bending moments, the value of which depends on the nonlinear deformations and geometrical parameters [3], which should be considered when designing and testing resources.

In the article the problem of determining the stress-strain state of flexible endless belt (saws) considering flexural stiffness at high strain and it provided that the law of Hooke material to tape. We assume that the axis of the drum loose tape outlined the curve close to the radius of the circle and has shared contacts with drums at the points 0, 1 (Figure 1, a). If weight belt neglected, the form of the elastic line is symmetrical about the horizontal axis assumptions allow use differential equation of elastic rod within the core class of problems of the theory of thin flexible rods E.N. Popov [3].

For the configuration of an elastic line (Fig. 1) process tensioning belt is divided into four qualitatively different stages that describe various nonlinear systems of defining equations. In the first stage (Figure 1b) will increase curvature 0 in the initial and final points 1 tape to the position where the radius of curvature of the borders of the line at the starting point 0 will be equal to the radius of the larger drum r_0 and the radius of curvature at point 1 is greater than the radius r_1 of the smaller drum.

With further increase in the distance between the centrifugal drum, formed arc coverage (Fig. 1, c) on a larger drum. The end of this phase will be the position of the elastic line tape in which the radius of curvature at the point it becomes equal to 1 r_1 .

Angle of coverage bigger drum γ at the end of of the second stage will be smaller threshold $\gamma' = \pi + 2 \arcsin(r_0 - r_1)/A$ (A - maximal distance between the axes of the drums). In the third stage stretching bands (Fig. 1 d) will increase the angle of coverage on a larger drum and will increase contact zone with less tape drum. The end of the third stage will be the position of the tape in which the angle of coverage bigger drum becomes equal to the limit value of the angle γ' . Angle of coverage meshoho drum at the end of stage is smaller threshold $\alpha' = \pi - 2 \arcsin(r_0 - r_1)/A$. In the fourth phase of deformation belt angle coverage larger drum is constant and equal to the limit value γ' , and the angle of coverage smaller drum will increase to the maximum value of the angle α' . The final configuration of the elastic line at the end

of this phase is (Fig. 1, e). Solution will result to the top of the tape, free from contact with the pulleys for the third stage (Figure 1 d) as the most common. We introduce the moving coordinate system XOY , $X'OY'$ strictly related to fluid end sections free from contact with the drums lots tape. In this moving frame XOY parallel to the fixed coordinate system $\bar{X}\bar{O}\bar{Y}$ with origin at point 1 elastic axis plot.

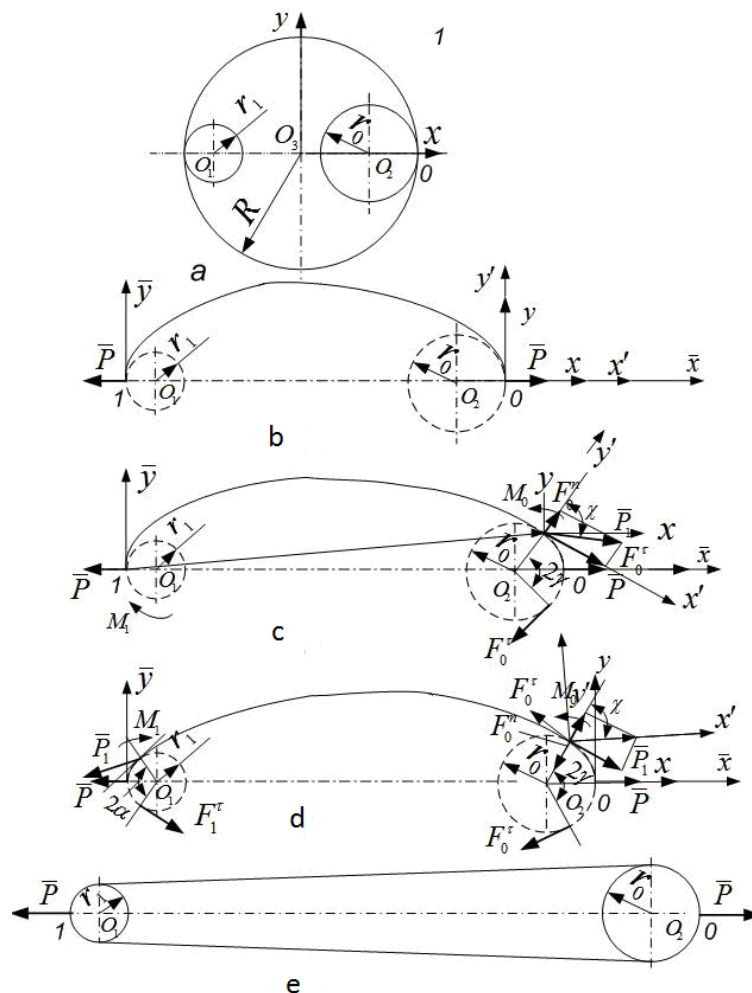


Figure. 1 Diagram tape: a, b - initial and final configuration, c, d, e - intermediate

Axis X' - oriented in the direction of the force \bar{P}_i , $F_0^r, F_0^n, F_1^r, F_1^n$ - tangential and normal components of force \bar{P}_i at the points 0 and 1 (Figure 1). By the end sections of the tape, except for forces \bar{P}_i , applied even bending moments M_i .

Differential equations curved elastic tape is reduced to the form [3]:

$$l^2 \frac{d^2 \zeta}{ds^2} = -\beta^2 \sin \zeta, \quad (1)$$

where l - the length of elastic tapes; s - arbitrary curvilinear coordinate point fluid, which is measured from the initial; $\zeta(s) = \nu(s) + \delta$ - dimensionless coefficient similarity which is the unknown function; $\nu(s)$ - angle of the tangent to the elastic line plots tape in fluid point; δ - angle to the axis X of the concentrated force \bar{P}_i applied at the points 0 and 1.

Decision of the differential equation (1) are those expressions:

$$\nu(s) = \nu_c + 2[\Psi(s) - \Psi_c]; \beta = K[F(\Psi_1) - F(\Psi_0)], \quad (2)$$

where $\Psi(s)$ - generalized elliptic amplitude, Ψ_0, Ψ_1 - its values at the points 0 and 1.

The current length free plot tape

$$l(\alpha, \gamma) = \pi R - 2(\alpha + \gamma), \quad (3)$$

The angles χ_0, χ_1 at the start and end points of the tape determined from equations:

$$\chi_0 = \pi/2 - \arctan(F_0^r / F_1^r), \chi_1 = 3\pi/2 - \gamma - \alpha + \arctan(F_0^r / F_1^r), \quad (4)$$

similarities and slope β :

$$\beta = (\pi R - r_0\gamma - r_1\alpha)\sqrt{P_1/H}, \quad (5)$$

where H - bending stiffness of the cross section of the tape.

By equations (4) and (5) only add the equation of equilibrium free plot line:

$$\begin{aligned} 2F_1^n \cos \alpha + 2F_1^r \sin \alpha + P &= 0; 2F_0^r \sin \gamma - 2F_0^n \cos \gamma + P = 0; \\ F_0^n \cos \gamma + F_0^r \sin \gamma - F_1^r \sin \alpha - F_1^n \cos \alpha &= 0; \\ F_0^n \sin \gamma - F_0^r \cos \gamma + F_1^n \sin \alpha - F_1^r \cos \alpha &= 0; \\ M_0 - M_1(F_0^n \sin \gamma - F_0^r \cos \gamma)h + (F_0^n \cos \gamma - F_0^r \sin \gamma)(r_0 \sin \gamma - r_1 \sin \alpha) &= 0. \end{aligned} \quad (6)$$

Instead, we introduce a generalized elliptic elliptic amplitude parameters φ_0 and φ_1 :

$$\varphi_0 = \Psi_0, \quad \pi - \varphi_1 = \Psi_1. \quad (7)$$

After transformation equations (4) - (6) with (7) we arrive at the system:

$$\begin{aligned} (\pi R - r_0\gamma - r_1\alpha)\sqrt{P_1 - K\sqrt{H[2F(K) - F(\varphi_1) - F(\varphi_0)]}} &= 0; \\ \varphi_0 - 0,25\pi - 0,5\arctg(F_0^r / F_1^r) &= 0; \\ \varphi_1 - 0,5(\pi + \gamma + \alpha) + \varphi_0 &= 0; \\ P - 2F_0^n \cos \gamma - 2F_0^r \sin \gamma &= 0; \\ 2\sqrt{P_1}\{\cos(\alpha - \gamma + \arctg(F_0^r / F_1^r)) + [\sin(\alpha - \gamma + \arctg(F_0^r / F_1^r)) \sin \alpha]\} - P &= 0; \\ P - 2F_1^r \cos \gamma - 2F_0^r \sin \gamma &= 0; \\ F_1^r \sin \gamma - F_0^r \cos \gamma + \sqrt{P_1}[(\cos(\alpha - \gamma + \arctg(F_0^r / F_1^r)) \sin \alpha - \\ - \sin(\alpha - \gamma + \arctg(F_0^r / F_1^r)) \cos \alpha] &= 0; \\ h(F_1^r \sin \gamma - F_0^r \cos \gamma) - \frac{2}{K}\sqrt{\frac{P_1}{H}}(\pi R - r_0 - r_1\alpha)(\sqrt{1 - K^2 \sin^2 \varphi_1} - \sqrt{1 - K^2 \sin^2 \varphi_0}) - \\ - (F_0^r \sin \gamma + F_1^r \cos \gamma)(r_0 \sin \gamma - r_1 \sin \alpha) &= 0. \end{aligned}$$

(7)

The method allows to calculate the tension in the most loaded areas of crowding tape on drums and convergence are The same approach can be used to determine the stress-strain state of flexible blades cleaners roots, and wide V-belts of the variator speed with the changing interaxial distance between pulleys and change their diameters .

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J21410-044

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MECHANICS OF INVENTIVE ACTIVITY MANAGEMENT IN PROJECTS OF INDUSTRIAL PROPERTY OBJECTS CREATION

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This article refers to methodological fundamentals of industrial property objects creation. We examine the state of the art in the field of scientific development of mechanics involved in inventive activity management in projects of industrial property objects creation. It is shown that the problem of creating an efficient mechanism remains unsolved.

Keywords: industrial property, inventive task, creative search, engineering solution, methodological fundamentals.

Introduction. Industrial property is one of the types of intellectual property and also its component. It is comprised of results of intellectual activity related to inventions. Core results of inventive activity are inventions and utility models. These results combined with industrial samples, trademarks, and other intellectual property objects, provide for a substantial advance in technology level as well as make a positive influence on economical development of industrial enterprises, the state and society [1]. Both inventions and utility models are essentially new technical solutions, which are products of creative search conducted for solving problem situations by carrying out inventive tasks.

In order to conduct creative search for principally new, original technical solutions, and transform the latter into inventions or utility models that meet the demand of society, an enormous input of labor and time is needed. That's why such activities usually take place in the course of an innovation project. Among the aspects favorable to success in achieving the goal of such project is inventive activity management. Inventive activity management is a complex of operations related to planning, organizing, and controlling the search for solutions of certain inventive tasks, along with further acquiring of rights for found solutions [2]. Mechanics of inventive activity management rely on a certain toolset, mainly comprised of techniques and methods of searching for new technical solutions. Despite the fact that today's methodological stock of inventive activity includes a great amount of methods of different complexity and efficiency ([3], [4]), scientists and inventors continue the work of perfecting methodological fundamentals involved in industrial property objects creation. Therefore, it is reasonable to examine the most prominent works of domestic authors and evaluate the state of the art in the field of scientific development of mechanics involved in inventive activity management in projects of industrial property objects creation.

Research description. Let's look through the most successful attempts of scientists, who worked in the field of development or perfecting the mechanics of search for technical solutions at the initial stage of inventive activity. An attempt of scientist, experienced intellectual property specialist, honored inventor of Ukraine Yuri Kuznetsov to perfect the mechanics of invention-making undeniably deserves

attention. Yuri Kuznetsov, professor at Kyiv Polytechnic Institute, analyzed methodological fundamentals of industrial property objects creation and researched problems related to creation of new technical systems referring to works by Genrich Altshuller. He described Altshuller's algorithm of solving inventive tasks coded "Ariz-71", which was based on usage of technical contradictions (in the meaning of finding and ruling out those contradictions). In order to carry out an inventive task, Yuri Kuznetsov suggests using typical techniques for eliminating technical contradictions [5, p. 68]. When he analyzed the creative process involved in inventive tasks, he described the classical approach, which lies in six subsequent stages on the road from problem statement to implementation of solution. He also made references to works of professors Meredith Tring and Eric Latewait of London universities on this matter [5, p. 85].

Similar approaches can be found in works of specialists in the fields of technical creativity, intellectual property, and the theory of inventive tasks solving, in particular O. Chus and V. Danchenko [6, p. 25-29], M. Reznik and V. Kozinets [7, p. 6-10], G. Pigorov, S. Antonenko and others [8, p. 47-50].

We'd like to pay special attention to the approach introduced by patent attorney of Ukraine Valeriy Kutsevich. In practical section of his tutorial "Fundamentals of heuristics", in which he gave detailed description of how inventive tasks are stated and solved, Kutsevich analyzed questionable situations and various types of problems within invention-making process. He stated that industrial property creators should know that in fact there are only two types of inventive tasks: 1) tasks related to creation of new means for achieving a known goal, and 2) tasks related to search of the goal, which can be achieved by practical usage of principally new potential means derived from natural or scientific discoveries.

Valeriy Kutsevich authored the course of lectures, which he was delivering to students in "Intellectual property" class at the Institute of Intellectual Property for many years. He stated that the development history of theories of creative task solving clearly shows to every unbiased researcher that virtually all attention of methodologists is focused on tasks of the first type. At the same time tasks of the second type, solving of which often leads to pioneering inventions based on innovative scientific discoveries introduced in technology for the first time, are still being treated as "orphans" by methodologists and adherents of "pure science" [9, p. 205].

We think that such approach is valuable not just because it makes a point in arranging the entire variety of inventive tasks in two types, but also because it gives technological recommendations on stating and solving tasks of both types. Valeriy Kutsevich, the author of "Fundamentals of heuristics" tutorial, introduced a formal and logic model of description for tasks of both types in a form of abstract frames, consolidated prerequisites for filling frames' sections, as well as consolidated recommendations for the search of missing data. At the same time, when solving a task of the first type "from a known goal to a new means of achieving it", Kutsevich suggests "to find a description of the nearest analogue of creation in regard to its technical essence (\equiv prototype) in some information base (not necessarily patent-related one) or in the Internet, ... then research correlation and interaction of the

prototype object with surrounding environment, ... and state what exactly needs to be changed in the prototype (for one's own notice first of all, and then in the invention description for patent office experts)." [9, p. 212]

The author of this approach to describing a possible way of solving an inventive task at the initial stage of inventive activity (from a known goal to a new means of achieving it) is convinced that every inventor should understand that the choice of ways of creative search for missing data depends on results of analytic work for goal-setting, which in its turn lies in examining of a whole lot of related characteristics, information, and conditions. Among the latter, the author suggests a minimum of this data:

- patentability conditions for inventions and (not often) utility models, as set by patent laws of a certain state;
- information about the composition and status of surrounding environment, in which the now vanished prototype functioned;
- inexhaustible variety of consumer properties, which provided for a competitive demand for the now vanished prototype.

It's worth mentioning that approaches we analyzed above, as well as some other, are described by scientists in a general form, which means they lack solid factual base. The latter makes it difficult to use said approaches in practice. Besides, more difficulties arise as these approaches make references to additional methodic materials. The same applies to other approaches, among which it's worth to analyze scientific work of the collective consisting of O. Svyatotsky, V. Petrov, G. Androschuk, O. Butnik-Siversky, and other renowned specialists in the field of intellectual property. In the "Industrial property protection in Ukraine" monograph they describe methods of search for solutions used in creation of industrial property objects [10, p. 343–415]. This description makes a whole section of the monograph (more than 70 pages of text), but we should accentuate that it is the description of only those methods, which are already widely known in creative activities, such as "brainstorm", "Synectics", "checking questions", and other including the Algorithm of solving inventive tasks (a modernized model, namely "Ariz-85-V"). However, authors do not provide any recommendations on improving the inventive activity mechanics.

Conclusion. So, after analyzing methodological fundamentals of intellectual property objects creation in general, and particularly existing approaches to the problem of searching for creative technical solutions having patentability in the course of creating or improving industrial property objects, we come to conclusion that scientists, practicing specialists, individual inventors, and creative collectives, understand the weak sides of methodical toolset for choosing ways of creative search at the time of creating or improving industrial property objects. Some of them make attempts to change the situation for the better and suggest already known or authored methods. However, as of today, the problem of creating an efficient mechanism of inventive activity management in projects of industrial property objects creation remains unsolved.

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Yagubov E.Z., Yagubov Z.Kh.

APPLICATION OF COMPOSITE AND FIBER PIPES IN GAS AND OIL INDUSTRY

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Abstract. The objective of this article is to clarify the principles of development of corrosion-resistant, leak tight and strong GRP pipes for the natural gas and oil industry.

Key words: glass-reinforced plastic pipe (GRP pipe), leak tightness, packing layer

All units made of composite materials and operated under the loads, particularly under internal yield pressure, suffer from main disadvantage of low fracture resistance under across fiber load.

It should be pointed out that composite materials including glass-fiber materials are apt to developing and frozen-in damage under loading.

Grounding on practice it is evident that observable cracking of units walls made of composite materials starts as early as $P_{tensile} = (0,15 \div 0,18)P_{process}$ under internal pressure, or under stresses $\sigma = (0,2 \div 0,3)\sigma_{inst.stress}$, where $\sigma_{inst.stress}$ means instantaneous strength of composite material, i.e. σ is beyond the non-porosity limit or earlier in case the reinforced binders are used (fig.1) [3].

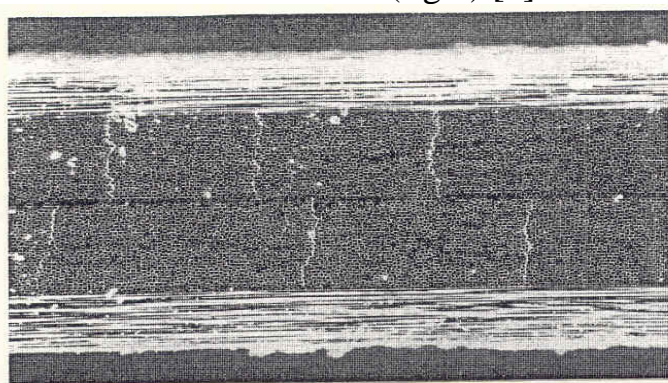


fig. 1. Glass-fiber material micrograph after loading

It doesn't cause noticeable reduction of material strength at large, as the binder's part while accommodating the load makes to a maximum of 3% of the fibers strength, but it causes the items unsealing (including vessels operated under high internal pressure such as pipelines and cylinders of different purposes etc.) that is inadmissible.

The author's studies make it possible to consider the composite pipes binder cracking process causing the uniformity loss to be unavoidable, especially when the construction is operated under high service pressures.

Thereby it evident that while designing and manufacturing the composite pipes, the most complex and crucial task is ensuring their vacuum tightness.

As far as the wall of glass-reinforced plastic pipe is designed on the ground of construction strength balance, so the degree and frequency of microfractures occurring in the wall under its internal pressure loading for longitudinal and

transverse texture layers (as well as for the intersecting layers of the wall texture made with the spiral winding) will be equal on a par.

Therefore, microfractures, occurring in the intersecting layers of the composite wall when meeting with each other form the end-to end channels (capillaries) which penetrate the pipe wall through or at some depth. And some of them may be of latent or medial nature, in other words these capillaries may be of neither internal nor external emergence of the composite wall (fig.2).

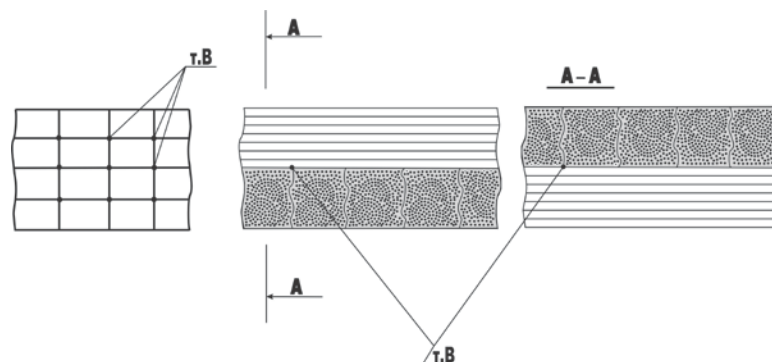


fig. 2. The scheme of forming the end-to end penetration capillaries (in point B) in the structure of the pipe wall made of composite and fiber materials and operated under the internal pressure.

The detailed analysis of binder fracturing speaks volumes for the fractures spacing quasiregularity and their comparatively even distribution through all the layers and the entire volume of the composite and fiber material.

This phenomenon being registered at experimental works is of exact and clear nature.

The frequency of fractures spacing both in longitudinal and transverse texture layers is strongly evident in micrographs (fig. 1 and fig. 3) of the wall of the glass-reinforced plastic pipe after its internal pressure loading of 0,7 of failure pressure.

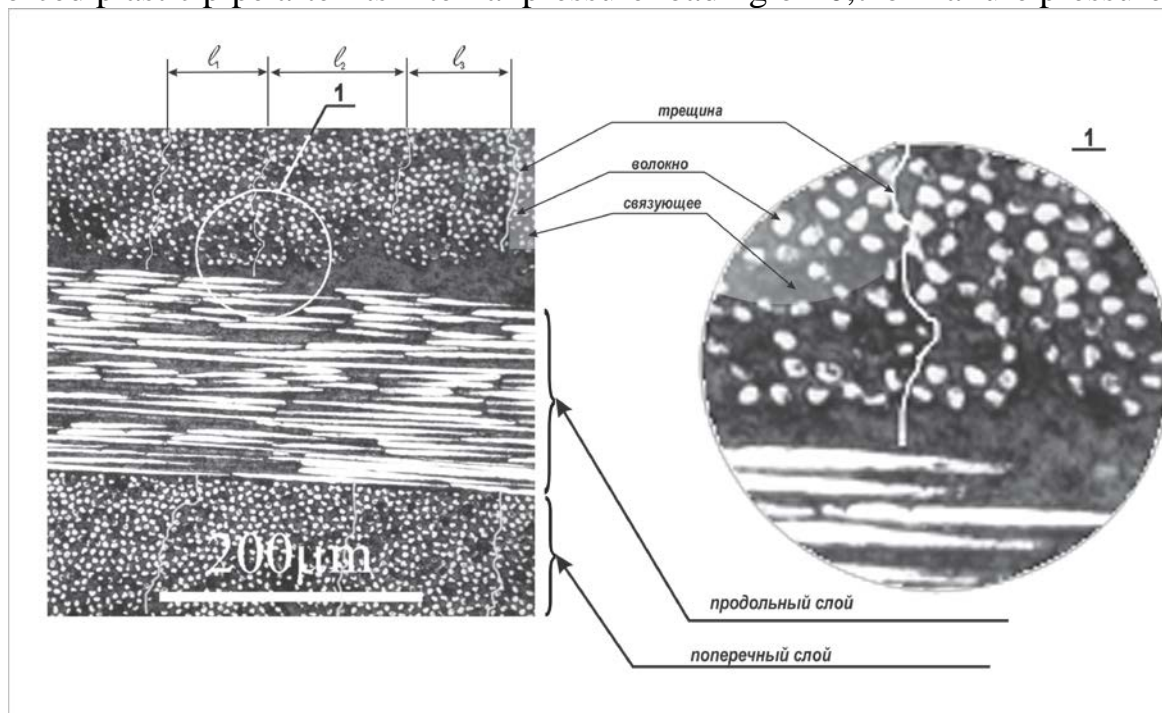


fig. 3. Fractures spacing in the structure of the composite pipe wall

The formation of the right capillaries family penetrating the pipe wall through results in unsealing and is caused by the abovesaid spacing at longitudinal and transverse fractures cross points.

Cumulative dimensions of capillaries sections $\sum_{i=1}^n \Delta L_{1,2}$, developed under fracturing of composite material will be proportionate to the quantities of working longitudinal σ_1 and transverse σ_2 strains [4, 5]

$$\sum_{i=1}^n \Delta L_1 = \frac{\frac{\sigma_2}{E_\epsilon} - \epsilon_{cb}}{1 - V_{\epsilon 1}}, \quad \sum_{i=1}^n \Delta L_2 = \frac{\frac{\sigma_1}{E_\epsilon} - \epsilon_{cb}}{1 - V_{\epsilon 2}}$$

where $V_{\epsilon 1,2}$ – is the volume content of the fibers along the strains σ_1 and σ_2 directions accordingly; ϵ_{cb} – is a binder deformation, E_ϵ – is a fibers coefficient of elasticity.

Unavoidable fracturing of the composite wall pipe structure which calls forth the item unsealing, as well as the strength reduction under the reloading, forces to look for ways of its sealing-off.

The undertaken study confirms that sealing layers (or coats) used with this purpose in reinforced plastic pipes are other than the quality assurance of the pipes.

While carrying both the natural gas and oil containing the natural gas there is a chance of arising diffusion processes of different nature causing the seal failure of the pipe as well as the spalling and subsequent swelling of the sealing layer from the inner walls of the pipe, called “bend” or “lacunal spalling” (fig.4) and which is due to the gas penetration in the interfacing area of the sealing layer and composite pipe [4, 7].

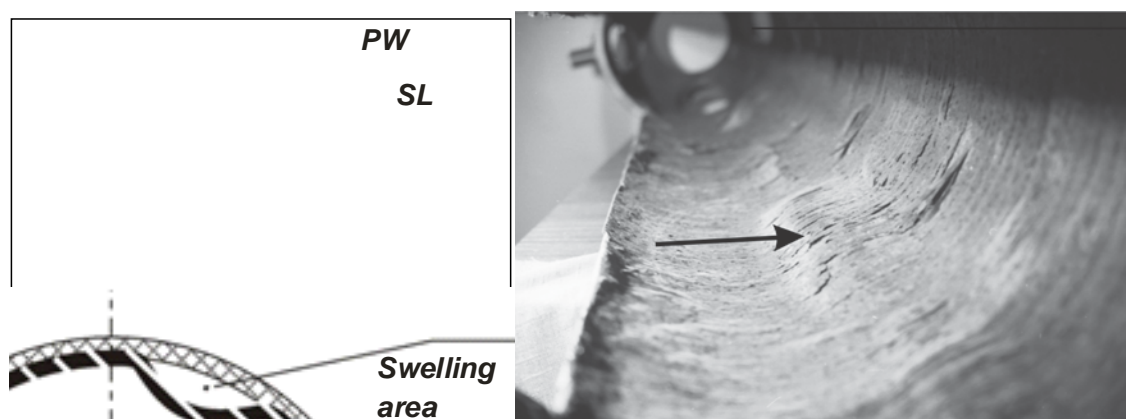


fig. 4. the scheme of the sealing layer swelling along the inner surface of the pipeline walls (PW-power winding, SL-sealing layer)

Thus, the problem of the reinforced plastic pipes sealing can't be solved only by making use of sealing layers. It is impossible as just the one of the mechanisms of gas diffusion through the sealing layer will occur.

The author suggests the structure of the reinforced plastic pipe with the riffled inner sealing layer favoring the “lacunal spalling” elimination.

The integrated design of the complex cross-spiral and tangential reinforcement 3D is at the heart of the structure of the composite pipe with the riffled sealing layer.

Continuous high speed spiral winding (criss-crossed under the angle of $\pm 45^\circ$) with the shrouded helical layer provides an engineering efficiency of pipe manufacturing at the highest level. Cross-spiral reinforcement renders possible to forward the wall elastic-strain energy from the action of the inner pressure on the in-structure force shifts of the spirals (reinforcement fibers) from the angles of $\pm 45^\circ$ towards the equilibriums $\pm 55^\circ 44'$. Herewith the occurred transversal microcracks are spontaneously joining and self-sealing. Thanks to this phenomenon the pipes fracture resistance and hermiticity are highly growing. Sealing layer material can be of different origin and nature (metal, polymeric, rubber-like etc.). Base structure of the developed composite pipe is represented in the figure 5 [1, 2, 6].

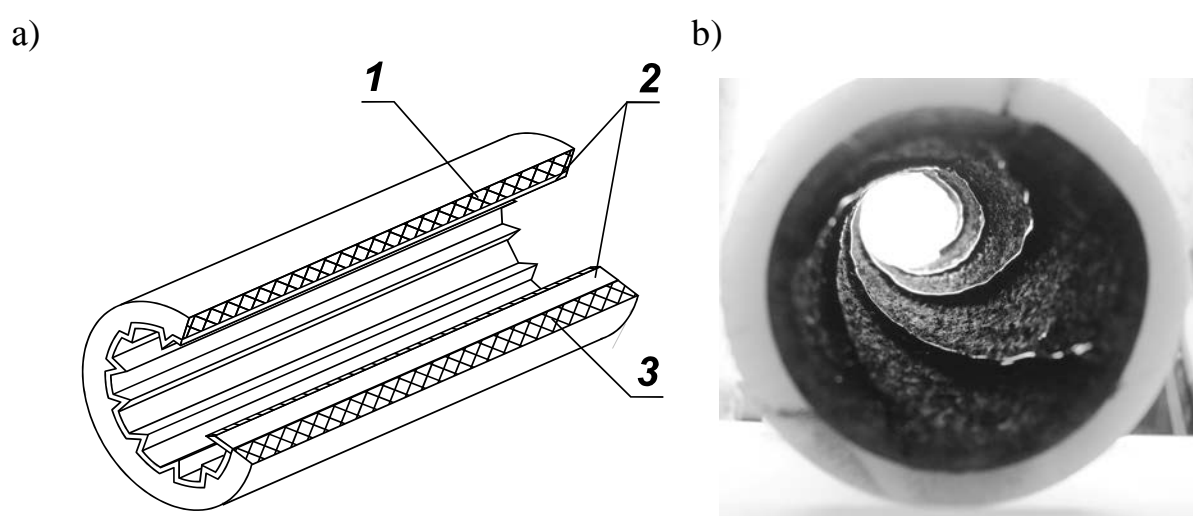


fig. 5. Base structure of the composite and fiber pipe with the riffled sealing layer (a) and a composite pipe test-piece with the spiral-helix riffled sealing layer

Experiments proved that the flow velocity in the pipe with the spiral-helix riffled sealing layer is not reducing in speed, but in a number of cases it is slightly (up to 5%) increasing the flow velocity in the pipe with the common sealing layer of elastomers.

The measurements are being carried out by means of the plated ultrasonic flowmeter «Flexim».

Thus the structure of the reinforced plastic pipe with the riffled sealing layer makes it possible to avoid the adverse events of “lacunal spalling” and unsealing of the pipe walls. Alongside with it doesn’t obstruct the flow velocity, but even sometimes accelerates it as compared to the metal pipe, and thereby increases the pipeline carrying capacity in the large.

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J21410-046

Rakov V.A.

EXPERIMENTAL STUDIES OF PROTOTYPE DEVICES OF HEATING OF THE ENGINE

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The article describes the design of the device heating the engine of exhaust gases and experimental determination of its heat capacity.

Keywords: heat transfer, engine warm-up; exhaust system, mathematical model, engine warming, energy efficiency.

Using waste heat to quickly warm the internal combustion engine - one of the most promising directions for improving the performance of vehicles. The article describes the results of tests of a prototype heater control (PHC) manufactured in the Vologda State University [1-5]. Tests were carried out at the stand of the "thermal wind tunnel" (Fig. 1) in a room with ambient temperature of +14 °C, humidity 80%. Primary coolant temperature is +11 °C. The volume of fluid in the circulation circuit - 2.5 liters, heating power of the air stream - 1500 W, the gas inlet temperature of 500° C [6-8].

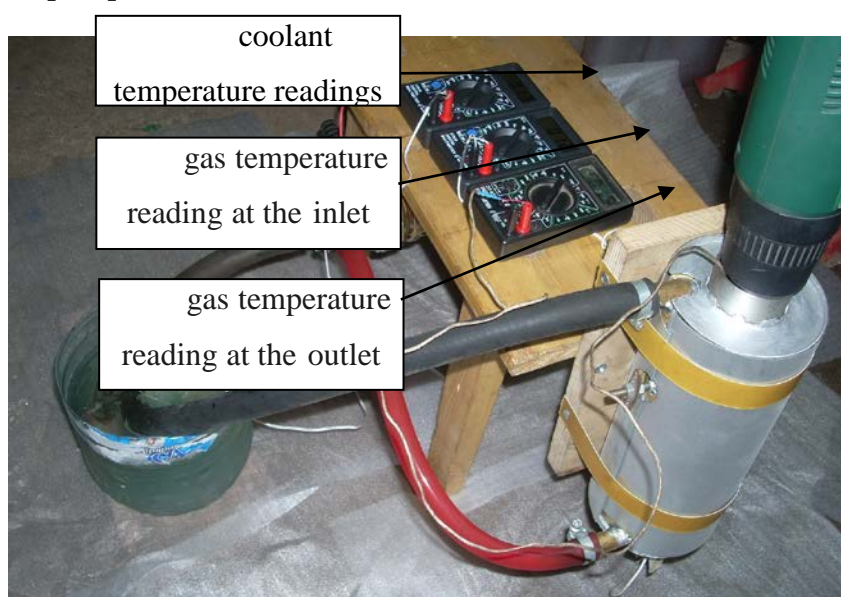


Fig. 1 - Test device accelerated warming of the engine

The purpose of testing is to determine the heat output of the heat exchanger, the heat leak detection circuit, determining the efficiency of conversion of thermal energy to identify possible ways to optimize the design.

On the basis of experimental data obtained theoretical dependence increase the coolant temperature at the engine warms up

$$t_t = 0,0711T + 10,735, ^\circ\text{C} \quad (1)$$

The coefficient of determination of the trend $R^2=0,9988$ indicates a high degree of convergence of the experimental and theoretical curve.

PHC thermal power can be determined from the following condition

$$1\text{kJ} = 1\text{W}\cdot\text{s}, \quad (2)$$

ie thermal energy W, rejection per unit time is equal to the thermal power P_1 . Given

that during the time interval adopted 1 minute thermal power will be calculated by the following formula

$$P_t = \frac{W}{60}, \text{ kW.} \quad (3)$$

After processing the results of measurements obtained dataset t_s approximating the dependence of the temperature of the coolant from time $t_r = f(T)$. Subjected to heat the coolant water. Specific heat of water (c) is constant and equals 4.184 kJ / (kg • K) [9-10]. Weight of water (M) in a 2.5 liter. With this energy rejection to the cooling system can be described by the following relationship

$$W = cM \frac{\Delta t}{\Delta T} = cM \frac{t_i - t_{i-1}}{60}, \text{ kJ} \quad (4)$$

Thus, based on the obtained theoretical coolant temperature at each time point energy calculated rejection to the cooling system. Based on these data, it was 41.6 kJ for every 60 seconds, which corresponds to 0.89 kW thermal power and coolant warm-up time from 11 to 83 °C puts 17 minutes.

The values obtained diverted energy and power PHC not include losses of thermal energy for heating the walls of the circulation loop W_n and heat dissipation into the environment W_s . To account for these factors conducted studies to determine the losses.

Determination of loss on heating the walls of the circulation loop

In the circulation circuit exist heat loss through the walls (Fig. 2.). For measurement of heat loss to heating the walls of the circulation circuit necessary to determine the specific heat of the materials from which it is made. Direct solution to this problem is to measure the geometric dimensions and the specific heats of all the parts that made the circulation loop that is rather complicated from a practical standpoint. Indirectly, this problem is solved by the heat capacity of the water.

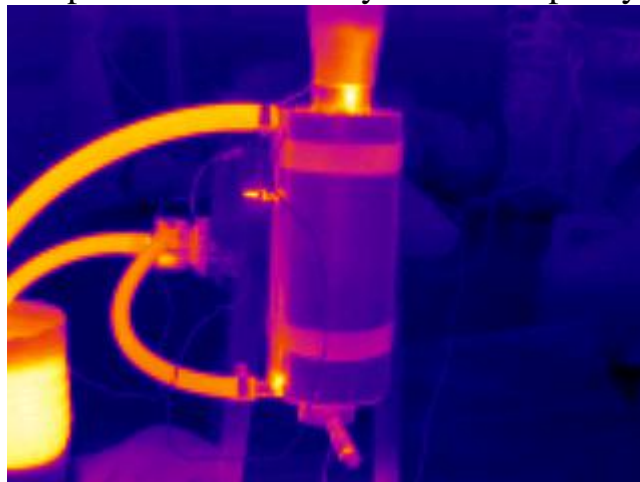


Fig. 2. – Photo heater control made with a thermal imager. Yellow shows where the strong radiation of heat through the walls

For this purpose the cold flow circuit filled with a known volume of water a predetermined temperature. The walls of the circulation loop take the heat energy from the coolant and its temperature falls to a value equal to Δ_{loss} . Then the total cost of thermal energy for heating circulation loop will be calculated by the following

formula

$$W_n = cM(\Delta_{\text{loss}}) = cM(t_n - t_{\text{given}}) = 4.183 \times 1.5 \times (55 - 49) = 37.65, \text{ kJ}, \quad (5)$$

where t_n and t_{given} – this is the desired flow temperature and its temperature after filling in the circulation loop.

Unit costs of thermal energy to the heating system by 1 °C will be equal

$$W_{\text{un.}} = \frac{W_n}{t_{\text{giver}} - t_{\text{evir}}} = \frac{37.65}{83.2 - 14} = 0.54, \text{ kJ/}^\circ\text{C} \quad (6)$$

is the ambient temperature. Specific loss $W_{\text{un.}} = 0.54 \text{ kJ/}^\circ\text{C}$ correspond to the absorber power $P_{\text{loss}} = 0.09 \text{ kW}$

Determination of heat losses to the environment

The temperature of the coolant in the circulation loop above the ambient temperature, which leads to the dissipation of heat to the environment by radiative and convective heat transfer. To determine these losses used method for determining losses by measuring the intensity of cooling the coolant in the system after turning off the hot gas in the PHC.

Power calculation of heat loss produced by the formula 5-6. According to the measurement processing every minute to the environment of the system is dissipated thermal energy 8.3 kJ, which corresponds to 0.17 kW of heating power. Thermal power transmitted coolant considering the heat dissipation into the environment will be equal

$$P = P_1 + P_C + P_H = 0.89 + 0.17 + 0.09 = 1.15 \text{ kW} \quad (7)$$

Evaluating the effectiveness of the coolant temperature differential

Through the air passage PHC pumped some volume of gas, which is equal to the heat capacity of 1.01 kJ / (kg • K), and the known temperature of the gas at the inlet and outlet of the heat exchanger. Passing through the heat exchanger, PHC loses its thermal energy. The coefficient of heat To use ranges from 0.93 to 0.73 with an increase in temperature of the liquid coolant. Also, it can be argued that part of the waste heat for heating of the coolant, and is dissipated through the case and the details of PHC.

As a result of experimental studies conducted PHC complex tests for determining the reliability of the basic characteristics [11-12].

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**DEVELOPMENT OF DIAGNOSTIC MATRICES IDENTIFY
FAULTS AND FAULT ELEMENTS OF HYBRID ENGINE***Vologda state University, Vologda, Lenina 15, 160000*

The article describes the relationships between the most probable malfunctions and used diagnostic parameters of hybrid engine. To identify these relationships are built diagnostic matrix.

Keywords: hybrid vehicle; diagnostic matrix, diagnostic parameters, technical condition assessment, hybrid power unit.

The most important stage of the Troubleshooting process is to establish the diagnosis. It was noted earlier that the hybrid engine (HE) of the vehicle consists of a main power plant - internal combustion engine (ICE), motors-generators (MG1) and (MG2) inverters (In.) and high-voltage battery (HVB). From each of the elements are determined to some extent parameters S1 and S2. Diagnosis of such a mechanism, through the use of a single parameter impossible. For solving the problem of diagnosis in this case on the basis of data about reliability of the object, the structural effect of the schema object uncovered links between its most probable malfunctions and used diagnostic parameters [1-4]. To identify these relationships are built diagnostic matrix representing a logical model that describes the communication between the diagnostic parameters «y» and possible faults, «A» object for multiple operation modes of the actuator (table. 1).

If diagnosed with a simple system with a monotonous modes (such as diagnostics of the cylinder-piston group of the ICE in one of parameters), one of the matrix, however, for a complex system this may not be enough. For example, in this case. During startup ICE exit from the permissible limit parameter «y5 (chain consumption HVB)» malfunction may be caused by disruption of the work of several nodes (A₂, A₄). To identify the reasons for the refusal have to have diagnostic matrix for several States of the system [5-8].

The list of possible malfunctions HE on the basis of the available statistical data (collectively systems): ICE (A₁); MG1 (A₂); MG2 (A₃); In. (A₄); HVB (A₅).

A list of the diagnostic parameters reflecting the technical condition of all the nodes HE, their actual values and the dynamics of changes for a hybrid car Toyota Prius NHW20:

- power MG1 (y1) mode of the motor (0 to 33 kW);
- power MG1 (y2) in generator mode, (-33 to 0 kW);
- power MG2 (y3) in motor mode (0 to 50 kW);
- power MG2 (y4) in generator mode (-5 to 0 kW);
- power HVB (y5) when discharge (0 to 21 kW);
- power HVB (y6) with battery (-5 to 0 kW).

The normative size of the dynamics of changes of the parameters is not constant, its the nature of the change is calculated according to the given parameters of movement of the car, which makes this technique universal [9-11].

Table 1

Matrix fault HE in-depth diagnosis

Diagnostic settings	Possible malfunction				
	ICE (A ₁)	MG 1 (A ₂)	MG 2 (A ₃)	In. (A ₄)	HV B (A ₅)
1. Engine start					
y1+	0	1	0	1	0
y1-	0	1	0	1	1
y5+	0	1	0	1	0
y5-	0	1	0	1	1
2. Start of motion					
y2+	0	0	0	0	1
y2-	1	1	1	1	0
y3+	1	1	1	0	1
y3-	0	1	0	1	1
y5+	1	1	0	0	0
y5-	0	0	1	1	1
y6-	1	1	0	1	1
3. The acceleration of the motion with the heavy load					
y3+	1	1	1	1	0
y5+	1	1	0	0	0
Y5-	0	0	1	1	1
4. Uniform motion with a small load					
y1+	0	1	0	1	0
y1-	0	1	1	1	0
y4+	0	1	0	1	0
y4-	0	1	1	1	0
5. Coasting, and deceleration					
y4-	0	0	1	1	1
y6-	0	0	1	1	1

(+) above the norm corridor; (-) is below the norm corridor.

Optimization of the aggregate of the diagnostic parameters

Malfunction of the engine and CDH can also be defined when using the simplified method of Troubleshooting. Its essence is that every source of power makes a certain contribution in the process of creating a traction force on wheels, it is a peculiarity of all the schemes of the HE (F. 1).

$$N_{\Sigma} = N_{ICE} + N_{HVB} \quad (1)$$

In order to estimate the contribution of engine power N_{ICE} and energy storage N_{HVB} using the simplified method is sufficient to have information about the nature of

changes in the power of one of the elements.

A list of the diagnostic parameters necessary for the evaluation of the technical condition of the engine and drive energy, their actual values for the Toyota Prius NHW20:

- power HVB (y5) at the discharge (0 to 21 kW);
- power HVB (y6) at a charge of (-10 to 0 kW).

Of course, it is probable that is faulty, for example, the inverter MG1, MG2. In this case, the cause of the problem can be installed with an integrated system diagnosis HE that will save time of diagnosis. Matrix fault for simplified method is presented in the table. 2.

Thus, the parameters of the technical condition of key nodes of the HE in different working conditions, most fully reflect their technical condition, which in combination with a built-in system of diagnostics and related parameters output processes improves the quality of diagnosis for estimating the technical state of the HE [12-13].

Table 2 – Matrix fault HE in a simplified diagnosis

Diagnostic settings	Possible malfunction	
	ICE (A ₁)	HVB (A ₅)
1. Engine start		
y5-	0	1
2. Start of motion		
y5+	1	0
y5-	0	1
3. The acceleration of the motion with the heavy load		
y5+	1	0
y5-	0	1
4. Coasting, and deceleration		
y4-	0	1
y6-	0	1

(+) above the norm corridor; (-) is below the norm corridor.

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J21410-048**Rakov V.A.****THE CHOICE OF PARAMETERS FOR ASSESSING THE
TECHNICAL CONDITION OF HYBRID POWER UNITS HIRE***Vologda state University, Vologda, Lenina 15, 160000*

The article presents the analysis of the diagnostic parameters, necessary for estimation of technical condition of the engine and battery hybrid system in the vehicle. Recommended method of estimation of technical condition on the selected parameters.

Keywords: hybrid vehicle; the diagnostic parameters, faults, technical condition assessment, hybrid power unit.

Selection of parameters for assessing the technical condition of hybrid engines (HE) is a challenging task. This is due to the fact that in the workflow process output (creating traction on the drive wheels) involved four separate units: the engine, the electric motor - generator 1 (MG1), motor - generator 2 (MG2) and high voltage battery (HVB). Each element is a separate operating unit separately [1-5].

For the system under consideration in establishing the failure of one of the most interesting sites summarizing the parameters related to the elements of the GE. In assessing the technical condition of HE have enough information about generalizing parameters output processes characterizing the technical condition of the unit as a whole (for example, fuel consumption per 100 km , the maximum output power of the motor , etc.). When evaluating a particular node or element can be used private parameters of the technical condition of the particular mechanism of the system (eg , winding resistance , self-discharge of the battery), and their reference values . Methodology for assessing the state of the internal combustion engine similar to those currently used in [1-2].

HE at diagnosing car can be used workflow settings and parameters associated processes functioning mechanisms [6-8].

Workflow options are HE: power output HE (S1), fuel consumption HE (S2), energy efficiency ratio HE (S3). Workflow (diagnostic features) are: electric power MG1 in motor mode (y1); MG1 electric power (y2) in the generator mode; electric power MG2 (y3) in motor mode; electric power MG2 (y4) as a generator; electric power HVB (y5) at discharge; electric power HVB (y6) at a charge; HVB self-discharge (y7); capacity HVB (y8).

Parameters associated processes are: noise (s1), vibration (s2), the heat engine (s3), heat power split device (PSD) (s4); heat HVB (s5). Workflow Settings HE are diagnostic parameters, each of which is characterized by the actual value and the rate of its growth [9-10].

Output process parameters are selected according to the criteria of optimality. Evaluation of selected parameters in Table made. 1.

The evaluation, based on the necessary requirements, selected diagnostic parameters y1-y6. Y5-y6 parameters can be used as diagnostic, only in combination with others. Y7-y8 parameters should be used as a private in the determination of the maximum permissible state HVB.

Table 1

Checking the diagnostic parameters for the selected criteria

Criterion \ process parameter	1	2	3	4	5	6	7	8
1. Functional importance for the assessment of the technical condition of the car								
2. Uniqueness depending on an operating vehicle								
3. Sensitivity (informative) in relation to the structural parameters.								
4. Stability in multiple dimensions, characterized by the degree of dispersion.								
5. Ability to separate and identify faults in their place of origin.								
6. Ensure manufacturability and cost in diagnosing/								

Note:

1. Parameter can only be measured over a long period of time
2. Depends on the battery temperature.
3. Could be due to various reasons.
4. More time for preparatory work.

Between structural (S1-S2) and diagnostic (y1-y6) parameters there are relationships (Figure 1), depending on the functional and structural features of the HE.

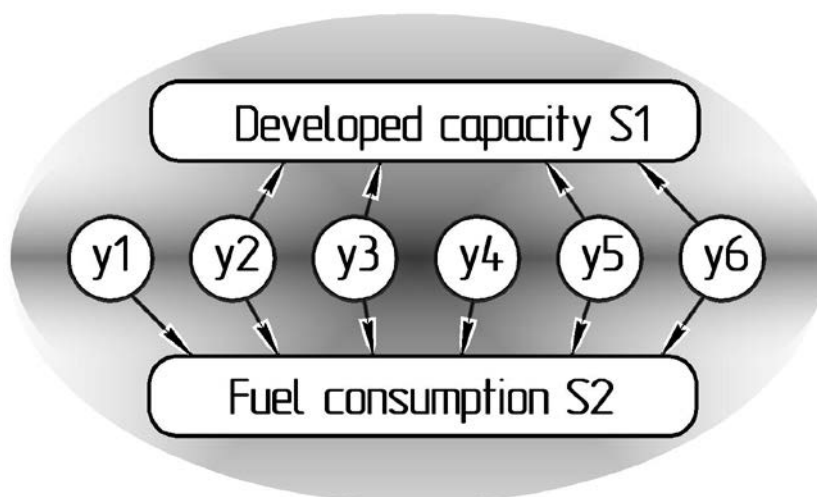
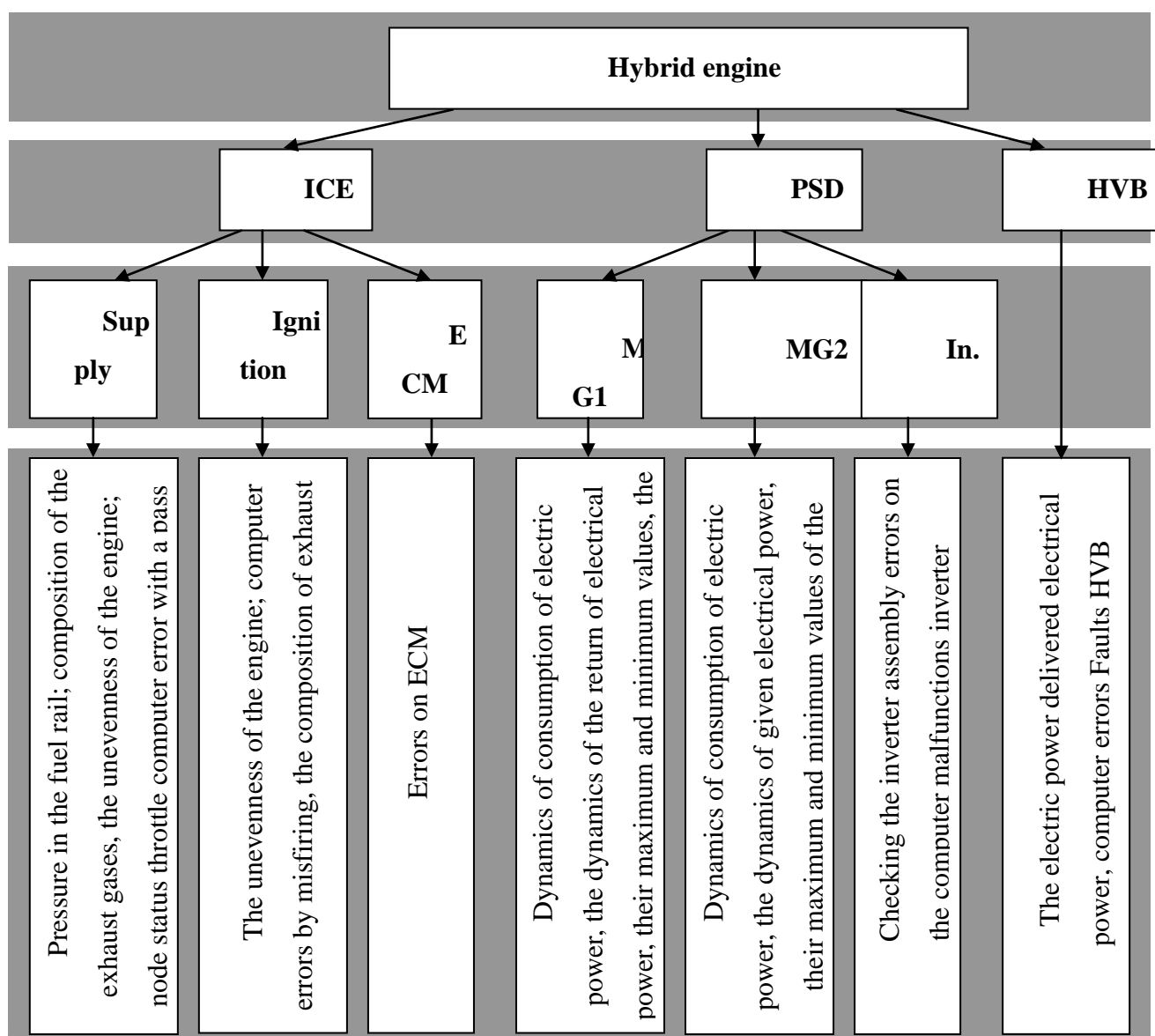


Fig. 1. Relations between structural and diagnostic parameters. y1 - MG1 power mode, kW; y2 - MG1 power a generator kW; y3 - MG2 power mode, kW; y4 - MG2 power a generator, kW; y5 - HVB power in discharge mode, kW; y6 - power HVB in charge mode, kW

Fig. 2 is a block diagram of the major failures by CSO sites.



The list of characteristic faults HE is based on statistical estimates of its reliability indicators.

Below are photos of the most affordable places to set current and voltage sensors in the circuit and the inverter HVB HE.

Fig. 3 left - Chain HVB, Fig. 4 Right - circuit DC bus inverter control MG1, MG2.





Fig. 3. Battery located behind the rear seat backrest. Plot connecting current and voltage sensor high voltage battery

Fig. 4. DC bus of the inverter MG1, MG2 engine compartment. Plot voltage sensors connected inverter.

HE by the proposed method is sufficient to use only 2 parameters: the electric power HVB (y5) at discharge; electric power HVB (y6) at a charge [11].

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DISTINGUISHING FEATURES OF NETWORK WAR AS A NEW KIND OF STRUGGLE

Abstract. This article discusses the new phenomenon of network war as a display of information and network society and also as a threat to international and national security. Identifies the key characteristics of network war that distinguish it from other kinds of wars. It is proved that, because of their characteristics, a new type of struggle difficult to control all parties of the conflict both in peacetime and in wartime.

Keywords: information revolution, information space, network war.

Introduction

Postmodern era in which we live radically changed the modern world. Civilization industrial heritage pushed by new information technologies that are able to be used both for peaceful and military purposes. Information technology revolution has produced more new threats and challenges to national security of distinct countries and the international community as a whole. An important value of modern society, which is based on knowledge, has become an information. This society is information, network.

The founder of the concept of the network society was M. Castells. Its generalized formulation specifies that the network society is a form of social structure that characterized the information society [2]. The network society appears to increase the role of information in society, the possibility of transmission, ways of multichannel communications, the growth of virtual communication, computerization of the population. Exploring the nature of the network society can explain the majority of modern social phenomena, processes and transformations that take place in it. Research of information and network society also provides an opportunity to assess the role of new information technologies, their effects and the impact on society as a whole.

The development of information and network society has generated a new kind of war – the network. Rapidly developing, information technology succeeded in driving the usual means of war, introduced to the world modern methods of military operations. Antagonism has shifted to the information area. Thus "the main weapon for the capture of the state and establishing strategic control over it, has become its own society. Capture is achieved by using a new type of fighting – a network war..."[1].

The term "network war" was proposed by American professors D. Arkvilla and D. Ronfeldtom [3]. They argue that the information revolution, and also the invention of new technologies and changing ways of thinking and actions made an extremely powerful internet space. They explain and "cyberwar" as a result of the information revolution. Network war makes it possible to better understand and explain the new format of the conflicts that engulfed humanity.

Network war differs from all others by a number of features that should be considered.

Firstly, its danger lies in the possibility of leading actions simultaneously in different directions. "Swarming" – by this term D. Arkvilla represents one of the characteristics and methods of the network war operations, and sudden concentration of power is seen as a determining factor in its effectiveness. [8] That is, the number of units from different points strikes a target from different directions in order continued pulsation. "Swarm networks must be able to quickly and secretly gather to attack the target, and then separated and scattered again, being in constant readiness for new pulsating effort" [6]. The professor also said that "in an era of global interconnection, saturated with advanced information technology, even small teams of fighters can cause great damage. There is an old Mongolian proverb: "With 40 soldiers you can turn the world" [5]. However, there is shown a second threat, which is that the enemy still needs to find before you fight him ("Arkvilla and Ronfeldt believe that network war transformed into a new "Hundred Years War", is not the hardest in the world in history, because it is the first time in the history of war when striker is not "[2]).

Thirdly, the ideological feature of networking war is its purpose. She determines that the aim of the war is not to win in direct contact with the enemy, but control and support needed ideas by allies and neutral sides. It is very interesting in this regard the view of Sun Tzu stated in the "Art of War": "... to get one hundred victories in one hundred battles it's not top benefits. Conquer the enemy's army without bringing the battle that's a real top superiority "[7] . This characterization shows that the main task of network operations is informational influence, so that is modeled mass consciousness, to form a model of behavior of the enemy, allies and neutral sides. Sun Tzu also aptly states how to conquer the enemy and get the desirable victory "depicts a favor to tighten it. Create disorder [in his power] and bring it. If the enemy relaxed, forcing him to exert force. If it is united, disconnect him [7]. These abstracts methods aptly formulated disruption of the enemy. Manipulation in this case, is not leaded by a separate entity, but on their intentions, actions and thoughts. [4]

The fourth feature of the network war is in its structure, where there is no hierarchy and single point of control. There abbreviation SPIN, which is somewhat undecided and abstract, but in fact it explains the current structure of the network society – Segmentary, Polycentric, Integrated Network [9]. Thus, network components are core, peripherals and nodes. However, it is not about a military organization system that supports the activities and development of the network war. It is a variety of non-governmental organizations in the field of education, culture and science, which are the centers of the network system. "The work of NGOs is a powerful influence on the mass consciousness. These organizations can organize a variety of socially active people: scientists, students, cultural activists. The result of a variety of seemingly unrelated to each other organizations is to create the correct atmosphere, which is reflected in the overall ideological mood of society "[4]. Again suitably said Sun Tzu that "the means by which enlightened rulers and wise commanders were subordinated others, and their achievements surpassed many were ahead of knowledge. Ahead of knowledge [...] should be obtained from the people, because it is the knowledge of the true state of the enemy. [7] Sun Tzu spoke about the activities of spies who provided the necessary information to management. Today

it is also important. Special agents, investigation, spies, and even a large number of hostile actors in the middle zone of the opponent capable of detecting the truth. Significant role play the society itself, which strongly responds to its own management and developments relating to their society.

So the basic idea of network war is the destruction of fundamental ideas of people about the nature of their culture, society and the state, in order to induce fear, disorient people and makes chaos in their minds. Therefore, a crucial role in the establishment and maintenance of networks will play not the power, but the idea, not the soldiers, but ideology, as well as the possibility and means of information transfer. Since to the principle of network large number of people working with one purpose by different numbers groups, acting agreed, guided by the idea, so their work is effective. Even if the network fails at any point (in node or specific group), anyway it does not stop functioning. Distinction of the network system is that minor failures cannot bring down the system, it is able to reproduce the desired potential and future successful activity.

Conclusions

Information and networking war is a new level of state and non-state management, of the art of war and interstate confrontation. Therefore, in the multi-channel network, both in peacetime and in wartime, there is an intensive exchange of information.

Significant that sense of network war is the formation of public opinion, the disorganization of the enemy, creating chaos, panic, moral and psychological exhaustion, etc.

While most social networks do not control the direction of the states, but more often they used them through their agents of influence. However, keep in mind that the enemy is actively influence on various non-governmental organizations, the media, religious structures and social movements.

Of course, that a society is unable to cope alone with the enemy. However, given that the information and psychological security of society is the primary factor in maintaining the integrity of the country and its physical and moral health, the state should take an active part in monitoring information flows in a network confrontation. In particular, the state should create its own system of exploration, defense and protection so that to detect, prevent and counteract information threats.

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