

# Intellectual Archive

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$$\begin{aligned} \frac{d}{dt} \left( \frac{1}{c^2} \frac{d^2 x}{dt^2} \right) &= \frac{8G}{c^2} \frac{d^2 x}{dt^2} \\ \frac{d}{dt} \left( \frac{1}{c^2} \frac{d^2 y}{dt^2} \right) &= \frac{8G}{c^2} \frac{d^2 y}{dt^2} \\ \frac{d}{dt} \left( \frac{1}{c^2} \frac{d^2 z}{dt^2} \right) &= \frac{8G}{c^2} \frac{d^2 z}{dt^2} \\ \frac{d}{dt} \left( \frac{1}{c^2} \frac{d^2 t}{dt^2} \right) &= \frac{8G}{c^2} \frac{d^2 t}{dt^2} \end{aligned}$$

$$\frac{d}{dt} \left( \frac{1}{c^2} \frac{d^2 x}{dt^2} \right) = \frac{8G}{c^2} \frac{d^2 x}{dt^2} + 10^{-11}$$

# Intellectual Archive

$$\frac{R^2}{2} \frac{1}{c^2} \frac{d^2 \theta}{dt^2} = \frac{8\pi G}{c^4} \frac{T_{\mu\nu}}{H}$$
$$\Omega = 4 \left( \frac{1+2A^2}{1-2A^2} - \frac{A^2 T^2}{A^2 T^2} \right) = A(1+4A^2 - 2A^2 T^2)$$
$$\frac{R^2}{2} \frac{1}{c^2} \frac{d^2 \theta}{dt^2} = \theta^i \wedge \theta^j \wedge \theta^k = \frac{a'}{ab} \frac{b+\pi b'}{7b^2} \theta^i \wedge \theta^j$$
$$\left[ \left( \frac{V_r}{r} \right)^2 + \left( \frac{\partial V_z}{\partial z} \right)^2 \right] + \left( \frac{\partial V_r}{\partial r} + \frac{\partial V_z}{\partial r} \right)^2 + \left( \frac{\partial V_\phi}{\partial r} - \frac{V_\phi}{r} \right)^2 + \left( \frac{\partial V_\phi}{\partial r} + \frac{V_\phi}{r} \right)^2$$
$$\frac{r^2}{c^2} \frac{d^2 \theta}{dt^2} \approx 10^{-10} \div 10^{-11}$$

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Toronto, November 2013

# ALGORITHM OF THE HIDDEN DISTRIBUTION OF CRYPTOGRAPHIC KEYS

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## *Abstract*

This article talks about the algorithm of the hidden distribution of cryptographic keys on open communication channels. Features of the offered algorithm are: first, addition of bits of a transferred cryptographic key in casual bits and their further stochastic hashing with use of the combining generator of pseudorandom sequences with nonlinear Boolean bent-function as complication function; secondly, concealment of a cryptographic key in the file container, which is in advance unknown to the recipient.

**Introduction.** The information security problem from unauthorized access was addressed all the time throughout the history of mankind. Ever since the ancient world two main directions of the solution of this task, existed and remain the same to this day. They are cryptography and steganography [3]. The purpose of cryptography is concealment of contents of messages at the expense of their enciphering. In steganography the fact of existence of the secret message is suppressed.

The main steganography concepts are the message and the container. The message of  $m \in M$  is the secure information which existence is necessary to hide,  $M = \{m_1, m_2, \dots, m_n\}$  – a set of all messages. Unsecure information which can be used for concealment of the message,  $C \in \{c_1, c_2, \dots, c_q\}$  – a set of all containers and  $q \gg n$ , is called as the container  $c \in C$ . The empty container (or the so-called container original) is a container  $c$  which doesn't contain hidden information. The filled container (container result) – container  $c$  - which doesn't contains hidden information of  $m(c_m)$ . One of requirements given: the container result shouldn't be visually differing from the container original.

Any cryptographic system is based on use of cryptographic keys. In symmetric cryptosystem the sender and the recipient of the message use the same confidential key. Process of distribution (mailing) of confidential keys between participants of information exchange in symmetric cryptosystems is rather difficult. Management of keys suggests the information

process including realization of the following main functions: generation, storage and distributions of keys.

Distribution of keys is the most responsible process in management of keys. It demands the following: efficiency and distribution accuracy; confidentiality and integrity of distribution of keys. For distribution of keys between users of a computer network exist the following methods [3]: use of one or several distribution centers of keys; direct exchange of session keys between users of a network.

**Statements of task.** It is necessary to develop algorithm of the hidden direct distribution of cryptographic keys between users of a computer network on open communication channels. It is expedient to apply steganography methods of concealment of information to the hidden distribution of keys in graphic file containers. Authors suggest to use the method of concealment of information offered by them in graphic file containers which aren't coordinated in advance between subscribers and are absent at the recipient of the message.

One of the ways to increase the cryptographic is to add uncertainty into the process of enciphering and concealment of information which can provide use of cryptographic generators of pseudorandom sequences (GOPS). Addition of bits of a cryptographic key in casual bits with the subsequent stochastic hashing of bits under control of the GOPS generator, and also information concealment in the least meaning bits of chromaticity of casual pixels of the graphic representation, which coordinate are defined by other GOPS generator, have to, according to authors, provide crypto firmness of algorithm of the hidden distribution of cryptographic keys.

**The main research of material.** Let's consider mathematical model of a steganosystem. Process of steganography transformation is described by dependences [1, 2]:

$$E: C \times M \rightarrow S \quad (1)$$

$$D: S \rightarrow M \quad (2)$$

where  $E$  direct and  $D$  return steganography transformation;  $S = \{(c_1, m_1), (c_2, m_2), \dots, (c_n, m_n), \dots, (c_q, m_q)\} = \{s_1, s_2, \dots, s_q\}$  – a set of containers results (steganography). Dependence (1) describes process of concealment of information, dependence (2) – extraction of hidden information. Necessary condition thus is lack of "crossing", that is, if  $m_a \neq m_b$  where  $m_a, m_b \in M$  and  $(c_a, m_a), (c_b, m_b) \in S$ , than  $E(c_a, m_a) \cap E(c_b, m_b) = \emptyset$ . Besides it is necessary, that the capacity of a set of  $|C| \geq |M|$ .

Steganosystem – is a set of  $\Sigma = (C, M, S, E, D)$  containers (originals and results), messages and transformations which connect them. By the principle Kerkhgofsa [1, 3], safety of system has to be based on a certain fragment of the secure information – a key which (as a rule, previously) is divided between the authorized persons. The sender, building in the confidential message the chosen container  $c$ , uses steganographic key  $k$ .

If the recipient knows the key, he can read the hidden message from the container. Any extraneous person won't be able to do it without knowledge of the key. Let  $C$  – be a nonempty set, then the  $sim(C) \rightarrow (-\infty, 1]$  is called as similarity function on a set of  $C$  if for any  $(x, y) \in C$  is fair that  $sim(x, y) = 1$  in case of  $x = y$  and  $sim(x, y) < 1$  at  $x \neq y$ . Steganosystem can be considered reliable, if as  $sim[c, E(c, m)] \approx 1$  for all  $m \in M$  and  $c \in C$ , and as the container  $c$  with it has to be chosen such, which wasn't used earlier.

Steganosystem with a secret key name set  $\Sigma = (C, M, S^K, E, D)$ , where  $C$  – a set of the containers originals,  $M$  – a set of confidential messages, and  $|M| \leq |C|$ ,  $S^K$  – a set of containers results, and  $sim(C, S^K) \rightarrow 1$ ;  $K$  – set confidential steganographic key,  $E: C \times M \times K \rightarrow S^K$  and  $D: S^K \times K \rightarrow M$  – functions of a direct and return steganographic conversion with properties  $D[E(c, m, k), k] = m$  for any  $m \in M$ ,  $c \in C$  and  $k \in K$  [1, 2]. Considering the big number of format variations, which could have hidden messages and containers (the text, the sound or video), the preliminary transformation of the message is convenient for embedding and optimizing reserve in the set container a format [1].

$$U: C \times M \times K \rightarrow W, w = U(c, m, k). \quad (3)$$

Randomness of function  $U$  is limited to requirements of stability to different influences on the received container result. Besides, function  $U$  is compound  $U = T \circ G$ , where

$$G: M \times K \rightarrow Z; T: C \times Z \rightarrow W. \quad (4)$$

Function  $G$  can be realized by means of cryptographic GOPS safe generator with  $K$  key as initial value. The operator of  $T$  modifies code words  $Z$  taking into account a container format, the optimum message for embedding as a result turns out. Process of embedding of the message of  $W$  in the container thus can be described the original of  $C$  as superposition of signals:

$$E: C \times V \times W \rightarrow S; s(x, y) = c(x, y) * v(x, y)w(x, y)p(x, y), \quad (5)$$

where  $v(x, y)$  – the mask of embedding of messages which considers, for example, characteristics of visual system of the average person and serves for reduction of a visibility of these messages;  $p(x, y)$  – projecting function which depends on a key; the sign "\*" is meant by the operator of superposition who generally includes, except addition, restriction of level and quantization [1, 2].

Suppose transfer from subscriber A to subscriber B  $k$  cryptographic key length of 256 bits. The steps of the algorithm is a hidden distribution of cryptographic keys through open channels of communication.

1. Five one-dimensional integer arrays  $M_1, M_2, M_3, M_4, M_5$  are created.
2. The  $M_1$  and  $M_2$  arrays on 256 cells, and the arrays  $M_3, M_4, M_5$  on 512 cells.
3. The  $M_1$  array is intended for storage of bits of a cryptographic key.

4. By means of the GOPS generator with a key of  $k_1$  256 casual bits which register in the  $M_2$  array are generated.
5. There is a concatenation of information bits from the  $M_1$  array and casual bits from the  $M_2$  array, the result of concatenation remains in the  $M_3$  array.
6. Process of stochastic hashing of information bits of a cryptographic key and casual bits from the  $M_3$  array copes with the help of the control  $M_4$  array intended for prevention of record of two bits in one cell of the  $M_5$  array. The control  $M_4$  array is initialized previously by zero.
7. The GOPS generator with a key of  $k_2$  generates the next pseudorandom number which undertakes on the module 512 and defines casual number of a cell of the  $M_5$  array in which the next bit from the  $M_3$  array will be written down.
8. If the  $M_5$  array cell with number defined in point №7, is free, in it the next bit from the  $M_3$  array registers and in the control  $M_4$  array the mark that the cell is occupied becomes.
9. If the cell of the  $M_5$  array is occupied that decides on the help of the control  $M_4$  array, steps №7 and №7-8 repeat until the free cell of the  $M_5$  array will be found.
10. Steps of algorithm №7-9 repeat until all 512 bits of the  $M_3$  array will be mixed.

The received 512 bits from the  $M_5$  array need to be hidden in the graphic file container. Let's consider algorithm of used  $p(x, y)$  projecting function. Let us have  $N$  younger bits in the container, and  $n$  of information bits which need to be built in the container. Provided that  $n < N$  information bits can be built in instead of younger bits of elements of the container. Let the file container represent a graphic representation the bmp format  $m \times l$  size. For formation of casual coordinates  $(x, y)$  the next pixel of a graphic representation the younger bit of chromaticity will be used for concealment of the information bit, the generated pseudorandom numbers undertake on the module  $m$  for calculation of value of coordinate  $x$  and on the module  $l$  for  $y$  definition.

Concealment of information bit is carried out on the basis of a method of the least meaning bits as follows: two least meaning bits of chromaticity of pixel if these bits define even number or 0 they are analyzed, and it is necessary to hide the zero information bit, the least meaning bit isn't modified but if it is required to hide single information bit there is a modification of the least meaning bit. In a case when two least meaning bits of chromaticity of pixel define odd number, and it is necessary to hide single information, the least meaning bit isn't modified when it is required to hide zero bit, the least meaning bit is modified.

Process of embedding of information bits in younger bits of casual pixels of the image copes with the help of the GOPS generator with a confidential steganographic key of  $k_3$  and the control massif which use prevents concealment of two information bits in one pixel. The recipient of the message without having the initial container original, but knowing length of the message and a confidential steganographic key of  $k_3$  can take at first hidden information, and then having carried out the return stochastic shift to restore the transferred cryptographic key having rejected casual bits.



**Conclusions.** Let's consider combinatory methods of an assessment of crypto firmness of the developed algorithm of the hidden distribution of cryptographic keys. These methods serve for an assessment of complexity of breaking of this or that algorithm of enciphering and are usually fair for a case of attack of the code "in a forehead" or in a different way a method of "brute force" (brute force). The essence of this method consists in calculation of number of possible combinations which the malefactor needs to touch for breaking. For the offered algorithm crypto firmness is provided at the expense of "admixture" of casual bits to an initial cryptographic key and their subsequent stochastic shift by means of the GOPS generator. Crypto firmness of algorithm directly depends on the size of a cryptographic key, number of casual bits and quality of GOPS. Authors used combining GOPS generator with nonlinear Boolean bent-function as complication function.

Let's assume that it is necessary to transfer a cryptographic key 256 bits long which added with 256 casual bits, and then stochastic mixed information and casual bits. Among the received 512 bits will be both casual, and information bits. As in advance to establish quantity 0 and 1 it is almost impossible, consider them approximately identical. A formula used for number of shifts with repetitions, will receive quantity of the options necessary for full search:

$$N_{options} = \frac{512!}{256! \cdot 256!} \approx 4.72 \cdot 10^{152}$$

Proceeding from these values it is possible to draw a conclusion that stochastic shifts with "admixture" of casual bits to the cryptographic key, realized in this algorithm, increase its resistance to breaking methods on the basis of full search, and concealment of the key ciphered thus in the graphic file container complicates to the malefactor detection of the fact of transfer of a key and extraction of this key from a graphic representation without knowledge of a steganographic key. This algorithm was realized in the environment of Aribasw, showed the working capacity and can be used as algorithm of the hidden distribution of cryptographic keys on open communication channels.

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# APPLICATION OF ELLIPTIC CURVES AND GAMMING FOR INFORMATION SECURITY FROM UNAUTHORIZED ACCESS

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**Introduction.** Elliptic curves are one of the main objects of studying in the modern theory of numbers and cryptography. The elliptic cryptography forms the independent section of cryptography devoted to studying of cryptosystems on the basis of elliptic curves. In particular, the Russian standard of the digital signature is based on elliptic curves GOST R 34.10-2001. Under "gaming" in this article is understood as addition of points of the elliptic curve corresponding to symbols of the alphabet with points of an elliptic curve, corresponding to "gamma". "Gamma" – pseudorandom sequence of points of an elliptic curve or the points corresponding to symbols of some other text.

**The main research of material.** The elliptic curve — mathematical object [3, page 13] which can be defined over any field and is described by the cubic equation of the following look:

$$y^2 + cxy + dy = x^3 + ex^2 + fx + g$$

Where c, d, e, f and g are the real numbers meeting some conditions. Newton proved that over a field of real numbers any elliptic curve can be transformed, by means of replacement of coordinates (1) to a look (2) (Weierstrass's formula).

$$X = \frac{l_1(x,y)}{l_3(x,y)} \quad Y = \frac{l_2(x,y)}{l_3(x,y)} \quad l_i \neq 0 \quad (1)$$

$$y^2 = x^3 + a * x + b \quad (2)$$

To find points of intersection of an elliptic curve with abscissa axis it is necessary to solve the cubic equation by means of formulas Cardano.

$$x^3 + a * x + b = 0$$

The discriminant of this equation looks like:

$$D = \left(\frac{a}{3}\right)^3 + \left(\frac{b}{2}\right)^2$$

If  $D < 0$ , the equation has three various valid a root  $\alpha$ ,  $\beta$ ,  $\gamma$  (figure 1).

If  $D = 0$ , the equation has three valid roots, we will assume  $\alpha$ ,  $\beta$ ,  $\beta$ , at least, two of them are equal (figure 2).

If  $D > 0$ , the equation has one valid root  $\alpha$  and two in a complex interfaced (figure 3).

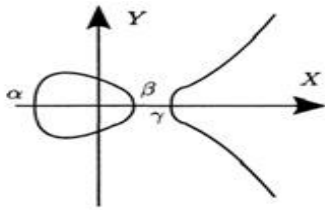


Figure 1.  $D < 0$

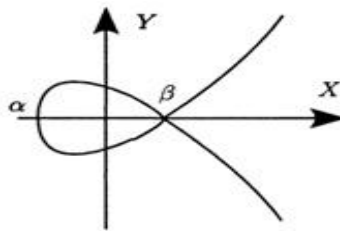


Figure 2.  $D = 0$

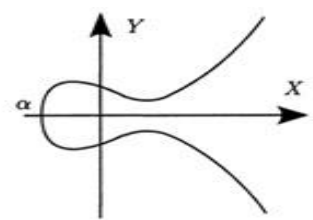


Figure 3.  $D > 0$

Points of an elliptic curve can be read. Subtraction of points of an elliptic curve (figure 4) is realized as follows: let's assume that it is necessary to find a difference of points of  $R$  and  $Q$ . For this purpose it is necessary to display a point of  $R$  of symmetrically  $OX$  axis and to receive  $R_1$  point. Putting points of  $R_1$  and  $Q$  it is received their sum —  $P_1$  point, then it is necessary to display a point of  $P_1$  of symmetrically  $OX$  axis and as a result we receive a point  $P$  being a difference of points of  $R$  and  $Q$ .

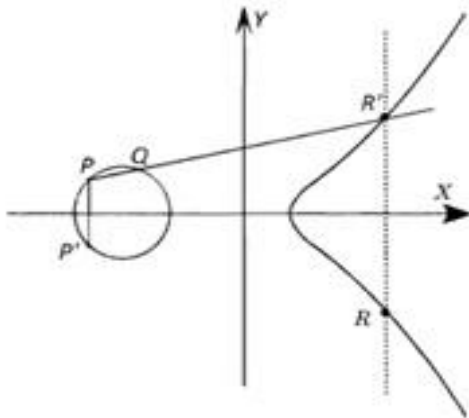


Figure 4. Subtraction of points of EC

Addition of points of an elliptic curve is equivalent to multiplication of numbers in not elliptic cryptography (figure 5).

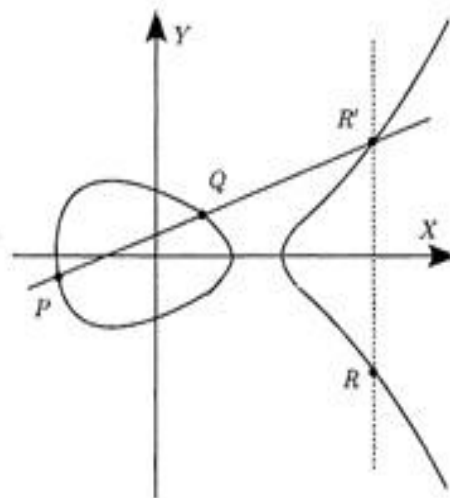


Figure 5. Addition of points of EC

The sum of two points, in turn, also belongs to an elliptic curve and has coordinates which are calculated on the following formulas:

$$\lambda = \frac{y_2 - y_1}{x_2 - x_1}, \text{ if } P \neq Q \text{ and}$$

$$\lambda = \frac{3x_1^2 + \alpha}{2y_1}, \text{ if } P = Q,$$

Where  $\lambda$ — angular coefficient of a secant and  $x_1, x_2, y_1, y_2$ — coordinates of points

$$P = (x_1, y_1), Q = (x_2, y_2), P + Q = T(x_3, y_3)$$

$$x_3 = \lambda^2 - x_1 - x_2 \text{ mod } p$$

$$y_3 = \lambda * (x_1 - x_3) - y_1 \text{ mod } p.$$

Important property of a set of points of an elliptic curve consists that they form Abel group. Let's consider the elliptic curve which has been set over a field of material numbers. In this case the elliptic curve will represent a flat curve and  $O$  "in infinity" point. Let  $E$  — an elliptic curve over a field of material numbers, and  $P$  and  $Q$  — two points on  $E$ . Let's determine points  $-P$  and  $P+Q$  by the rules given below [1, page. 70].

Rule 1. Points  $P = (x, y)$  and  $-P$  have identical coordinates  $x$ , and their coordinates of  $y$  differ only with a sign,  $-(x, y) = (x, -y)$  [2, page. 82].

Rule 2. If  $P$  and  $Q$  have various coordinates  $x$  direct  $l=PQ$  has with  $E$  in accuracy one point of intersection of  $R$  except two cases: when direct  $l$  appears tangent  $P$  in a point (then we believe  $R=P$ ) or a tangent in  $Q$  (then  $R=Q$ ). Define now the sum of points of  $P+Q$  as  $R$  point.

The following algorithm is applied to realization of algorithm of stochastic enciphering and "gamming" with use of Abel group of points of an elliptic curve:

1. For each communication session by means of the generator of pseudorandom sequence (GOPS) №1 with a key of  $k_1$  the new alphabet with check on uniqueness of a symbol to which there corresponds some point lying on an elliptic curve is created.
2. For each communication session by means of the generator of pseudorandom sequence (GOPS) №1 with a key of  $k_1$  the new alphabet with check on uniqueness of each symbol to which there corresponds some point lying on an elliptic curve is created.
  3. Read out from the file block by block source text subject to enciphering.
  4. Define serial numbers of symbols of the block of a source text in the generated alphabet.
    - 4.1 Set quantity of casual symbols with which the block of a source text will "be diluted".
    - 4.2 Generate casual symbols by means of №2 GOPS with a key of  $k_2$  and we define serial numbers of these symbols in the alphabet.
    - 4.3 Create the one-dimensional integer massif with a length equal to quantity of only a few symbols of the block of a source text plus quantity of the generated casual symbols. Write down to the massif serial numbers of these symbols in the alphabet. Using №3 GOPS with  $k_3$  key, stochastic mix elements of this massif.
5. The alphabet generated in point 1 registers to the two-dimensional massif.

6. By means of №4 GOPS with a key of  $k_4$  it is carried out cyclic shifts of lines and columns of the two-dimensional massif received in the previous point, thereby carry out stochastic hashing of the alphabet for each ciphered symbol.

7. Read out from the one-dimensional massif received in point 4.3, serial number in the alphabet of the next ciphered symbol and carry out replacement of this number by the corresponding serial number from the alphabet mixed in point 6, in such a way there is a stochastic replacement of each symbol.

8. Make the enciphering based on an elliptic curve as follows:

8.1 Define generating point of  $G$  elliptic curves.

8.2 Generate a random number of  $k$ .

8.3 The user chooses as an open key any point of  $P_B$  of an elliptic curve, and as a confidential key some number of  $n_B$ . The equation looks like:

$$C_m = \{k * G, P_m + k * P_B\} \quad (9)$$

where  $P_m$  - a point of an elliptic curve corresponding to a ciphered symbol.

9. Read out from the key file the next scales symbol.

10. Put the points of an elliptic curve corresponding to a symbol of a source text and a scales symbol.

11. The result of enciphering is written down in the file.

Secret key in this system of enciphering are “gamma” symbols and keys of GOPS generators.

Deciphering happens as follows:

1. Read out from the corresponding files the next symbol of the ciphered text and a scale symbol.

2. Find a difference of points of the elliptic curve corresponding to a symbol of the ciphered text and a symbol of gamma.

3. Apply the following the equation:

$$P_m + k * P_B - n_B * (k * G) = P_B + k * (n_B * G) - n_B * (k * G) \quad (10)$$

4. Having received the deciphered coordinates of points of EC, define serial numbers of the symbols corresponding to these coordinates, that is replacement symbols which write down to the one-dimensional massif.

5. For definition of serial numbers of symbols of a source text and casual symbols carry out the return cyclic shifts of lines and columns two-dimensional massif in which the alphabet is written down. Read out from the one-dimensional massif received in point 4, serial number in the alphabet of the next ciphered symbol and carry out its replacement by the

corresponding serial number from the two-dimensional massif with the alphabet. The serial numbers of symbols got thus register to the one-dimensional massif.

6. With the help of №3 GPSP with a key of  $k_3$  it is rejected casual symbols in the one-dimensional massif from point 5 and restore an initial order of initial symbols.

Let's estimate computing firmness of the offered algorithm of stochastic enciphering with use of Abel group of points of an elliptic curve. The generated alphabet for each communication session contains 144 symbols and includes capital and lower case letters of the Latin alphabet and Cyrillic, and also punctuation marks and other necessary symbols. If the module on which there are calculations, is equal, for example,  $p = 751$ , the number of points on this elliptic curve makes  $n = 727$ . The total of various alphabets can be counted on a formula  $A_n^m = \frac{n!}{(n-m)!}$  for number of placements. As  $n=727$ , and  $m=144$ . Use of cyclic shifts of lines and columns of the two-dimensional massif to which the generated alphabet is written down, defines stochastic hashing of elements of this massif therefore any symbol of the alphabet can be replaced on any other. If, for example, length of initial dough makes 1000 symbols, quantity of possible options that makes about  $10^{2158}$ . For unauthorized access to information the malefactor needs to define also what of the deciphered symbols are casual, and then to reject these casual symbols and to restore an initial sequence in the text of initial symbols.

**Conclusions.** The offered algorithm of stochastic enciphering with use of Abel group of points of an elliptic curve differs from existing algorithms that for each communication session the new unique alphabet in which to each symbol of the alphabet there correspond coordinates of some point on an elliptic curve is generated; then the source text is supplemented with casually generated symbols and by means of the generator of pseudorandom sequences there is their stochastic hashing, further there is a stochastic replacement of each symbol which is ciphered with use of casual parameter. Stochastic transformation of the initial information which is subject to protection against unauthorized access, allows to increase crypto firmness from breaking by a method of full search. This algorithm was realized in the environment of Aribasw and C# (SHARP), successfully passed test for correctness of results of enciphering and deciphering and can be used for information security from unauthorized access.

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## POSSIBLE WAYS OF INFORMATION SECURITY ON THE HIDDEN CHANNEL IN ELECTRO DIGITAL SIGNATURE

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**Introduction.** In computer networks the creation of the hidden data link using algorithms of the digital signature (DS) is possible. The hidden channel – is an unforeseen by the developer communication channel on which messages can be transferred.

Let's say that for realization of the hidden communication channel subscribers A and B exchange confidential messages, and don't want anyone to learn their contents. In that case A and B can simply cipher the messages by means of symmetric or asymmetric cryptosystem. But what if some party C, given the power, can force A and B to open the keys and, thereby, to read contents of the sent letters [3]. Then the subscribers A and B should transfer the messages on the hidden communication channel.

**The main research of material.** Examples of DS on the basis of Onga-Shnorra-Shamira and Elgamal can be examples of it:

1) For realization of the hidden communication channel on the basis of Onga-Shnorra-Shamira DS, the subscriber A creates the unclassified electronic digital letter which signs the DS. Let's consider algorithm of creation of the hidden data link:

1. It is necessary to generate simple number of p.

$p = 20965\_57522\_55599\_48381\_65640\_12682\_89294\_80366\_27757\_04125\_85321.$

2. It is necessary to generate simple number of q.

$q = 524\_13938\_06389\_98709\_54141\_00317\_07232\_37009\_15693\_92603\_14633.$

3. Let's find multiplication of simple numbers of p and q,

$$n = p \times q;$$

$n = 109\_88883\_61346\_53270\_11519\_55309\_94082\_21433\_82869\_49067\_30074\_98751\_09077\_70284\_21779\_75910\_88737\_35685\_76934\_77622\_54173\_02193.$

4. The subscriber A, chooses a random number of k the smallest common factor  $(k, n) = 1$ , as a confidential key, and safe image transfers to the subscriber of B.

$k = 101\_38471\_35900\_09972\_41845\_07521\_12418\_54002\_29300\_24391\_39080\_52433\_88030\_17857\_85033\_54028\_57616\_38594\_50522\_62960\_45698\_08558.$

5. Calculate an open key of DS on a formula:

$$h = -k^{-2}(\text{mod } n);$$

$h = 106\_87870\_09061\_52833\_61191\_83933\_52053\_17318\_65530\_00604\_35905\_82962\_46703\_49048\_65535\_67486\_08392\_19351\_49936\_28845\_03235\_29065.$

6. Find M- a document hash value.

$M = 1382\_84847\_09165\_00511\_11918\_70517\_30116\_45583\_99521\_29616.$

7. Hidden message, (example: "The appearance is failed Petrov the traitor, communication on the spare channel. "), cipher in the form of r number.

$r=33341\_20134\_17181\_60301\_13061\_50134\_17062\_01816\_03341\_71806\_05012\_00613\_28341\_90333$ .

8. Calculate the first part of DS, on a formula:

$$S_1 = \frac{1}{2} \left( \frac{M}{r} + r \right) \bmod r \quad (1)$$

$S_1=108\_26089\_00102\_01367\_24697\_41536\_81577\_31147\_90246\_28873\_59350\_68774\_71930\_68760\_78681\_63442\_25996\_57098\_18051\_47207\_25418\_03135$ .

9. Calculate the second part of DS, on a formula:

$$S_2 = \frac{k}{2} \left( \frac{M}{r} - r \right) \bmod n \quad (2)$$

$S_2=23\_04330\_44609\_99093\_36824\_22900\_31352\_18910\_36684\_11661\_84201\_71445\_01324\_73699\_70302\_73771\_10316\_37970\_47167\_31875\_92211\_25785$ .

10. Check of authenticity of DS, is carried out on a formula:  $M' = (S_1^2 + hS_2^2) \bmod n$ . The checking party C can be convinced that the signature is original, and given DS and the signature to it in an explicit form doesn't contain hidden information. Hidden information can be received by calculations on the following formula:  $R = \frac{M}{S_1 + \frac{S_2}{k}}$  (3). Let's prove that these

calculations allow to take hidden information. Let's replace in a formula (3),  $S_1$  of (1) and  $S_2$  of (2). Receive,  $\frac{M}{\frac{1}{2} \left( \frac{M}{r} + r \right) + \frac{\frac{k}{2} \left( \frac{M}{r} - r \right)}{k}} = \frac{M}{\frac{1}{2} \left( \frac{M}{r} + r + \frac{M}{r} - r \right)} = \frac{M}{\frac{1}{2} \times \frac{2M}{r}} = r$ . Therefore, the proof of the hidden data link is investigated, true.

2) Let's consider the organization of the hidden channel on the basis of DS of Elgamal with the compound module, based on complexity of the solution of a problem of factorization. Application in schemes of DS similar to system of Elgamal, the compound module instead of the simple is connected with that the large number of such schemes that don't provide resistance to the attacks based on calculation of the signature by selection of parameter  $r$  in the form [4]  $r = a^t y^u \bmod p$ . In such attacks the knowledge of function of Euler from the module, therefore can be eliminated with use of the compound module.

A number of possible schemes of realization of DS with the compound module is presented in table 1 [4].

Table 1. DS options with the compound module.

№ n/n	Check equation Signatures	Equation of formation of the signature	Signature
1	$r^H = y^r \alpha^S \bmod n$	$kH = xr + S \bmod q'$	$(r, S)$
2	$\alpha^H = y^r r^S \bmod n$	$H = xr + kS \bmod q'$	$(r, S)$
3	$r^H = y^{r^S} \bmod n$	$kH = xrS \bmod q'$	$(r, S)$
4	$r^H = y^{r+S^2} \bmod n$	$kH = xr + S^2 \bmod q'$	$(r, S)$

Where  $n$  - the compound module representing multiplication of large simple numbers  $p$  and  $q$  - document hash value;  $H$  - confidential key;  $y$  - open key;  $q'$  - the generated large simple number of 160-256 bits in size being a divider of large simple numbers;  $p-1$  and  $q-1$  - parameter which contains the confidential message;  $\alpha$  - the smallest number, such that;  $\alpha^{q'} \bmod n = 1$  the DS  $r$  parameter is calculated on a formula:  $r = \alpha^k \bmod n$  [4];  $(r, S)$  couple of numbers represents document DS.

On the basis of the offered DS, the hidden channel is organized as follows. Let the hidden channel transfer a confidential message M: "Shares of the company X will grow!". Previously the



subscriber A and B agree about a method of enciphering of the confidential message M. The hidden message substitutes for number  $k$ , and other steps of algorithm of formation of DS don't change.

As hidden information of the transferred electronic document with DS value of parameter serves:  $k = 1125522424253432351133242451133423411142434443$ .

At a preparatory stage of formation of the signature the subscriber A chooses two big simple numbers  $p$  and  $q$  multiplies them, receiving the module:

$$n = p \times q \quad (1)$$

Value  $n$  is accepted as part of an open key  $(y, n)$ , and values of simple multipliers are kept a secret or destroyed after calculation:

$$\varphi(n) = (p-1)(q-1) \quad (2)$$

The subscriber A chooses as a secret key  $x$  any number smaller than  $n$ . This number is used not only for the message signature, but also as a key for sending and reading the hidden message.

The same as for the signature of the electronic document the open key  $y$  calculated on a confidential key  $x$  is used:

$$y = \alpha^x \bmod n \quad (3)$$

For the potential violator at the equation of generation of the signature there are two unknown sizes:  $x$  and  $k$ . Therefore it has no opportunity with a high probability to calculate a confidential key  $x$ .

Length of number  $\alpha$  can be chosen rather small (less than a size of used values  $p$  and  $q$ ); the number  $\alpha$  has to satisfy to the following equation:

$$\alpha^q \bmod n = 1 \quad (4)$$

The subscriber A signs the electronic document, hiding in the signature the hidden message  $k$ . On the equation of formation of the signature from the scheme by 1 subscriber A it is calculated  $r$  and  $S$ :

$$r = \alpha^k \bmod n, \quad (5)$$

$$kH = xr + S \bmod q'. \quad (6)$$

Procedure of checking the authenticity of the electronic document signed with the help of a digital signature with the compound module, happens as follows. The recipient has a transferred electronic document with a digital signature  $(r, S)$ . Subscriber B knows the secret key  $x$ , open key  $y$ , and a compound module  $n$ .

The equation of check of DS, according to the scheme 1 (see table 1) looks like:

$$r^H = y^r \alpha^S \bmod n. \quad (7)$$

The left part  $lp$  and right part  $rp$  members of equation are calculated separately:

$$lp = r^H \bmod n, \quad (8)$$

$$rp = y^r \alpha^S \bmod n. \quad (9)$$

If both members of equation of check are equal, the digital signature corresponds to the document and it can be considered original. If results differ, the signature counterfeit.

For recovery of hidden information the recipient needs to calculate  $k$  from the equation of formation of the signature 1 (table 1):

$$k = \frac{xr + S}{H} \bmod q'. \quad (10)$$

The subscriber B calculates  $k$ , and then makes operation of decoding of the hidden message on in advance known to subscribers A and B algorithm and a key.

Lack of the organization of the hidden channel on a basis above the offered schemes of DS is need of transfer of a confidential key  $x$  to the subscriber B. The specified shortcoming can be overcome using schemes of formation and check of DS of Elgamal with the compound module, given in table 2.

Table 2. DS options with the compound module for formation of the hidden channel without knowledge of a confidential key.

<b>№ n/n</b>	<b>Check equation Signatures</b>	<b>Equation of formation of the signature</b>	<b>Signature</b>
<b>1</b>	$r^S = \alpha^{r+H} \bmod n$	$kS = r + H \bmod q'$	$(r, S)$
<b>2</b>	$F(r) = F(\alpha^{SH * F(r)} \bmod n)$	$k = SH * F(r) \bmod q'$	$(F(r), S)$
<b>3</b>	$F(r) = F(\alpha^{SH + F(r)} \bmod n)$	$k = SH + F(r) \bmod q'$	$(F(r), S)$
<b>4</b>	$r' = (\alpha^{Sr'+H} \bmod n) \bmod g$	$k = Sr' + H \bmod q'$	$(r', S)$

Where  $F$  - some difficult reversible squeezing function,  $g$  - simple number 160-256 bits long ( $g \neq q'$ ),  $r' = r \bmod g$ .

For program realization of the hidden channel on the basis of schemes of DS of ElGmal with the compound module, presented in table 1 and 2, language of object-oriented programming of Java and the environment of programming of NetBeans IDE 7.0.1 is chosen. The Java language possesses such advantages as multitasking, support of the Internet protocols and a multiplatform.

Let's consider results of realization of algorithm of the hidden channel on the basis of the first scheme of DS with the compound module, from table 2, in the Java programming language in the environment of NetBeans IDE 7.0.1:

At a preparatory stage we generate large simple number  $p, q, q'$ : 256 bits in size:

$q' = 23096956678164115651437\ 3612860150572827242382955591950668225474862$   
 $195232833177.$

$p = 212596176165563265380698002518616824871229031456052408962244683801$   
 $561135279774893.$

$q = 8005208736322670069373713934363914893508301956845390717373862346417$   
 $07605366260215.$

Compound module  $n = 18634731178399553393445422055225217906696381624222$   
 $9087273454348308841138633489472992838255278921996225358512148710454998127128796$   
 $982446438468729893364472099641269.$

Choose the smallest number  $\alpha$ , such that  $\alpha^{q'} \bmod n = 1$ :  $\alpha = 43333$ : then the subscriber A chooses a confidential key  $x$ , any number smaller than  $n$ :

Secret key  $x = 1865956567500816360436111850039724044944261261672768$   
 $531827962123727123172427196.$

Confidential information of the small size cipher by means of in advance coordinated between subscribers A and B cryptalgorithm and use the received number as the parameter which is used as the hidden channel for transfer of the confidential message to

$M = 1255224242534323511332424511334234111424344\ 43.$

Then we calculate an open key  $y$  on a formula  $y = \alpha^x \bmod n$ :

$y=718409304170893547573742367082629313436646361597082799365562741824224$   
 $4432859289408775225738458435711955560432519274767342950647891586737806112321301$   
 $397625873297.$

Calculate the DS parameter  $r$  using a formula  $r = \alpha^k \bmod n$  :

$r=162517230411921445797853440646105022921728249070749433989224276620654$   
 $2298910950044729621467780260391731187887375233000301240805866678674568025726202$   
 $0603994134196.$

Then with a formula  $S = \frac{r+H}{k} \bmod q'$  we calculate parameter  $S$ , couple of numbers will be a digital signature of this document ( $r, S$ ):

$S=217978963086132416663196552107546965867339260503691558062969389885$   
 $0338444090429.$

For DS check, the software calculates separately the left and right parts of the following equation  $r^S = \alpha^{r+H} \bmod n$ .

Left part of equation of check:

$lp=14941670315228224439879977397230156003997866295584258823814575067877$   
 $4723301765521287588209593262025205134060329145350887334768927007186534837339764$   
 $185835564825794.$

Right part of equation of check:

$rp=1494167031522822443987997739723015600399786629558425882381457506787747$   
 $2330176552128758820959326202520513406032914535088733476892700718653483733976418$   
 $5835564825794.$

Both members of equation of check are equal, therefore, the digital signature corresponds to the electronic document and it can be considered original.

As measures of protection from the organization of the hidden data link schemes with the simplified equation of check the signatures presented in table 3 [4] are offered. Based on complexity of extraction of roots on the compound module, in these schemes a digital signature is the number which is calculated on a formula:

$$r = \alpha^k \bmod n. \quad (11)$$

For calculation  $k$  on known  $r$  and  $n$ , a problem of discrete logarithming, effective algorithm solution to which doesn't exist, needs to be solved.

Table 3. Schemes with the simplified equation of verification of the signature.

<b>№ n/n</b>	<b>Check equation Signatures</b>	<b>Formulas for value k calculation</b>	<b>Open key</b>
<b>1</b>	$r^y = y^H \bmod n$	$k = \frac{xH}{y} \bmod q'$	$(y, n)$
<b>2</b>	$r^v = y^H \bmod n$	$k = \frac{xH}{v} \bmod q'$	$(y, n)$
<b>3</b>	$r^H = y \bmod n$	$k = \frac{x}{H} \bmod q'$	$(y, n)$
<b>4</b>	$r^{H^v} = y \bmod n$	$k = xH^{-v} \bmod q'$	$(y, n)$
<b>5</b>	$r^H = \alpha \bmod n$	$k = H^{-1} \bmod q'$	$(\alpha, n)$
<b>6</b>	$r^{H^v} = \alpha \bmod n$	$k = H^{-v} \bmod q'$	$(\alpha, n)$

**Conclusions.** In schemes of DS presented in table 1, the organization of the hidden data link is possible, but for this purpose it is necessary to transfer to the subscriber B a confidential key  $x$ . While, in the schemes presented in table 2, the organization of the hidden data link is possible without transfer of a confidential key  $x$ .

As protection against the organization of the hidden data link authors suggest to use schemes with the simplified equation of check the signatures presented in table 3 in which realization of the hidden channel since finding of parameter  $k$  from the equation of verification of the signature is a problem of finding of a discrete logarithm not solved generally so far isn't possible.

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**SYNTHESIS AND STUDY OF THE ACTOPROTECTIVE ACTIVITY OF 4-R-5-ADAMANTANE-1-YL-3(ALKYLTHIO)-4-H-1,2,4-TRIAZOLES, 2-(4-R-5-ADAMANTANE-1-YL-4H-1,2,4-TRIAZOLE-3-YLTHIO)ACETIC ACIDS AND THEIR SALTS.**

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Keywords: derivatives of 1,2,4-triazoles, physico-chemical properties, actoprotective activity

**ABSTRACT**

Synthesized new S-derivatives of 5-(adamantane-1-yl)-4-R-4H-1,2,4-triazoles-3-thiols: 3-alkyl-5-(adamantane-1-yl)-4-R-4H-1,2,4-triazoles, 2-(5-(adamantane-1-yl)-4-R-4H-1,2,4-triazoles-3-ylthio)acetate acids and their salts, where R-methyl, phenyl. It studied the structure and physico-chemical properties of the synthesized compounds, investigated their actoprotective activity.

The problem of physical and mental fatigue is a scourge in today's society. The last decade there has been a tendency to increase working hours and workload of workers and managers. So people suffer from fatigue, which leads to stress and various

diseases. When the rest can not solve this problem, doctors use actoprotectors. Namely drugs that enhance mental and physical activity. But they have a number of side effects.

Derivatives of 1,2,4-triazoles show different types of activities: antioxidant, hypolipidemic, hypocholesterolemic, hepatoprotective, antimicrobial and others [1, 3, 4, 5, 7, 8].

**The target** of our work was the synthesis of s-derivatives of 5-(adamantane-1-yl)-4-R-4H-1,2,4-triazoles-3-thiols: 3-alkyl-5-(adamantane-1-yl)-4-R-4H-1,2,4-triazoles, 2-(5-(adamantane-1-yl)-4-R-4H-1,2,4-triazoles-3-ylthio)acetic acids and its salts, where R-methyl, phenyl and study of their actoprotective activity.

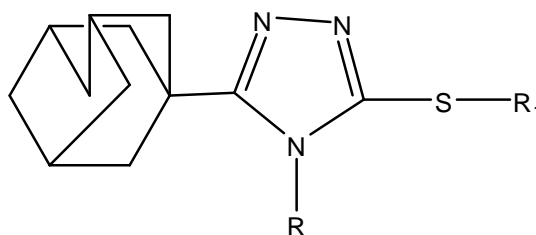
### **Materials and methods**

**The objects of study** are 4-R-5-adamantane-1-yl-3-(alkylthio)-4H-1,2,4-triazoles, 2-(4-R-5-adamantane-1-yl-4H-1,2,4-triazoles-3-ylthio)acetic acids and their salts.

As starting materials we have used 2-(adamantane-1-yl)-N-phenylhydrazinecarbothioamide and 2-(adamantane-1-yl)-N-methylhydrazinecarbothioamide which were synthesized by reaction of adamantane-1-carboxylic acid, hydrazide with phenylisothiocyanate and methylisothiocyanate accordingly in the base of methyl alcohol. Synthesis of 5-(adamantane-1-yl)-4-R-4H-1,2,4-triazoles-3-thiols was carried out by cyclization of 2-(adamantane-1-yl)-N-phenylhydrazinecarbothioamide and 2-(adamantane-1-yl)-N-methylhydrazinecarbothioamide in an alkaline base. Getting 3-alkylthio-5-(adamantane-1-yl)-4-R-4H-1,2,4-triazoles by the addition of  $\alpha$ -halogenalkanes to the corresponding 5-(adamantane-1-yl)-4-R-4H-1,2,4-triazolo-3-thiols in n-butanol base. For 2-(5-(adamantane-1-yl)-4-R-4H-1,2,4-triazoles-3-ylthio) of acetic acids in isopropanol base to 5-(adamantane-1-yl)-4-R-4H-1,2,4-triazoles-3-thiol was added an equivalent amount of sodium hydroxide, the precipitate was dissolved by heating and added monochloroacetic acid in aqueous solution. The salts of the corresponding acids were obtained by interaction of corresponding acids (compounds I, II, Table 1.) With organic (morpholine, piperidine, diethanolamine, diethylamine, monoethanolamine), inorganic bases (aqueous ammonia, potassium hydroxide) and salts (zinc sulfate, iron (III) chloride) in alcoholic or aqueous media.

Therefore, got compounds are white crystalline substances (compound I, Ia, Ib, Ic, Id, Ie, If, Ig, II, IIa, IIb, IIc, IId, IIE, IIe, IIf, IIg Table 1.; III, IIIb, IV, IVa, IVc, IVd, IVE Table 2.), light yellow (compound IIIId, IIIg, IVf, IVh, IVi Table 2.), yellow (compound IVg Table 2.) light brown (compounds IIIa, IIIc, IIIe, IIIf, Table IVb. 2). For analysis the obtained compounds were recrystallized from methanol or i-propanol or n-butanol. Physico-chemical constants of the obtained compounds are given in Table. 1 and 2.

Table 1

Physico-chemical constants of 3-R<sub>1</sub>thio 5-(adamantane-1-yl)-4-R-1,2,4-triazoles

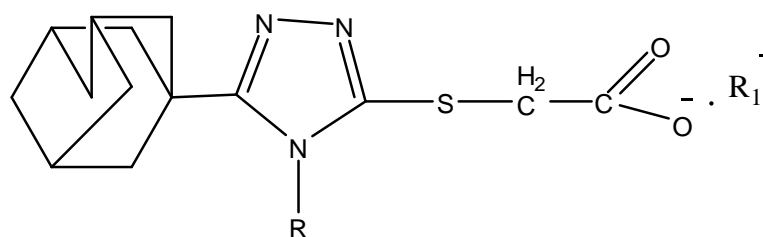
No compounds	R	R <sub>1</sub>	T. of melt., °C	Formula	result, %
I	CH <sub>3</sub>	H	235-237	C <sub>13</sub> H <sub>19</sub> N <sub>3</sub> S	73,40
II	C <sub>6</sub> H <sub>5</sub>	H	132-133	C <sub>18</sub> H <sub>21</sub> N <sub>3</sub> S	78,67
Ia	CH <sub>3</sub>	H-C <sub>4</sub> H <sub>9</sub>	>230	C <sub>17</sub> H <sub>27</sub> N <sub>3</sub> S	73,77
Ib	CH <sub>3</sub>	H-C <sub>5</sub> H <sub>11</sub>	>230	C <sub>18</sub> H <sub>29</sub> N <sub>3</sub> S	74,50
Ic	CH <sub>3</sub>	H-C <sub>6</sub> H <sub>13</sub>	>230	C <sub>19</sub> H <sub>31</sub> N <sub>3</sub> S	80,52
Id	CH <sub>3</sub>	H-C <sub>7</sub> H <sub>15</sub>	>230	C <sub>20</sub> H <sub>33</sub> N <sub>3</sub> S	75,54
Ie	CH <sub>3</sub>	H-C <sub>8</sub> H <sub>17</sub>	178-180	C <sub>21</sub> H <sub>35</sub> N <sub>3</sub> S	76,12
If	CH <sub>3</sub>	H-C <sub>9</sub> H <sub>19</sub>	>230	C <sub>22</sub> H <sub>37</sub> N <sub>3</sub> S	73,33
Ig	CH <sub>3</sub>	H-C <sub>10</sub> H <sub>21</sub>	>230	C <sub>23</sub> H <sub>39</sub> N <sub>3</sub> S	77,17
IIa	C <sub>6</sub> H <sub>5</sub>	H-C <sub>4</sub> H <sub>9</sub>	>230	C <sub>22</sub> H <sub>29</sub> N <sub>3</sub> S	69,72
IIb	C <sub>6</sub> H <sub>5</sub>	H-C <sub>5</sub> H <sub>11</sub>	105-108	C <sub>23</sub> H <sub>31</sub> N <sub>3</sub> S	65,57
IIc	C <sub>6</sub> H <sub>5</sub>	H-C <sub>6</sub> H <sub>13</sub>	>230	C <sub>24</sub> H <sub>33</sub> N <sub>3</sub> S	66,45
IId	C <sub>6</sub> H <sub>5</sub>	H-C <sub>7</sub> H <sub>15</sub>	>230	C <sub>25</sub> H <sub>35</sub> N <sub>3</sub> S	72,51
IIe	C <sub>6</sub> H <sub>5</sub>	H-C <sub>8</sub> H <sub>17</sub>	150-152	C <sub>26</sub> H <sub>37</sub> N <sub>3</sub> S	70,11
IIIf	C <sub>6</sub> H <sub>5</sub>	H-C <sub>9</sub> H <sub>19</sub>	>230	C <sub>27</sub> H <sub>39</sub> N <sub>3</sub> S	71,42
IIg	C <sub>6</sub> H <sub>5</sub>	H-C <sub>10</sub> H <sub>21</sub>	>230	C <sub>28</sub> H <sub>41</sub> N <sub>3</sub> S	65,74

No compounds	found, %				calculated, %			
	C	H	N	S	C	H	N	S
I	62,45	7,70	16,82	12,83	62,61	7,68	16,85	12,86
II	69,21	6,82	13,53	10,31	69,42	6,80	13,49	10,30
Ia	67,01	8,93	13,72	10,48	66,84	8,91	13,76	10,50
Ib	67,82	9,12	13,17	10,07	67,66	9,15	13,15	10,04
Ic	68,21	9,39	12,62	9,58	68,42	9,37	12,60	9,61
Id	69,30	9,54	12,13	9,26	69,11	9,57	12,09	9,23
Ie	69,54	9,78	11,63	8,90	69,75	9,76	11,62	8,87
If	70,17	9,90	11,21	8,55	70,35	9,93	11,19	8,54
Ig	70,72	10,07	10,81	8,24	70,90	10,09	10,78	8,23

IIa	72,06	7,92	11,40	8,69	71,89	7,95	11,43	8,72
IIb	72,25	8,17	11,04	8,43	72,40	8,19	11,01	8,40
IIc	73,05	8,39	10,59	8,13	72,87	8,41	10,62	8,11
IId	73,08	8,60	10,28	7,81	73,30	8,61	10,26	7,83
IIe	73,93	8,78	9,95	7,54	73,71	8,80	9,92	7,57
IIf	73,91	8,97	9,63	7,34	74,09	8,98	9,60	7,33
IIg	74,59	9,12	9,33	7,11	74,45	9,15	9,30	7,10

Table 2

Physico-chemical constants of 2-(5-(adamantane-1-yl)-4-R-4H-1,2,4-triazoles-3-ylthio)acetic acids and their salts



No compounds	R	R <sub>1</sub>	T. of melt., °C	Formula	result, %
III	CH <sub>3</sub>	H	140-142	C <sub>15</sub> H <sub>21</sub> N <sub>3</sub> O <sub>2</sub> S	67,65
IV	C <sub>6</sub> H <sub>5</sub>	H	156-158	C <sub>20</sub> H <sub>23</sub> N <sub>3</sub> O <sub>2</sub> S	65,24
IIIa	CH <sub>3</sub>	1/3Fe	184-185	C <sub>45</sub> H <sub>60</sub> FeN <sub>9</sub> O <sub>6</sub> S <sub>3</sub>	84,11
IIIb	CH <sub>3</sub>	½ Zn	>230	C <sub>30</sub> H <sub>40</sub> N <sub>6</sub> O <sub>4</sub> S <sub>2</sub> Zn	85,54
IIIc	CH <sub>3</sub>	morpholinum	60-62	C <sub>19</sub> H <sub>30</sub> N <sub>4</sub> O <sub>3</sub> S	66,40
IIId	CH <sub>3</sub>	piperidinum	96-98	C <sub>20</sub> H <sub>32</sub> N <sub>4</sub> O <sub>3</sub> S	64,96
IIIe	CH <sub>3</sub>	diethylaminum	98-100	C <sub>19</sub> H <sub>32</sub> N <sub>4</sub> O <sub>2</sub> S	68,82
IIIf	CH <sub>3</sub>	diethanolaminum	58-60	C <sub>19</sub> H <sub>32</sub> N <sub>4</sub> O <sub>4</sub> S	67,41
IIIg	CH <sub>3</sub>	monoethanolaminum	134-136	C <sub>17</sub> H <sub>28</sub> N <sub>4</sub> O <sub>3</sub> S	51,63
IVa	C <sub>6</sub> H <sub>5</sub>	K	76-77	C <sub>20</sub> H <sub>22</sub> KN <sub>3</sub> O <sub>2</sub> S	69,59
IVb	C <sub>6</sub> H <sub>5</sub>	1/3Fe	>230	C <sub>60</sub> H <sub>66</sub> FeN <sub>9</sub> O <sub>6</sub> S <sub>3</sub>	88,77
IVc	C <sub>6</sub> H <sub>5</sub>	½ Zn	>230	C <sub>40</sub> H <sub>44</sub> N <sub>6</sub> O <sub>4</sub> S <sub>2</sub> Zn	89,77
IVd	C <sub>6</sub> H <sub>5</sub>	NH <sub>4</sub>	167-169	C <sub>20</sub> H <sub>26</sub> N <sub>4</sub> O <sub>2</sub> S	65,89
IVe	C <sub>6</sub> H <sub>5</sub>	morpholinum	184-186	C <sub>24</sub> H <sub>32</sub> N <sub>4</sub> O <sub>3</sub> S	68,62
IVf	C <sub>6</sub> H <sub>5</sub>	piperidinum	160-162	C <sub>25</sub> H <sub>34</sub> N <sub>4</sub> O <sub>2</sub> S	69,07
IVg	C <sub>6</sub> H <sub>5</sub>	monoethanolaminum	50-52	C <sub>22</sub> H <sub>30</sub> N <sub>4</sub> O <sub>3</sub> S	52,08
IVh	C <sub>6</sub> H <sub>5</sub>	diethanolaminum	71-73	C <sub>24</sub> H <sub>34</sub> N <sub>4</sub> O <sub>4</sub> S	69,40
IVi	C <sub>6</sub> H <sub>5</sub>	diethylaminum	175-177	C <sub>24</sub> H <sub>34</sub> N <sub>4</sub> O <sub>2</sub> S	70,94

No	found, %	calculated, %
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compounds	C	H	N	S	C	H	N	S
III	58,43	6,87	13,66	10,46	58,61	6,89	13,67	10,43
IV	64,85	6,28	11,40	8,67	65,01	6,27	11,37	8,68
IIIa	55,59	6,18	12,96	9,88	55,43	6,20	12,93	9,87
IIIb	52,97	5,96	12,36	9,48	53,13	5,94	12,39	9,46
IIIc	57,99	7,68	14,17	8,14	57,84	7,66	14,20	8,13
IIId	61,01	8,20	14,24	8,19	61,19	8,22	14,27	8,17
IIIe	59,79	-	14,76	8,40	59,97	-	14,72	8,43
IIIf	55,48	7,84	13,60	7,75	55,32	7,82	13,58	7,77
IIIg	55,54	7,67	15,16	8,72	55,41	7,66	15,20	8,70
IVa	58,26	-	10,34	7,85	58,44	-	10,31	7,87
IVb	61,87	5,75	10,84	8,29	62,06	5,73	10,86	8,28
IVc	59,73	5,54	10,49	7,96	59,88	5,53	10,47	7,99
IVd	61,96	6,77	14,47	8,32	62,15	6,78	14,50	8,30
IVe	63,29	7,04	12,30	7,04	63,13	7,06	12,27	7,02
IVf	65,85	7,52	12,35	7,07	66,05	7,54	12,32	7,05
IVg	61,55	7,03	13,04	7,44	61,37	7,02	13,01	7,45
IVh	60,59	7,21	11,82	6,77	60,73	7,22	11,80	6,76
IVi	64,92	7,77	12,64	7,24	65,13	7,74	12,66	7,24

**5-(adamantane-1-yl)-4-methyl-4H-1,2,4-triazoles-3-thiol and 5-(adamantane-1-yl)-4-phenyl-4H-1,2,4-triazolo-3-thiol (6, 7, table1.)**

**A.** 0.15 mol of KOH is added to an aqueous solution of 0.1 mol of 2-(adamantane-1-yl)-N-methylhydrazinecarbothioamide or 2-(adamantane-1-yl)-N-phenylhydrazinecarbotioamide and boiled for 1 hr. It is neutralized by acetic acid. It is formed a white precipitate, which was filtered and recrystallized (dioxane:water, 20:1)

**3-alkylthio-5-(adamantane-1-yl)-4-R-4H-1,2,4-triazoles**

0.01 mol of NaOH is added to 0.01 mol of 5-(adamantane-1-yl)-4-R-4H-1,2,4-triazoles-3-thiol, where R – phenyl or methyl, in butanol base. It is heated to the dissolving of the precipitate. It is added 0.01 mol of halogenalkanes (1-brombutane or 1-brompentane or 1-bromhexane or 1-bromheptane or 1-bromoktane or 1-bromnonane or 1-bromdekane). It is boiled to the neutral pH base. It is evaporated. It is recrystallized from n-butanol. It is received such substances (Ia – Ig, IIa – IIg, table1.).

**2-(5-(adamantane-1-yl)-4-methyl-4H-1,2,4-triazoles-3-ylthio)acetic acids and 2-(5-(adamantane-1-yl)-4-phenyl-4H-1,2,4-triazoles-3-ylthio)acetic acids (9, 17, tabl. 2).**

**A.** 0.01 mol of NaOH is added to 0.01 mol of 5-(adamantane-1-yl)-4-R-4H-1,2,4-triazoles-3-thiol, where R – phenyl or methyl, in 40 ml of i-propanol. The mixture was heated to the dissolving of the precipitate pre-dissolved in a minimum amount of water 0.01 mol of monochloroacetic acid is gradually added. The reactive mixture is boiled for 5 hours, cooled. It is added 40 ml of water. It is formed a white precipitate. For further analysis the substances (I, II, table 2.) are recrystallized from i-propanol.

**Salts of 2-(5-(adamantane-1-yl)-4-R-4H-1,2,4-triazoles-3-ylthio)acetic acids (compounds Ia – Ib, IIa – IIg, table2).**

**A.** 0.01 mole of monoethanolamine and morpholine or piperidine or diethanolamine or diethylamine is added to a solution of 0.01 mol of 2-(5-(adamantane-1-yl)-4-R-4H-1,2,4-triazoles-3-ylthio)acetic acids in 30 ml of i-propanol, correspondently, is heated in a water bath to the dissolving of the precipitate. It is evaporated. It is washed by the diethyl ester, dried, recrystallized from methanol (13, 20, 21, 48, table 2.), i-propanol (12, 14, 15, 16, table 2.), n-butanol (18, 19, table 2).

**B.** 0.01 mol of KOH is added to a solution of 0.01 mol of 2-(5-(adamantane-1-yl)-4-R-4H-1,2,4-triazoles-3-ylthio)acetic acids in 30 ml of water. It is dissolved by heating and adding 0.005 mol of ZnSO<sub>4</sub>. The precipitate that formed was filtered and washed by water, dried, and get substances (89, 90, table 2).

**C.** 0.01 mol of KOH is added to a solution of 0.01 mol of 2-(5-(adamantane-1-yl)-4-R-4H-1,2,4-triazoles-3-ylthio)acetic acids in 30 ml of water. It is dissolved by heating and adding 0.0033 mol of FeCl<sub>3</sub>. The precipitate that formed was filtered and washed by water, dried, and get substances (91, 92, table 2).

**D.** 0.01 mol of NH<sub>4</sub>OH or KOH are added to a solution of 0.01 mol of 2-(5-(adamantane-1-yl)-4-R-4H-1,2,4-triazoles-3-ylthio)acetic acids in 30 ml of water. The solution was heated on a water bath to the total dissolving of the precipitate. It is evaporated and recrystallized from methanol, and get substances (10, 11, table 2).

## **RESULTS OF THE RESEARCH AND DISCUSSIONS**

The structure of all synthesized compounds by us, is confirmed by the complex using of modern physico-chemical methods of analysis: elemental, IR-, UV-spectroscopy, PMR-spectrometry, and its individuality is made by the method of thin layer chromatography [6].

In IR-spectra of compounds I, II band fluctuations groups are present characteristic for the nucleus of 1,2,4-triazoles: NH– in the range of 3400-3100  $\text{cm}^{-1}$ , –C=N – 1690-1620  $\text{cm}^{-1}$ . There are also band fluctuations of –C–S groups at 705-570  $\text{cm}^{-1}$ . There are bands fluctuations within the 2600-2550  $\text{cm}^{-1}$ , which may indicate to the presence in the molecule of –SH groups.

There are band fluctuations groups characteristic for the nucleus of 1,2,4-triazoles: NH– in the range of 3400-3100  $\text{cm}^{-1}$ , –C=N – 1690-1620  $\text{cm}^{-1}$  studying in IR-spectra of compounds Ia – Ig, IIa – IIg. There are also present band fluctuations groups –C–S – at 705-570  $\text{cm}^{-1}$ . There are band fluctuations characteristic for –CH<sub>3</sub> group within 2975-2950  $\text{cm}^{-1}$  and group –CH<sub>2</sub> – 2940-2915  $\text{cm}^{-1}$ .

In IR-spectra of compounds III, IV (Fig. 1) there are bands fluctuations groups characteristic for the nucleus of 1,2,4-triazoles: NH– in the range of 3400-3550  $\text{cm}^{-1}$ , –C=N – 1690-1620  $\text{cm}^{-1}$ . There are also present band fluctuations of –C–S – groups at 705-570  $\text{cm}^{-1}$  and there are no fluctuations bands within the 2600-2550  $\text{cm}^{-1}$ , which may indicate to the presence in the molecule of –SH groups. There are band fluctuations characteristic for group –COOH within 1725-1700  $\text{cm}^{-1}$ .

In the study of IR-spectra of compounds IIIa – IIIg, IVa – IVi we found the bands of valent fluctuations of NH– groups within 3400-3550  $\text{cm}^{-1}$ , group –C=N – at 1690-1620  $\text{cm}^{-1}$ . It is found characteristic fluctuations of –COO<sup>–</sup> groups within the 1420-1300  $\text{cm}^{-1}$  and 1610-1550  $\text{cm}^{-1}$ . There are characteristic fluctuations of –NH<sub>2</sub><sup>+</sup> groups within the 1620-1560  $\text{cm}^{-1}$ , –NH<sub>3</sub><sup>+</sup> groups within 1620-1560  $\text{cm}^{-1}$  and –OH within 1000-1075  $\text{cm}^{-1}$ .

The study was conducted on a group of white non-linear rats weighing 200-260 g. In the study of actoprotective activity we used the method of forced swimming with a load of 10 % of the rat's weight [2]. The load was fixed at the base of the animal's tail. Swimming was performed to exhaustion, which was fixed after 10-seconds immersion of laboratory animals under water. Rats were individually immersed in a container of a large size of the layer of water that exceeds 60 cm. Water temperature was 24-26<sup>0</sup> C. The researched compounds and standard of comparison – riboxinum was injected intraperitoneally 20 minutes prior the animals' diving at a dose of 100 mg/kg. The time

of swimming is recorded in seconds. A control group of animals that received saline intraperitoneally 20 minutes before the diving was also used in comparison.

Table 3

Actoprotective activity of s-derivatives 5-(adamantane-1-yl)-4-R-4H-1,2,4-triazoles-3-thiols in comparison with riboxinum

№ 3/π	code compounds/group	Average duration of forced rats' swimming, M±m	P	Correlation in comparison with control group, Δ%
1	control	227,71±8,692		0
2	IVg	194,14±13,984	>0,05	-14,74
3	IIC	257,29±16,475	>0,05	12,99
4	IVa	293,00±12,877	<0,05	28,67
5	IIf	274,71±21,198	>0,05	20,64
6	IIIe	301,29±10,877	<0,05	32,31
7	IIIc	223,86±14,395	>0,05	-1,69
8	IIE	96,00±10,335	<0,05	-57,84
9	III	75,43±7,467	<0,05	-66,88
10	Riboxinum	278,00±23,639	>0,05	22,08

The study of actoprotective activity (table 3) of s-derivatives of 5-(adamantane-1-yl)-4-R-4H-1,2,4-triazoles-3-thiols indicates that given compound show actoprotective activity in the range of 66,88 – 32,31 %. Diethylammonium 2-(5-(adamantane-1-yl)-4-methyl-4H-1,2,4-triazoles-3-ylthio) acetate (compound IIIe), which contains C<sub>5</sub> carbon atom of 1,2,4-triazole cycle adamantane-1-yl substituent methyl radical to C<sub>4</sub> carbon atoms, a carboxyl group and the cation of diethylammonium has the most expressed actoprotective activity of 32,31 % (P < 0.05).

IIC, IIf, IVa compounds have showed moderate actoprotective activity increasing action with the interval of 12,99 – 28,67 %. It is identified a compound, which is in 6,59 % higher than the standard in comparison with riboxinum. It is potassium 2-(5-(adamantane-1-yl)-4-phenyl-4H-1,2,4-triazoles-3-ylthio) acetate (compound IVa),

containing phenyl radical cation and potassium the replacement of which is on cation monoethanolammonium (IVg) was accompanied by a reduction of up to 14,74 % ( $P > 0,05$ ).

The replacement of diethylammonium cation on the cation of morpholine in diethylammonium 2-(5-(adamantane-1-yl)-4-methyl-4H-1,2,4-triazoles-3-ylthio) acetate reduces the actoprotective activity (compound IIIe, IIIc).

Introduction of potassium cation leads to increased activity, whereas methyl substitution on phenyl radical in the molecule of potassium 2-(5-(adamantane-1-yl)-4-phenyl-4H-1,2,4-triazoles-3-ylthio) acetate reduces the actoprotective activity (compound IVa).

Reducing of the carbon chain in the molecule of 3-(adamantane-1-yl)-5-(oktylthio)-4-phenyl-4H-1,2,4-triazoles to 3-(adamantane-1-yl)-5-(hexylthio)-4-phenyl-4H-1,2,4-triazoles leads to a slight increase of activity, to the enlargement of the number of carbon atoms to 3-(adamantane-1-yl)-5-(nonylthio)-4-phenyl-4H-1,2,4-triazoles contributes to actoprotective action of (compound IIc, IIe, IIf).

### Conclusions

1. It is synthesized a series of new compounds of 5-(adamantane-1-yl)-4-R-4H-1,2,4-triazoles-3-thiols, the structure of which was confirmed by the complex using of modern physico-chemical methods of analysis.
2. The researched compounds are derivatives of 5-(adamantane-1-yl)-4-R-4H-1,2,4-triazoles-3-thiols which show actoprotective activity.
3. Diethylammonium 2-(5-(adamantane-1-yl)-4-methyl-4H-1,2,4-triazoles-3-ylthio) acetate has the most expressed actoprotective activity of 32,31 % ( $P < 0,05$ ) the activity of which is greater than the known standard drug riboxinum on 10,23 %.

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# **A PHYSICAL SPLITTING METHOD FOR THE SOLUTION OF A PROBLEM OF SPREAD OF HARMFUL SUBSTANCES INTO THE ATMOSPHERE**

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## *Abstract*

In the work of research, forecasting and monitoring of the air mass of the atmosphere of industrial regions, a mathematical model and an efficient numerical algorithm, based on the method of splitting into physical processes, is developed and analysis are done by numerical calculations on a computer.

Relevance. Despite the global economic crisis, the volume of gross domestic product has been increasing steadily. New industrial manufacturing facilities, that significantly affect the natural environment, are being built. The volume of waste substances, those contain harmful impurities and higher temperature, is increasing. Forming thermals, these things spread into the atmosphere at various distances and create harmful compounds. Falling into the soil and water, these substances damage the wildlife: deteriorate productivity of farmland and cause the loss of products' quality; create unsanitary conditions for the population, and so on. It makes conceived to solve this acute problem on a global scale.

In this connection, it is necessary to develop a modern system of monitoring, forecasting and decision management by using IT-technologies, methods of modeling and computer simulation for the solutions of aforementioned problem.

Materials and methods. A mathematical model of the process of transfer and diffusion of pollutants emitted into the environment from industrial objects is described using the full equations of fluid mechanics, based on the laws of

conservation of mass and momentum, the corresponding initial and boundary conditions [1-4]:

$$\begin{aligned} & \frac{\partial \theta(x, y, z, t)}{\partial t} + u \frac{\partial \theta(x, y, z, t)}{\partial x} + v \frac{\partial \theta(x, y, z, t)}{\partial y} + \\ & + (w - w_g) \frac{\partial \theta(x, y, z, t)}{\partial z} + \sigma \theta(x, y, z, t) = \\ & = \mu \left( \frac{\partial^2 \theta(x, y, z, t)}{\partial x^2} + \frac{\partial^2 \theta(x, y, z, t)}{\partial y^2} \right) + \\ & + \frac{\partial}{\partial z} \left( \gamma(z) \frac{\partial \theta(x, y, z, t)}{\partial z} \right) + Q(x, y, z, t), \end{aligned} \quad (1)$$

$$\theta(x, y, z, 0) = \theta_0(x, y, z), \quad \text{when } t=0 \quad (2)$$

$$\theta(x, y, z, t) \Big|_{x=0, x=a} = \theta(x, y, z, t) \Big|_{y=0, y=b} = 0, \quad (3)$$

$$\gamma \frac{\partial \theta(x, y, z, t)}{\partial n} = -\varpi_g \sin \alpha \theta(x, y, z, t) + \beta \theta(x, y, z, t) - f_0(x, y, z, t) \quad \text{on } G_{pz}, \quad (4)$$

$$\gamma \frac{\partial \theta(x, y, z, t)}{\partial z} = 0 \quad \text{on } G_H, \quad (5)$$

which are settled in the area of  $D = (0 < x < a, 0 < y < b, 0 < z < H, t > 0)$ .

Here  $\theta(x, y, z, t)$  - the amount of spreading material,  $t$  - time  $x, y, z$  - coordinates  $u, v, w$  - wind velocity components in directions  $x, y, z$ , respectively,  $w_g$  - settling velocity of a particle,  $\gamma_z$  - the coefficient of turbulent mixing,  $\mu$  - the coefficient of diffusion,  $\sigma$  - absorption coefficient  $\alpha$  - the slope of surface area,  $\beta$  - coefficient of interaction with the underlying surface,  $Q(x, y, z, t)$  - power of sources,  $f(x, y, z,$



t) - the number of aerosol particles detached from rough earth's surface,  $G_{pz}$ ,  $G_H$  - respectively the boundary surface of the earth where precipitation or absorption of harmful substances is occurred, boundary of the upper layer of the atmosphere where transfer or diffusion of particles doesn't occur vertically.

Mathematical model of the object of study is described by two physical processes: the first - the process of transferring substances into the environment in the direction of motion of the air mass of the atmosphere, the second - the process of molecular diffusion of substances in the atmosphere.

The formulation of the problem shows that obtaining a solution by using analytical methods is difficult. For the numerical solution of the problem we assume that the solution sought is a smooth function in all spaces[5]. The process of transfer of substances from its conservation along the trajectory will be considered as a first problem:

$$\frac{\partial \theta_1}{\partial t} + u \frac{\partial \theta_1}{\partial x} + v \frac{\partial \theta_1}{\partial y} + (w - w_g) \frac{\partial \theta_1}{\partial z} = -\frac{1}{2} \sigma \theta_1 + \frac{1}{2} f; \quad (6)$$

$$\theta_1(x, y, z, 0) = \theta_2^n(x, y, z), \quad \text{при } t = t_n \quad (7)$$

$$\theta_1(x, y, z, t) \Big|_{x=0, x=a} = \theta_1(x, y, z, t) \Big|_{y=0, y=b} = 0, \quad (8)$$

$$\gamma \frac{\partial \theta_1(x, y, z, t)}{\partial n} = -\varpi_g \sin \alpha \theta_1(x, y, z, t) + \beta \theta_1(x, y, z, t) - f_0(x, y, z) \text{ on } G_{pz}, \quad (9)$$

$$\gamma \frac{\partial \theta_1(x, y, z, t)}{\partial z} = 0 \quad \text{on } G_H. \quad (10)$$

and 2-nd problem is diffusion of substances, taking into account their absorption in the air mass of the atmosphere:

$$\frac{\partial \theta_2}{\partial t} - \mu \frac{\partial^2 \theta_2}{\partial x^2} - \mu \frac{\partial^2 \theta_2}{\partial y^2} - \frac{\partial}{\partial z} (\gamma \frac{\partial \theta_2}{\partial z}) = -\frac{1}{2} \sigma \theta_2 + \frac{1}{2} f; \quad (11)$$

$$\theta_2(x, y, z, t_j) \Big|_1 = \theta_1^{j+1}(x, y, z, t_{j+1}); \quad (12)$$

$$\theta_2 \Big|_{x=0, L_1} = \theta_2 \Big|_{y=0, L_2} = 0; \quad \theta_2 \Big|_{z=0, H} = 0. \quad (13)$$

To solve the problem (6) - (10) using a finite-difference method, we approximate the differential operators on the difference and get [6-7]:

$$\begin{aligned} & \frac{\theta_{1,i,j,k}^{n+1/3} - \theta_{1,i,j,k}^n}{\Delta t/3} + u \frac{\theta_{1,i+1,j,k}^{n+1/3} - \theta_{1,i-1,j,k}^{n+1/3}}{2h_1} + v \frac{\theta_{1,i,j+1,k}^n - \theta_{1,i,j-1,k}^n}{2h_2} + \\ & + (w - w_g) \frac{\theta_{1,i,j,k+1}^n - \theta_{1,i,j,k-1}^n}{2h_3} = -\frac{1}{3} \sigma \theta_{1,i,j,k}^{n+1/3} + \frac{1}{3} f_{i,j,k}^n; \end{aligned} \quad (14)$$

$$\begin{aligned} & \frac{\theta_{1,i,j,k}^{n+2/3} - \theta_{1,i,j,k}^{n+1/3}}{\Delta t/3} + u \frac{\theta_{1,i+1,j,k}^{n+1/3} - \theta_{1,i-1,j,k}^{n+1/3}}{2h_1} + v \frac{\theta_{1,i,j+1,k}^{n+2/3} - \theta_{1,i,j-1,k}^{n+2/3}}{2h_2} + \\ & + (w - w_g) \frac{\theta_{1,i,j,k+1}^{n+1/3} - \theta_{1,i,j,k-1}^{n+1/3}}{2h_3} = -\frac{1}{3} \sigma \theta_{1,i,j,k}^{n+2/3} + \frac{1}{3} f_{i,j,k}^{n+1/3}; \end{aligned} \quad (15)$$

$$\frac{\theta_{1,i,j,k}^{n+1} - \theta_{1,i,j,k}^{n+2/3}}{\Delta t/3} + u \frac{\theta_{1,i+1,j,k}^{n+2/3} - \theta_{1,i-1,j,k}^{n+2/3}}{2h_1} + v \frac{\theta_{1,i,j+1,k}^{n+2/3} - \theta_{1,i,j-1,k}^{n+2/3}}{2h_2} +$$

$$+(w - w_g) \frac{\theta_{1,i,j,k+1}^{n+1} - \theta_{1,i,j,k-1}^{n+1}}{2h_3} = -\frac{1}{3} \sigma \theta_{1,i,j,k}^{n+1} + \frac{1}{3} f_{i,j,k}^{n+2/3}; \quad (16)$$

Instead of (14) - (16) we can write

$$\frac{\theta_{1,i,j,k}^{n+1/3} - \theta_{1,i,j,k}^n}{\Delta t/3} + u \frac{\theta_{1,i+1,j,k}^{n+1/3} - \theta_{1,i-1,j,k}^{n+1/3}}{2h_1} = (L_2^n + L_3^n) - \frac{1}{3} \sigma \theta_{1,i,j,k}^{n+1/3} + \frac{1}{3} f_{i,j,k}^n; \quad (17)$$

$$\frac{\theta_{1,i,j,k}^{n+2/3} - \theta_{1,i,j,k}^{n+1/3}}{\Delta t/3} + v \frac{\theta_{1,i,j+1,k}^{n+2/3} - \theta_{1,i,j-1,k}^{n+2/3}}{2h_2} = (L_1^{n+1/3} + L_3^{n+1/3}) - \frac{1}{3} \sigma \theta_{1,i,j,k}^{n+2/3} + \frac{1}{3} f_{i,j,k}^{n+1/3}; \quad (18)$$

$$\frac{\theta_{1,i,j,k}^{n+1} - \theta_{1,i,j,k}^{n+2/3}}{\Delta t/3} + (w - w_g) \frac{\theta_{1,i,j,k+1}^{n+1} - \theta_{1,i,j,k-1}^{n+1}}{2h_3} = (L_1^{n+2/3} + L_2^{n+2/3}) - \frac{1}{3} \sigma \theta_{1,i,j,k}^{n+1} + \frac{1}{3} f_{i,j,k}^{n+2/3}; \quad (19)$$

By grouping the terms of equation (17) we get:

$$\frac{u \Delta t/3}{2h_1} \theta_{1,i+1,j,k}^{n+1/3} + \left(1 + \frac{\Delta t/3}{3} \sigma\right) \theta_{1,i,j,k}^{n+1/3} - \frac{u \Delta t/3}{2h_1} \theta_{1,i-1,j,k}^{n+1/3} = F_{1,i,j,k}$$

$$\text{or } a_i \theta_{1,i+1,j,k}^{n+1/3} + b_i \theta_{1,i,j,k}^{n+1/3} - c_i \theta_{1,i-1,j,k}^{n+1/3} = d_i$$

$$\text{whereat } a_i = \frac{u \Delta t/3}{2h_1}; \quad b_i = 1 + \frac{\Delta t/3}{3} \sigma; \quad c_i = \frac{u \Delta t/3}{2h_1}; \quad d_i = F_{1,i,j,k}$$

$$F_{1,i,j,k} = (L_2^n + L_3^n) \theta_{1,i,j,k}^n + \theta_{1,i,j,k}^n + \frac{\Delta t/3}{3} f_{1,i,j,k}^n$$

and with (18) we get:

$$\frac{v\Delta t/3}{2h_2}\theta_{1,i,j+1,k}^{n+2/3} + \left(1 + \frac{\Delta t/3}{3}\sigma\right)\theta_{1,i,j,k}^{n+2/3} - \frac{v\Delta t/3}{2h_2}\theta_{1,i,j-1,k}^{n+2/3} = F_{2,i,j,k}$$

$$\text{or } \bar{a}_i\theta_{1,i,j+1,k}^{n+2/3} + \bar{b}_i\theta_{1,i,j,k}^{n+2/3} - \bar{c}_i\theta_{1,i,j-1,k}^{n+2/3} = \bar{d}_i$$

$$\text{whereat } \bar{a}_i = \frac{v\Delta t/3}{2h_2}; \quad \bar{b}_i = 1 + \frac{\Delta t/3}{3}\sigma; \quad \bar{c}_i = \frac{v\Delta t/3}{2h_2}; \quad \bar{d}_i = F_{2,i,j,k}$$

$$F_{2,i,j,k} = (L_1^{n+1/3} + L_3^{n+1/3})\theta_{1,i,j,k}^{n+1/3} + \theta_{1,i,j,k}^{n+1/3} + \frac{\Delta t/3}{3}f_{2,i,j,k}^n$$

in place of (19) we get:

$$\frac{(w-w_g)\Delta t/3}{2h_3}\theta_{1,i,j,k+1}^{n+1} + \left(1 + \frac{\Delta t/3}{3}\sigma\right)\theta_{1,i,j,k}^{n+1} - \frac{(w-w_g)\Delta t/3}{2h_3}\theta_{1,i,j,k-1}^{n+1} = F_{3,i,j,k}$$

$$\text{or } \bar{a}_i\theta_{1,i,j,k+1}^{n+2/3} + \bar{b}_i\theta_{1,i,j,k}^{n+2/3} - \bar{c}_i\theta_{1,i,j,k-1}^{n+2/3} = \bar{d}_i$$

$$\text{whereat } \bar{a}_i = \frac{(w-w_g)\Delta t/3}{2h_3}; \quad \bar{b}_i = 1 + \frac{\Delta t/3}{3}\sigma; \quad \bar{c}_i = \frac{(w-w_g)\Delta t/3}{2h_3};$$

$$\bar{d}_i = F_{3,i,j,k}, \quad F_{3,i,j,k} = (L_1^{n+2/3} + L_2^{n+2/3})\theta_{1,i,j,k}^{n+2/3} + \theta_{1,i,j,k}^{n+2/3} + \frac{\Delta t/3}{3}f_{3,i,j,k}^n$$

As,

$$\theta_1|_{x=0,L_1} = \theta_1|_{y=0,L_2} = \theta_1|_{z=0,L_3} = 0$$

$$\alpha_0 = 0; \quad \beta_0 = 0;$$

For the equation of transfer of particles in the directions of coordinates  $x, y, z$  we obtain:

$$a_i \theta_{1,i+1,j,k}^{n+1/3} + b_i \theta_{1,i,j,k}^{n+1/3} - c_i \theta_{1,i-1,j,k}^{n+1/3} = d_i$$

$$\text{As } a_i = \frac{u\Delta t}{6h_1}; \quad b_i = 1 + \frac{\Delta t}{9} \sigma; \quad c_i = \frac{u\Delta t}{6h_1};$$

$$d_i = (L_2^n + L_3^n) \theta_{1,i,j,k}^n + \theta_{1,i,j,k}^n + \frac{\Delta t}{9} f_{1,i,j,k}^n;$$

$$L_2^n = \frac{v\Delta t}{6h_2} [\theta_{1,i,j+1,k}^n - \theta_{1,i,j-1,k}^n]; \quad L_3^n = \frac{(w-w_g)\Delta t}{6h_3} [\theta_{1,i,j,k+1}^n - \theta_{1,i,j,k-1}^n];$$

$$\bar{a}_i \theta_{1,i,j+1,k}^{n+2/3} + \bar{b}_i \theta_{1,i,j,k}^{n+2/3} - \bar{c}_i \theta_{1,i,j-1,k}^{n+2/3} = \bar{d}_i$$

$$\text{As } \bar{a}_i = \frac{v\Delta t}{6h_2}; \quad \bar{b}_i = 1 + \frac{\Delta t}{9} \sigma; \quad \bar{c}_i = \frac{v\Delta t}{6h_2};$$

$$\bar{d}_i = (L_1^{n+1/3} + L_3^{n+1/3}) \theta_{1,i,j,k}^{n+1/3} + \theta_{1,i,j,k}^{n+1/3} + \frac{\Delta t}{9} f_{2,i,j,k}^n;$$

$$L_1^{n+1/3} = \frac{u\Delta t}{6h_1} [\theta_{1,i+1,j,k}^{n+1/3} - \theta_{1,i-1,j,k}^{n+1/3}]; \quad L_3^{n+1/3} = \frac{(w-w_g)\Delta t}{6h_3} [\theta_{1,i,j,k+1}^{n+1/3} - \theta_{1,i,j,k-1}^{n+1/3}];$$

$$\bar{\bar{a}}_i \theta_{1,i,j,k+1}^{n+2/3} + \bar{\bar{b}}_i \theta_{1,i,j,k}^{n+2/3} - \bar{\bar{c}}_i \theta_{1,i,j,k-1}^{n+2/3} = \bar{\bar{d}}_i$$

$$\text{As } \bar{\bar{a}}_i = \frac{(w-w_g)\Delta t}{6h_3}; \quad \bar{\bar{b}}_i = 1 + \frac{\Delta t}{9} \sigma; \quad \bar{\bar{c}}_i = \frac{(w-w_g)\Delta t}{6h_3};$$

$$\bar{\bar{d}}_i = F_{3,i,j,k}, \quad F_{3,i,j,k} = (L_1^{n+2/3} + L_2^{n+2/3}) \theta_{1,i,j,k}^{n+2/3} + \theta_{1,i,j,k}^{n+2/3} + \frac{\Delta t}{9} f_{3,i,j,k}^n;$$

$$L_1^{n+2/3} = \frac{u\Delta t}{6h_1} [\theta_{1,i+1,j,k}^{n+2/3} - \theta_{1,i-1,j,k}^{n+2/3}]; \quad L_2^{n+2/3} = \frac{v\Delta t}{6h_2} [\theta_{1,i,j+1,k}^{n+2/3} - \theta_{1,i,j-1,k}^{n+2/3}];$$

$$\text{As } \theta_1|_{x=0,L_1} = \theta_1|_{y=0,L_2} = \theta_1|_{z=0,L_3} = 0$$

$$\alpha_0, \beta_0 \text{ on } x=0, \quad y=0, \quad z=0;$$

$$\alpha_0(x, y, z) = 0; \quad \beta_0(x, y, z) = 0;$$

The initial conditions  $\theta_1(x, y, z, 0) = \theta_2(x, y, z);$  for  $t = 0;$

Task 2. Considering the diffusion equation and approximating the derivatives we get:

$$\begin{aligned} & \frac{\theta_{2,i,j,k}^{n+1/3} - \theta_{2,i,j,k}^n}{\Delta t/3} - \mu \frac{\theta_{2,i+1,j,k}^{n+1/3} - 2\theta_{2,i,j,k}^{n+1/3} + \theta_{2,i-1,j,k}^{n+1/3}}{h_1^2} - \mu \frac{\theta_{2,i,j+1,k}^n - 2\theta_{2,i,j,k}^n + \theta_{2,i,j-1,k}^n}{h_2^2} + \\ & + \frac{(\gamma_{k-0,5}\theta_{2,i,j,k-1}^n - (\gamma_{k+0,5} + \gamma_{k-0,5})\theta_{2,i,j,k}^n + \gamma_{k+0,5}\theta_{2,i,j,k+1}^n)}{h_3^2} = \frac{1}{2}\sigma\theta_{2,i,j,k}^{n+1/3} + \frac{1}{2}f_{i,j,k}^n; \end{aligned} \quad (20)$$

$$\begin{aligned} & \frac{\theta_{2,i,j,k}^{n+2/3} - \theta_{2,i,j,k}^{n+1/3}}{\Delta t/3} - \mu \cdot \lambda^{n+1/3} - \mu \frac{\theta_{2,i,j+1,k}^{n+2/3} - 2\theta_{2,i,j,k}^{n+2/3} + \theta_{2,i,j-1,k}^{n+2/3}}{h_2} + \\ & + \beta^{n+1/3} = -\frac{1}{2}\sigma\theta_{2,i,j,k}^{n+2/3} + \frac{1}{2}f_{i,j,k}^{n+1/3}; \end{aligned} \quad (21)$$

$$\begin{aligned} & \frac{\theta_{2,i,j,k}^{n+1} - \theta_{2,i,j,k}^{n+2/3}}{\Delta t/3} - \mu\alpha^{n+2/3} - \mu\xi^{n+2/3} + \\ & + (\gamma_{k-0,5}\theta_{2,i,j,k-1}^{n+1} - (\gamma_{k-0,5} + \gamma_{k+0,5})\theta_{2,i,j,k}^{n+1} + \gamma_{k+0,5}\theta_{2,i,j,k+1}^{n+1}) / h_3^2 = \\ & = -\frac{1}{2}\sigma\theta_{2,i,j,k}^{n+1} + \frac{1}{2}f_{i,j,k}^{n+2/3}; \end{aligned} \quad (22)$$

Где

$$\begin{aligned} \alpha^{n+1/3} &= \frac{\theta_{2,i+1,j,k}^{n+1/3} - 2\theta_{2,i,j,k}^{n+1/3} + \theta_{2,i-1,j,k}^{n+1/3}}{h_1^2}; \\ \beta^{n+1/3} &= \frac{(\gamma_{k-0,5}\theta_{2,i,j,k-1}^{n+1/3} - (\gamma_{k-0,5} + \gamma_{k+0,5})\theta_{2,i,j,k}^{n+1/3} + \gamma_{k+0,5}\theta_{2,i,j,k+1}^{n+1/3})}{h_2^2}; \end{aligned}$$

$$\xi^{n+2/3} = \frac{\theta_{2,i,j+1,k}^{n+2/3} - 2\theta_{2,i,j,k}^{n+2/3} + \theta_{2,i,j-1,k}^{n+2/3}}{h_2^2};$$

$$\alpha^{n+2/3} = \frac{\theta_{2,i+1,j,k}^{n+2/3} - 2\theta_{2,i,j,k}^{n+2/3} + \theta_{2,i-1,j,k}^{n+2/3}}{h_1^2}.$$

Instead of (20) we get

$$\begin{aligned} & -\frac{\Delta t}{3} \cdot \frac{\mu}{h_1^2} \theta_{2,i+1,j,k}^{n+1/3} + (2\frac{\Delta t}{3} \cdot \frac{\mu}{h_1^2} - \frac{\Delta t}{6} \sigma + 1) \theta_{2,i,j,k}^{n+1/3} - \frac{\Delta t}{3} \cdot \frac{\mu}{h_1^2} \theta_{2,i-1,j,k}^{n+1/3} = \\ & = \theta_{2,i,j,k}^n + \mu \alpha_1^n - \beta_1^n + \frac{\Delta t}{6} f_i^n \end{aligned}$$

$$a_i' = \frac{\Delta t \mu}{3h_1^2}; \quad b_i' = \left( \frac{2\Delta t \mu}{3h_1^2} - \frac{\Delta t \sigma}{6} + 1 \right); \quad c_i' = \frac{\Delta t \mu}{3h_1^2};$$

$$d_i' = \theta_{2,i,j,k}^n + \mu \alpha_1^n - \beta_1^n + \frac{\Delta t}{6} f_i^n$$

Here

$$\alpha_1^{n+1/3} = \frac{\theta_{2,i+1,j,k}^{n+1/3} - 2\theta_{2,i,j,k}^{n+1/3} + \theta_{2,i-1,j,k}^{n+1/3}}{h_2^2};$$

$$\beta_1^{n+1/3} = \frac{(\gamma_{k-0,5} \theta_{2,i,j,k-1}^{n+1/3} - (\gamma_{k-0,5} + \gamma_{k+0,5}) \theta_{2,i,j,k}^{n+1/3} + \gamma_{k+0,5} \theta_{2,i,j,k+1}^{n+1/3})}{h_3^2};$$

Together with (21) we obtain the following formulae

$$a_j'' = \frac{\Delta t \mu}{3h_2^2}; \quad b_j'' = \left( \frac{2\Delta t \mu}{3h_2^2} - \frac{\Delta t \sigma}{6} + 1 \right); \quad c_j'' = \frac{\Delta t \mu}{3h_2^2};$$

$$d_j'' = \theta_{2,i,j,k}^{n+1/3} + \mu \alpha^{n+1/3} - \beta^{n+1/3} + \frac{\Delta t}{6} f_j^{n+1/3}$$

Вместе (22)

And with (22)

$$\begin{aligned} & \frac{\Delta t}{3} \cdot \frac{\gamma_{k+0,5}}{h_3^2} \theta_{2,i,j,k+1}^{n+1} - ((\gamma_{k+0,5} + \gamma_{k-0,5}) \frac{\Delta t}{3h_3^2} - \frac{\Delta t}{6} \sigma + 1) \theta_{2,i,j,k}^{n+1} - \frac{\Delta t}{3} \cdot \frac{\gamma_{k-0,5}}{h_3^2} \theta_{2,i,j,k+1}^{n+1} = \\ & = \theta_{2,i,j,k}^{n+2/3} + \mu \alpha^{n+2/3} - \mu \xi^{n+2/3} + \frac{\Delta t}{6} f_i^{n+2/3} \end{aligned}$$

$$a_k''' = \frac{\Delta t}{3} \cdot \frac{\gamma_{k+0,5}}{h_3^2}; \quad b_k''' = ((\gamma_{k+0,5} + \gamma_{k-0,5}) \frac{\Delta t}{3h_3^2} - \frac{\Delta t}{6} \sigma + 1); \quad c_k''' = \frac{\Delta t}{3} \cdot \frac{\gamma_{k-0,5}}{h_3^2};$$

$$d_k''' = \theta_{2,i,j,k}^{n+2/3} + \mu \alpha^{n+2/3} - \mu \xi^{n+2/3} + \frac{\Delta t}{6} f_i^{n+2/3};$$

The boundary conditions for the diffusion equation are:

$$\left. \frac{\partial \theta_2}{\partial z} \right|_{z=0} = \beta \theta_2 \quad \text{è} \quad \left. \frac{\partial \theta_2}{\partial z} \right|_{z=H} = 0;$$

$$\frac{-\theta_{2,2} + 4\theta_{2,1} - 3\theta_{2,0}}{2h} = \beta \theta_{2,1};$$

$$-\theta_{2,2} + 4\theta_{2,1} - 3\theta_{2,0} = 2h\beta \theta_{2,1};$$

$$-\theta_{2,2} + (4 - 2h\beta)\theta_{2,1} - 3\theta_{2,0} = 0;$$

$$\theta_{2,2} = (4 - 2h\beta)\theta_{2,1} - 3\theta_{2,0};$$

from the sweep method

$$\theta_1 = -\frac{(c_1 - 3a_1)}{(4a_1 - b_1 - 2h\beta a_1)} \theta_0 + \frac{d_1}{(4a_1 - b_1 - 2h\beta a_1)};$$

$$\alpha_0 = \frac{(c_1 - 3a_1)}{(4a_1 - b_1 - 2h\beta a_1)}; \quad \beta_0 = \frac{d_1}{(4a_1 - b_1 - 2h\beta a_1)}; \quad \text{при for } z=0;$$



$$\left. \frac{\partial \theta_2}{\partial z} \right|_{z=H} = 0; \Rightarrow \frac{-\theta_K + 4\theta_{K-1} - 3\theta_{K-2}}{2h} = 0;$$

Или or

$$\theta_K = \frac{(4 - 3A_{K-2})B_{K-1} + 3B_{K-2}}{(1 - (4 - 3A_{K-2})A_{K-1})} \quad \text{if } \delta \neq 0 \quad z = H.$$

And so by splitting the problem into physical processes we have received conservative numerical algorithm, and by realizing that we can explore and predict the spread of harmful substances into the atmosphere.

We have developed a program tool by us in the language of Delphi Borland to carry out numerical experiments on a computer.

Discussion of results and conclusions.

As a result of computational experiments, it is showed that the reduction of steps of time integration, solutions obtained from the individual tasks (equations (6) - (10) and equations (11) - (13)) tend to the solution of the main problem (1) - (5).

Numerical calculations carried out on a computer at different speeds of wind in the horizontal and vertical directions showed that when the constants -  $u, v, w, w_g, \mu, \gamma$  do not change by the time, the solution obtained by the method of splitting into physical processes gives good results. Inaccuracies in solutions of split problems arise due to changes in the above parameters, as from the time and in the space variables.

In carrying out numerical calculations on a computer, the definition of the parameters of  $\mu, \gamma$  in the boundary layer of the atmosphere is one of the most difficult and important tasks of dynamic meteorology.

The vertical distribution under stable and neutral stratification of the atmosphere is investigated. In carrying out computational experiments we use characteristic values of  $\gamma$  obtained by solving the system of equations, describing the processes that occur in the atmospheric boundary layer and the experimental data. It is known that during unstable stratification of  $\gamma$  increases from 200 to 400 m and then decreases with increasing height, at neutral stratification it increases from 100 to 1300 m, with a stable stratification it changes from 50 to 70m, and then sharply decreases with height.

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# MUNICIPAL CHARGES IN FINANCING PRODUCTION AND PROVISION OF PUBLIC BENEFITS

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## ПЛАТЕЖИ КОММУНАЛЬНОГО ХАРАКТЕРА В ФИНАНСИРОВАНИИ ПРОИЗВОДСТВА И ПРЕДОСТАВЛЕНИЯ ОБЩЕСТВЕННЫХ БЛАГ

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### *Abstract*

The objective of the given article is to research essence of municipal charges and their role in financing production and provision of public benefits. The author distinguishes municipal charges among other revenues of local self-government bodies since they are not forced and depend on the volume of consumed public benefits.

During the research it was found out that municipal charges meet specific principles of local taxation. In addition, specific principles for municipal charges have been worked out. Considerable advantages of such charges justify a choice of local self-government bodies in their favor.

Issues under consideration set the basis for subsequent applied elaboration related to necessity of implementing reforms of local taxation and revising legislative norms in order to create preconditions for subsequent systematic reforms of local finances in different countries.

Economic efficiency in production of public benefits justifies necessity of financially independent local and regional self-government. Such is ensured by presence of broad expense authorities as well as financial resources of their own that are sufficient for quality implementation of the former. The latter are ensured mainly due to tax revenues (local taxation).

An existing practice of the most developed states indicates substantial limited nature of own finance base of local bodies that stipulates topicality of searching for alternative sources of production and provision of public benefits including municipal charges among others.

Ukrainian researchers working on the matter of forming own revenue base of local self-government include V. Andrushchenko [1], O. Kirilenko [6], I. Lunina [6], V. Oparin [9], O. Suntsova [8], V. Fedosov [9] et al. Scholars reveal problems leading to insufficient financial autonomy of local self-government bodies and examine issues in relation to reforming local taxation and mobilizing non-tax revenues of local budgets.

Western researchers working on issues of filling local budgets include: Ch. Blankart [2], J. Buchanan [5], G. Musgrave [12], D. King [11], J. Stiglitz [7], H. Zimmermann [10, 13] et al.

At the same time, a vast majority of studies does not sufficiently examine issues of using municipal charges in financing production and provision of public benefits and their possibilities in partial replacement of local taxation.

Therefore, the objective of the article is to research essence of municipal charges and their role in financing production and provision of public benefits.

In accordance with an area of secondary value, decentralized or local / regional public benefits are own in terms of scope of authorities and decentralized by measuring level of constituent competence. Their production and provision are financed by own revenue sources of local / regional self-government bodies.

Own sources of revenues comprise the following:

- local taxes and duties;
- other revenues received due to decisions of local / regional self-government bodies, including municipal charges.

It is economically feasible to form own finance resources due to permanent and expected purposeful payments (municipal charges, duties, other compulsory payments) and non-purposeful payments (taxes). However, we are interested in their division depending on use of forced collecting and volume of consumed public benefits. Judging by these criteria, own revenues of local / regional self-government bodies are to be divided into taxes and municipal charges.

According to H. Zimmermann and K. Henke, municipal charges from the point of view of their compliance with pricing market mechanism are divided into the following:

- consumer tariffs (e. g., tolls, garbage disposal fees, etc.);
- administrative tariffs similar to taxes (e. g., customs dues, license fees, etc.)

The authors point out that the first category implies proportionality of payments to volume of consumed public services. Administrative tariffs do not meet this standard as citizens can hardly refuse from such public services, and that is why change of demand depending on the cost of such services is not observed [13, p. 105].

On the basis of similar reasoning, we consider it feasible to examine administrative tariffs as tax payments.

Local budgets are also filled with revenues from lease, sales of fixed assets and land; revenues of local self-government bodies coming from equity participation in activities of enterprises as dividends, revenues from own enterprises, and other revenues. Such payments are also not connected with volume of public benefits consumed by population and are non-purposeful, but they are not compulsory unlike taxes. However, their characteristic features give reasons to consider them as taxes for the objective of the given research.

Within the context of subsequent research we deem necessary to determine which public benefits shall be provided due to taxes and duties and other compulsory payments (taxes) and which shall be provided due to municipal charges only.

First, we are to determine whether municipal charges meet the following specific principles of local / regional taxation:

- the principle of reciprocal equivalence;

- the principle of local origin;
- the principle of even tax load on different categories of tax-payers;
- the principle of minimal influence on cyclical fluctuations of economy;
- the principle of correspondence to state tax revenue growth rates;
- the principle of correspondence to needs of local population and legal entities;
- the principle of self-dependency [4, p. 20-21].

Municipal charges represent partial or complete payments for services (public benefits) by population and legal entities. Unlike taxes, they are strictly equivalent to consumed public benefits. If taxation means that the more people pay, the more public benefits they get, when concerned with municipal charges, individual payers receive exact amount paid for. This specific principle of local / regional taxation (principle of reciprocal equivalence) can be realized only by direct taxation. And even in this case, it is important for tax-payers to realize necessity of paying for public benefits. Such problem does not arise with municipal charges and thus it provides for an advantage of municipal charges over local / regional taxation.

Municipal charges also meet the principle of local origin. They are paid for locally only by those using those or another public benefits. And, unlike taxation, when collecting municipal charges, problems of redistributing tax load from one local unit to another do not arise.

Municipal charges can be identical for all payers, differentiated for legal entities and population, or depend on volume of public benefits consumed, etc. Therefore, the principle of even load of municipal charges on different categories of payers is especially topical. Ignoring this principle can cause violating optimal correlation of industrial structures and labor resources along with local fluctuations of consumer prices as a result of different municipal charges built into the cost of products.

Establishment of overpriced tariffs on municipal charges for legal entities with the purpose of suppressing tariffs for population at the lowest level can result in hidden complete payments by population of a given local unit as well as other local units in which products are realized as they are built into the cost of offered commodities, works and services.

Introduction of differentiated tariffs depending on volume of consumed public benefits is compared to progressive taxation on local / regional level. It can result in stratification of population depending on income in local units.

Based on possible negative consequences of establishing differentiated tariffs, it is feasible to implement the principle of even load of municipal charges on different categories of payers on local / regional level. However, authorities of differentiating tariffs must lay with a state.

When certain public benefits are consumed evenly by all residents in accordance with requirements of law, collecting such payments is similar to per capita taxation that violates the principle of social justice. In this case, production and provision of such public benefits shall be financed from public finance resources. Moreover, with the purpose of maintaining effect of individual consumer demand influencing provision of

public benefits, it is appropriate to organize financing of its provision on a per capita principle [3].

The principle of minimal influence on cyclical fluctuations of economy is realized without authoritative efforts on local / regional level upon introduction of municipal charges. It is stipulated by legal entities and population of a given local unit paying for consumed public benefits only.

Production of public benefits at the expense of municipal charges usually employs the principle of expenditure self-repayment. Besides, local / regional self-government bodies are interested in timely revision of tariffs on municipal charges taking into account existing price levels for public benefits. Otherwise, direct providers of such public benefits get losses that are to be compensated from budget resources. It reinforces realizing the principle of correspondence to state tax revenues growth rates and suggests the principle of correspondence of municipal charges to existing consumer price level.

When providing public benefits at the expense of local / regional taxation, their consumers, i. e., tax-payers cannot directly influence amount and composition of public benefits. The choice is done by means of elections and voting. As for public benefits provided at the expense of municipal charges, amount of their production depends on each concrete consumer and their consent to consume public benefits as well as pay for such. The latter are provided more effectively, and their providers are capable of and have to respond to changes in population preferences.

Composition of public benefits provided by local / regional self-government bodies at the expense of municipal charges should be met by their consumers. Otherwise, it leads to eliminated production capacities of public benefits providers as well as negative migration of population to local units that provide better composition of such. It forces local / regional self-government bodies to take into account principle of correspondence to needs of local population and legal entities when collecting municipal charges.

Local / regional self-government bodies shall have necessary authorities in relation to establishing composition of public benefits provided at the expense of municipal charges and in realizing tariffs policy. It provides for taking into account local terms of production of public benefits, satisfying demand for new public benefits, and thus providing such economically efficiently. It justifies necessity of realizing the principle of self-dependency when introducing municipal charges.

Hence, municipal charges are similar to local / regional taxes in meeting specific principles of local taxation. Based on their nature, some are applied automatically (principles of reciprocal equivalence, local origin, minimal influence on the cyclical fluctuations of economy). Realizing further principles needs additional state control and calls for need to put specific principles of municipal charges, among which the following are to be distinguished:

- 1) the principle of even load of municipal charges on different categories of tax-payers;
- 2) the principle of self-repayment;

- 3) the principle of correspondence of municipal charges to current consumer price levels;
- 4) the principle of correspondence to needs of local population and legal entities;
- 5) the principle of self-dependency.

Municipal charges have certain advantages over tax revenues, including the following:

- eradicating problem of redistributing payments load to other local units to other. However, a problem may arise when redistributing load of municipal charges from population to legal entities or between certain population layers due to differentiated tariffs;
- possibility for payers of municipal charges to independently regulate amount of such depending on volume of consumed public benefits;
- clear understanding of ways of utilizing payments by payers of municipal charges that removes dissatisfaction resulting from forced collecting;
- possibility of just distribution of public benefits between consumers as not all consumers enjoy possibilities to utilize evenly public benefits provided at the expense of public finance resources (taxes), e. g., due to remoteness from providers of public benefits, differences in welfare defined not only by income but also presence of spare time, etc. It results in advantages of consumption by some consumers in comparison to others. This problem can be solved by changing sources of financing production and provision of public benefits from taxes to municipal charges;
- possibility to determine necessary amount of producing public benefits and react to changes in population preferences in a timely manner. Taxes, at the opposite, poorly represent degrees of public benefits consumption;
- collecting purposeful payments (such as municipal charges) increases responsibility of government bodies for efficient expenditures in comparison to non-purposeful payments;
- narrowing of bureaucratic mechanisms need of which is diminished dramatically due to collecting municipal charges. Managing financial streams of municipal charges for consumed public benefits is implemented more efficiently as a result of population involvement;
- municipal charges can be used to effectively limit excess (uneconomical) consumption of public benefits. When paying taxes, it is not understood by population how much and for which public benefits exactly it pays. Tax-payers can only compare general volume of taxes with general volume of consumed public benefits. Interest in thrifty consumption of public benefits is absent but it cannot lead to subsequent reduction of taxes. This problem can be solved by introducing municipal charges.

Above-mentioned advantages of municipal charges over taxes can be efficiently used by local / regional self-government bodies when producing local / regional public benefits. Appropriate terms of providing public benefits at the expense of public finance resources (taxes) are the following:

- 1) collective consumption of public benefits;



- 2) impossibility of individual exemption from consumption;
- 3) non-competitiveness among consumers;
- 4) indivisibility of benefits;
- 5) expensive benefits provided by private entities and not consumed by general consumers;
- 6) presence of considerable positive external effects upon provision of benefits;
- 7) considerable capital investments and risks upon provision of benefits;
- 8) common useful or necessary benefits;

However, when choosing source of financing and facing problems of considerable capital investments and risks associated with producing public benefits, and also of insufficient solvency of general consumers, it is cost-beneficial to choose municipal charges. Concurrently, to solve above mentioned problems needs, the following shall be done:

- carrying out capital investments at the expense of public local / regional finance resources with subsequent gradual repayment at the expense of consumers. Risks upon producing public benefits can also be compensated partially or fully at the expense of public local / regional finance resources;
- setting tariffs for consumers with insufficient levels of solvency aimed at partial repayment of charges for producing public benefits. In this case, as we have already noted, the problem of optimal tariff differentiation must be tackled by state;
- introducing transfer budget payments to consumers with insufficient level of solvency. In this case, due to inability of local / regional self-government bodies to pursue a policy of smoothing population income, state shall must financially provide for solving the problem.

To sum up, due to lack of sufficient causes to provide public benefits at the expense of taxes (public finance resources) advantage shall be given to municipal charges. Such decision is justified by delegated authorities of local / regional self-government bodies, but decisions in relation to sources shall be adopted by state.

When population has to consume certain public benefits in accordance with law, collecting charges for such is similar to taxing and violates the principle of social justice. Therefore, such public benefits shall be produced and provided at the expense of public financial resources.

"Municipal charges and fees as a form of financing local public benefits act as a market pricing mechanism. Consumers of public benefits are compelled to compare gains from such public benefits and charges they shall bear for getting them. Such situation meets in the greatest degree the fundamental principle of local compliance assisting effective implementation of public sector tasks", in a most degree" [10, c. 136].

Issues under consideration shall set basis for further deeper applied elaboration related to necessity of carrying out reforms of local taxation and revising legislative norms to create preconditions for subsequent system reformation of local finances in different countries.

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# Length of words and frequency of words in the text "Heroij nachego vremeni" M.Yu. Lermontovs: "Fatalist"

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## *Abstracts*

The total of words in product is made 1445, and with their frequency - 2682, calculated on work [1]. The increase of quantity of words in dynamics goes since length of a word from 16 up to 6 letters, then one letter falls till length of a word. Frequency of words grows from 16 till 15 lengths of words, and then from 14 letters up to 6 letters, then falls till length of a word three letters, grows till length of a word two letters and one letter falls till length of a word. Dependence of quantity of words on frequency is submitted by a parabola with relative speed of quantity of words from frequency 1,5475. Dependence of frequency of words on their length also is described by a parabola with relative speed of frequency of words from length of words 2,1693. Dependence of cumulative quantity of words on cumulative frequency is submitted to a S-shaped curve with relative speed of cumulative quantity of words from cumulative frequency 2,7549 which can serve as the characteristic of the text. Dependence of the logarithm of lengths of words on the logarithm of cumulative frequency is approximated by polynoms of the second and third degree with high factors of plural correlation. Dependence of the logarithm of cumulative quantity of words and cumulative frequency of words on the logarithm of length of words is described by polynoms of the second and third degrees. Dependence of the logarithm cumulative frequencies of words from the logarithm of length of words is described by linear model, a polynoms of the second and third degrees and logarithmic model. Dependence of the logarithm of length of words on the logarithm of cumulative frequency is described by polynoms of the second and third degrees. Thus the average logarithmic length of a word depending on a kind of the equation changes from 2,5945 up to 3,4443. Dependence of the logarithm of lengths of words on the logarithm of cumulative quantity of words has the same values. As well as in previous our researches with reduction of length of words the increase of their frequency up to the certain limit is observed. At reduction of the cumulative data the logarithm imposing curve logarithms of frequency and logarithms of quantity of words up to the certain limit is observed, and then there is a prevalence of a curve of logarithms of frequency over a curve of logarithms of quantity of words. As well as in previous our researches with reduction of length of words the increase of their frequency up to the certain limit is observed. At reduction of the cumulative data the logarithm imposing curve logarithms of frequency and logarithms of quantity of words up to the certain limit is observed, and then there is a prevalence of a curve of logarithms of frequency over a curve of logarithms of quantity of words [2-3].

**Keywords:** *quantity of words, frequency of words, length of words, dynamics of quantity of words, dynamics of length of words, average length of words, cumulative quantity of words, cumulative frequency of words, modeling, linear dependence, sedate dependence, logarithmic dependence, polynoms of the second degree, polynoms of the third degree*

LW	NW	F	CNW	CF	LN CNW	LN CF	LN LW	LW	NW	F	CNW	CF	LN CNW	LN CF	LN LW
16	1	1	1	1	0	0	2,7725	8	163	196	481	534	6,1759	6,2804	2,0794
15	8	11	9	12	2,1972	2,4849	2,7080	7	218	270	699	804	6,5497	6,6896	1,9459
14	9	8	18	20	2,8904	2,9957	2,6390	6	249	347	948	1151	6,8544	7,0484	1,7917
13	16	17	34	37	3,5264	3,6109	2,5649	5	215	328	1163	1479	7,0588	7,2991	1,6094
12	25	25	59	62	4,0775	4,1271	2,4849	4	150	264	1313	1743	7,1801	7,4634	1,3862
11	47	49	106	111	4,6634	4,7095	2,3979	3	77	314	1390	2057	7,2371	7,629	1,0986
10	83	84	189	195	5,2417	5,2730	2,3025	2	40	346	1430	2403	7,2654	7,7845	0,6931
9	129	143	318	338	5,7621	5,8230	2,1972	1	15	279	1445	2682	7,2759	7,8943	0

The total of words in product is made 1445, and with their frequency - 2682, designed on the basis of a technique in work [1]. The increase of quantity of words in dynamics(changes) goes since length of a word from 16 up to 6 letters, then one letter falls till length of a word. Frequency of words grows from 16 till 15 lengths of words, and then from 14 letters up to 6 letters, then falls till length of a

word three letters, grows till length of a word two letters and one letter falls till length of a word. Dependence of quantity of words on frequency (Fig.1) is submitted by a parabola as the equations:  $y=7,8809x+23,325$ ,  $R^2 = 0,1940$ ;  $y=58,9910\ln(x)-22,7730$ ,  $R^2 = 0,2987$ ;  $y = -2,8493x^2 + 56,3180x - 121,9900$ ,  $R^2 = 0,6201$ ;  $y = 2,2606x^{1,5475}$ ,  $R^2 = 0,6314$ ;  $y = -0,5730x^3 + 11,7630x^2 - 46,0840x + 44,5960$ ,  $R^2 = 0,8937$ . Relative speed of quantity of words from frequency has made 1,5475. Dependence of frequency on length of words (Fig. 2) is submitted by a parabola as the equations:  $y = 150,2200\ln(x) - 120,3400$ ,  $R^2 = 0,7355$ ;  $y = 26,9650x - 61,5750$ ,  $R^2 = 0,8626$ ;  $y = -0,5336x^2 + 36,0360x - 88,7890$ ,  $R^2 = 0,8683$ ;  $y = 1,1764x^{2,1693}$ ,  $R^2 = 0,9528$ ;  $y = -0,5277x^3 + 12,9230x^2 - 58,2640x + 64,6130$ ,  $R^2 = 0,9564$  with relative speed of frequency of words from length of a word 2,1693.

Dependence of cumulative quantity of words on cumulative frequency is submitted to the S-shaped curve described by the equations (Fig. 3):  $y=612,6000\ln(x)-574,1700$ ,  $R^2 = 0,6808$ ;  $y=118,1900x-404,4000$ ,  $R^2 = 0,9222$ ;  $y=5,5488x^2+23,8560x-121,4100$ ,  $R^2 = 0,9564$ ;  $y = -1,3507x^3 + 39,9910x^2 - 217,5100x + 271,2400$ ,  $R^2 = 0,9885$ ;  $y=0,9666x^{2,7549}$ ,  $R^2 = 0,9898$  with relative speed of cumulative quantity of words from cumulative frequency 2,7549 which can serve as the characteristic of the text.

Dependence of the logarithm of lengths of words on the logarithm of cumulative frequency (Fig. 4) is approximated by the equations:  $y = -0,7970\ln(x) + 3,4443$ ,  $R^2 = 0,6348$ ;  $y = -0,1554x + 3,2380$ ,  $R^2 = 0,8791$ ;  $y = -0,0126x^2 + 0,0591x + 2,5945$ ,  $R^2 = 0,9765$ ;  $y = -0,0014x^3 + 0,0223x^2 - 0,1859x + 2,9931$ ,  $R^2 = 0,9947$ . Dependence of the logarithm of length of words on the logarithm of cumulative frequency is described by polynomials of the second and third degrees. Thus the average logarithmic length of a word depending on a kind of the equation changes from 2,5945 up to 3,4443. Dependence of the logarithm of lengths of words on the logarithm of cumulative quantity of words has the same values.

Dependence of the logarithm of cumulative quantity of words and cumulative frequency of words on the logarithm of length of words (Fig.5) is submitted by the equations: for dependence of the logarithm of cumulative quantity of words on the logarithm of length of words:  $y = 0,4292x + 1,5987$ ,  $R^2 = 0,8745$ ;  $y = -0,0375x^2 + 1,0659x - 0,3112$ ,  $R^2 = 0,9863$ ;  $y = 2,7549\ln(x) - 0,034$ ,  $R^2 = 0,9898$ ;  $y = 0,0014x^3 - 0,0743x^2 + 1,3239x - 0,7309$ ,  $R^2 = 0,9890$ , and for dependence of the logarithm cumulative frequencies of words from the logarithm of length of words:  $y = 0,4582x + 1,5502$ ,  $R^2 = 0,9058$ ;  $y = -0,0322x^2 + 1,0063x - 0,0941$ ,  $R^2 = 0,9811$ ;  $y = 0,0017x^3 - 0,0766x^2 + 1,3172x - 0,6000$ ,  $R^2 = 0,9846$ ;  $y = 2,8862\ln(x) - 0,0882$ ,  $R^2 = 0,9876$ .

As well as in previous our researches with reduction of length of words the increase of their frequency up to the certain limit is observed. At reduction of the cumulative data the logarithm imposing curve logarithms of frequency and logarithms of quantity of words up to the certain limit is observed, and then there is a prevalence of a curve of logarithms of frequency over a curve of logarithms of quantity of words [2-3].

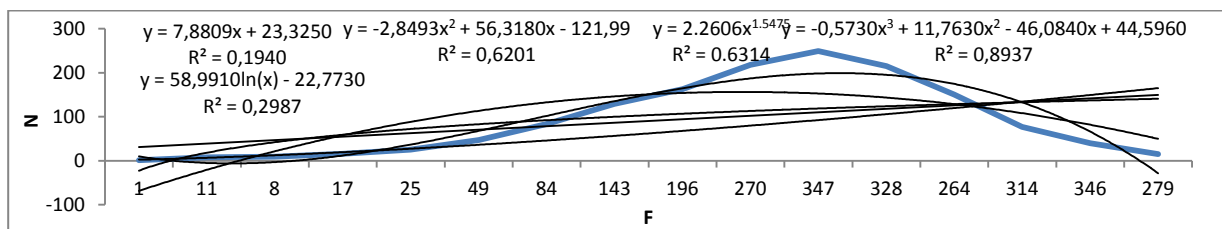


Fig. 1. Dependence of quantity of words (N) and frequencies of words (F)

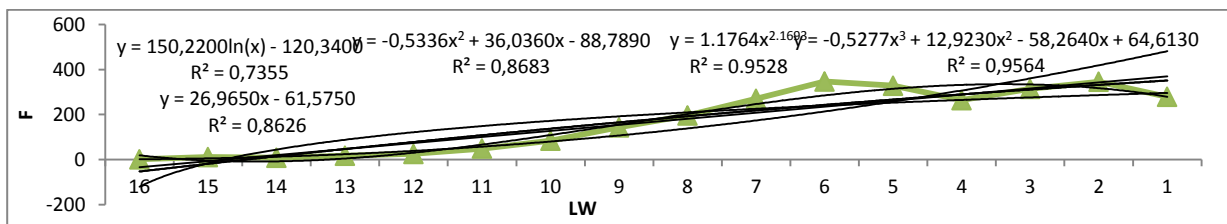


Fig.2. Dependence of frequency (F) of words on length of words (LW)

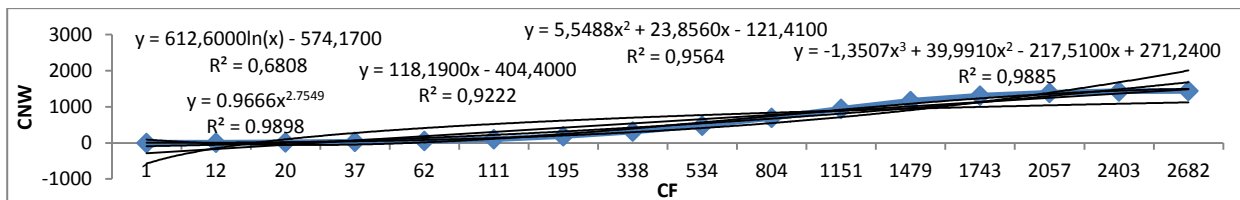


Fig.3. Dependence of cumulative quantity of words (CNW) on their cumulative frequency (CF)

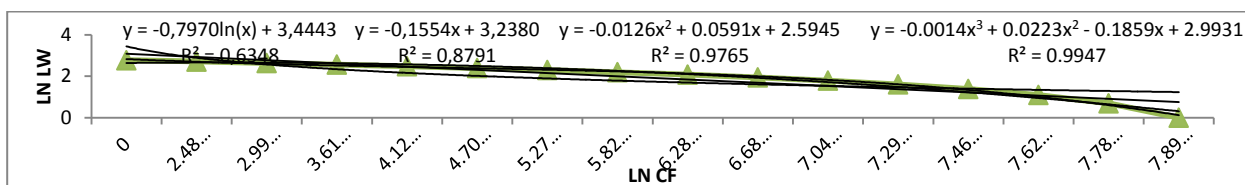


Fig.4. Dependence of the logarithm of lengths of words (LN LW) on the logarithm of cumulative frequency (LN CF)

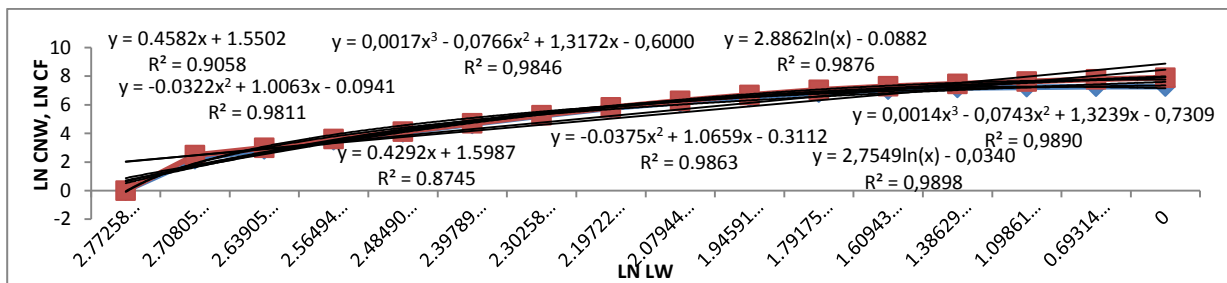


Fig. 5. Dependence of the logarithm of cumulative quantity of words (LN CNW) and cumulative frequency of words (CF) on the logarithm of length of words (LN LW)

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# Length of words and frequency of words in the text M.Yu. Lermontovs: "Mzyri"

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## Abstract

The total of words in product is made 1854, and with their frequency - 3433, calculated on a technique [1]. The increase of quantity of words in dynamics goes since length of a word 15 and up to 5 letters, and then falls till length of one letter. Frequency of words grows since length of a word of 15 letters up to 5 letters, then falls till length of four letters, grows till length of three letters and falls till length of two letters and grows till length of one letter. Dependence of quantity of words on frequency is submitted by a parabola with relative speed of quantity of words 1,8460. Dependence of frequency of words and their quantities from length of words is submitted by a parabola with relative speed of frequency of words 2,507 and with relative speed of quantity of words 1,8460. Therefore all experimental data are given to cumulate and submitted as logarithms. Dependence of cumulative quantity of words on their cumulative frequency is described by a S-shaped curve with relative speed of cumulative number of words 2,9807 which differs from dependence of quantity of words on frequency in 1,62 times and described by sedate model, polynoms of the third and second degrees. Dependences of logarithms cumulative quantities of words from the logarithm of cumulative frequency have relative speed of cumulative quantity of words 0,8963. Dependences of logarithms of cumulative frequencies on the logarithm cumulative quantities of words are described by relative speed of cumulative frequencies 0,9186. In dependence of the logarithm of length of words on the logarithm of cumulative frequency the average logarithmic length of a word from a kind of the equation changes from 2,5366 up to 3,3509, that is this size not a constant.

**Keywords:** quantity of words, frequency of words, length of words, dynamics of quantity of words, dynamics of length of words, average length of words, cumulative quantity of words, cumulative frequency of words, modeling, linear dependence, sedate dependence, logarithmic dependence, polynoms of the second degree, polynoms of the third degree

The total of words in product is made 1854, and with their frequency – 3433 , calculated on a technique [1]. The increase of quantity of words in dynamics goes since length of a word 15 and up to 5 letters, and then falls till length of one letter. Frequency of words grows since length of a word of 15 letters up to 5 letters, then falls till length of four letters, grows till length of three letters and falls till length of two letters and grows till length of one letter. Dependence of quantity of words on frequency (Fig. 1) is submitted by a parabola as the equations:  $y = 13,668x + 14,257$ ,  $R^2 = 0,2149$ ;  $y = 91,244\ln(x) - 46,109$ ,  $R^2 = 0,2928$ ;  $y = -4,4101x^2 + 84,229x - 185,67$ ,  $R^2 = 0,5445$ ;  $y = 1,5052x^{1,8460}$ ,  $R^2 = 0,6497$ ;  $y = -1,1818x^3 + 23,953x^2 - 103,2x + 103,64$ ,  $R^2 = 0,8732$  with relative speed of quantity of words 1,8460. Dependence of frequency of words and their quantities from length of words (Fig. 2) as parabolas are described accordingly by the equations: for frequency  $y = 219,3400\ln(x) - 179,0900$ ,  $R^2 = 0,6618$ ;  $y = 41,9390x - 106,6500$ ,  $R^2 = 0,7914$ ;  $y = 0,7497x^2,5077$ ,  $R^2 = 0,9286$ ;  $y = -0,6244x^2 + 51,9290x - 134,95$ ,  $R^2 = 0,7940$ ;  $y = -1,0597x^3 + 24,809x^2 - 116,1400x + 124,4600$ ,  $R^2 = 0,8974$  with relative speed of frequency of words 2,5077; for quantity of words  $y = 13,6680x + 14,2570$ ,  $R^2 = 0,2149$ ;  $y = 91,2440\ln(x) - 46,1090$ ,  $R^2 = 0,2928$ ;  $y = -4,4101x^2 + 84,2290x - 185,6700$ ,  $R^2 = 0,5445$ ;  $y = 1,5052x^{1,8460}$ ,  $R^2 = 0,6497$ ;  $y = -1,1818x^3 + 23,9530x^2 - 103,2000x + 103,6400$ ,  $R^2 = 0,8732$  with relative speed of quantity of words 1,8460. Therefore all experimental data are given to cumulate and submitted as logarithms. We shall consider dependence of cumulative quantity of words on their cumulative frequency as S-shaped curve (Fig. 3) which corresponded to the equations:  $y = 791,0700\ln(x) - 737,6900$ ,  $R^2 = 0,6481$ ;  $y = 162,9200x - 569,7000$ ,  $R^2 = 0,8991$ ;  $y = 10,0990x^2 + 1,3390x - 111,8900$ ,  $R^2 = 0,9500$ ;  $y = 0,7170x^{2,9807}$ ,  $R^2 = 0,9626$ ;  $y = -2,1570x^3 + 61,8670x^2 - 340,7600x + 416,1400$ ,  $R^2 = 0,9822$ .

Relative speed of cumulative number of words on sedate model has made 2,9807 which differs from dependence of quantity of words on frequency in 1,62 times. This dependence on size  $R^2$  is well described by sedate model, polynoms of the third and second degrees. Dependences of logarithms cumulative quantities of words from the logarithm of cumulative frequency (Fig. 4) are described by the equations:  $y = 0,5091x + 1,1384$ ,  $R^2 = 0,9185$ ;  $y = 2,9807\ln(x) - 0,3326$ ,  $R^2 = 0,9626$ ;  $y = 0,8296x^{0,8963}$ ,  $R^2 = 0,9697$ ;  $y = -0,0389x^2 + 1,1313x - 0,6246$ ,  $R^2 = 0,9975$ ;  $y = -0,0014x^3 - 0,0044x^2 + 0,9036x - 0,2731$ ,  $R^2 = 0,9990$  with relative speed of logarithms cumulative quantities of words 0,8963. This dependence on size  $R^2$  is well described by linear, logarithmic, sedate models, polynoms of the third and second degrees. Dependences of logarithms of cumulative frequencies on the logarithm of cumulative quantities of words (Fig. 5) are described by the equations:  $y = 0,5473x + 1,0012$ ,  $R^2 = 0,9443$ ;  $y = 3,1591\ln(x) - 0,4960$ ,  $R^2 = 0,9618$ ;  $y = 0,8154x^{0,9186}$ ,  $R^2 = 0,9771$ ;  $y = -0,0342x^2 + 1,0949x - 0,5502$ ,  $R^2 = 0,9987$ ;  $y = -0,0010x^3 - 0,0100x^2 + 0,9351x - 0,3036$ ,  $R^2 = 0,9993$  with relative speed of logarithms of cumulative frequencies 0,9186. This dependence on size  $R^2$  is well described by linear, logarithmic, sedate models, polynoms of the third and second degrees. Dependence of the logarithm of length of words on the logarithm of cumulative frequency is described by the following equations:  $y = -0,8020\ln(x) + 3,3509$ ,  $R^2 = 0,6425$ ;  $y = -0,1643x + 3,1741$ ,  $R^2 = 0,8826$ ;  $y = -0,0141x^2 + 0,0607x + 2,5366$ ,  $R^2 = 0,9779$ ;  $y = -0,0016x^3 + 0,0245x^2 - 0,1943x + 2,9303$ ,  $R^2 = 0,9952$ . This dependence on size  $R^2$  is well described by polynoms of the third and second degrees. Thus the average logarithmic length of a word depending on a kind of the equation changes from 2,5366 up to 3,3509.

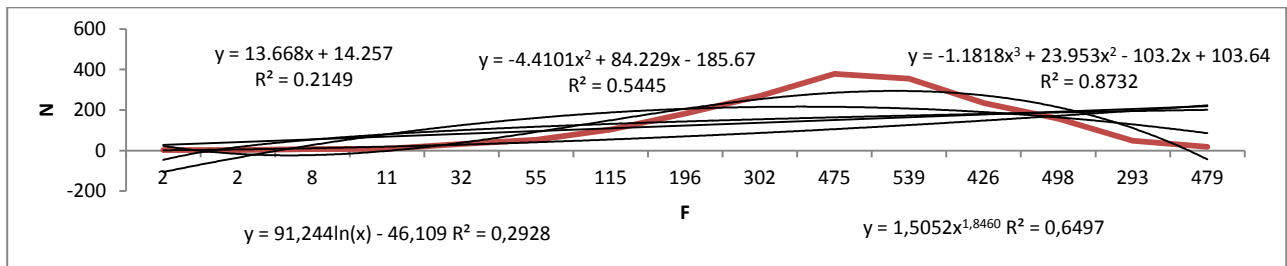


Fig. 1. Dependence of quantity of words (N) from their frequency (F)

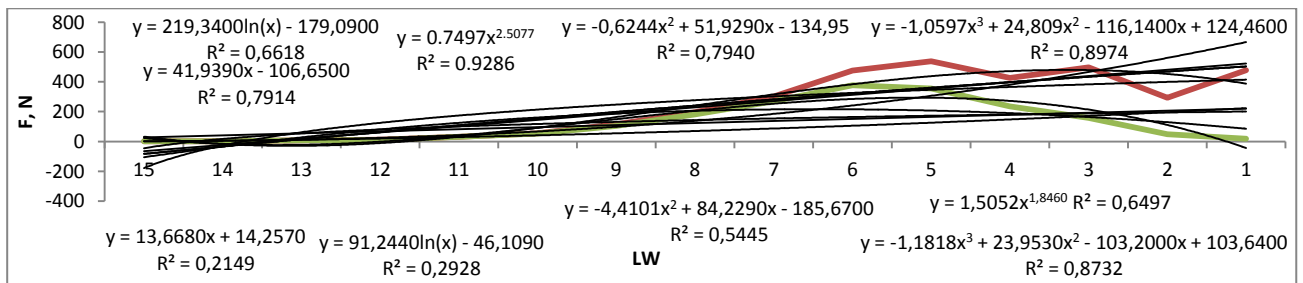


Fig. 2. Dependence of frequency of words (F) and their quantities (N) from length of words (LW) слов (LW)

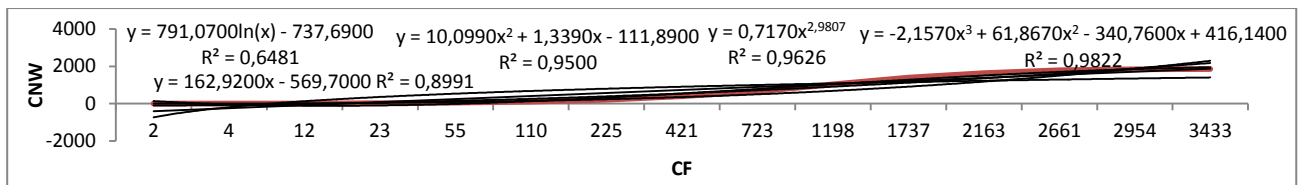


Fig.3. Dependence of cumulative quantity of words (CNW) from their cumulative frequency (CF)

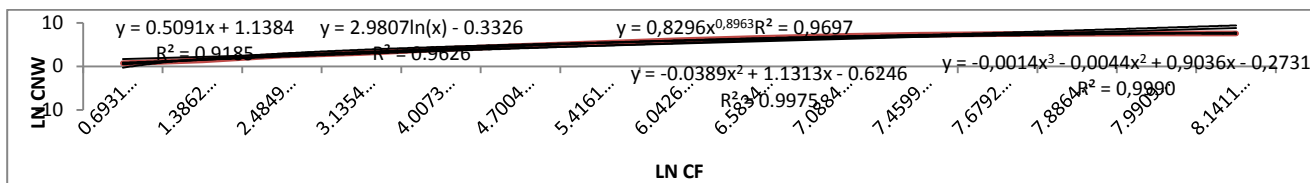


Fig. 4. Dependences of logarithms cumulative quantities of words (LN CNW) from logarithms of cumulative frequency (LN CF)

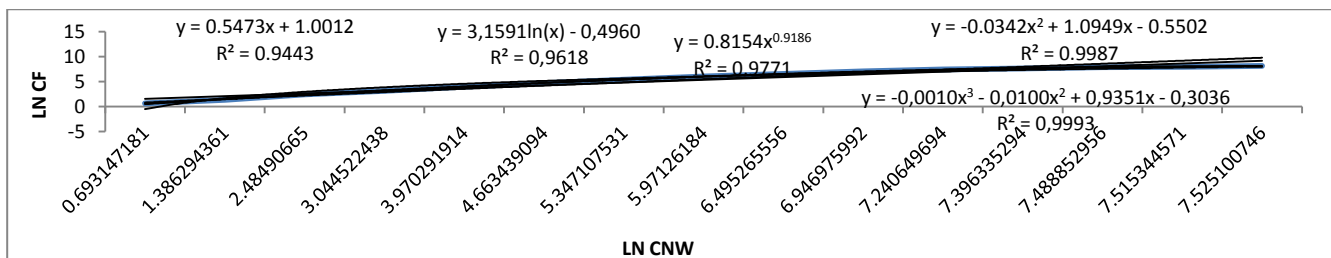


Fig. 5. Dependences of logarithms of cumulative frequencies (LN CF) from logarithms of cumulative quantity (amount) of words (LN CNW)

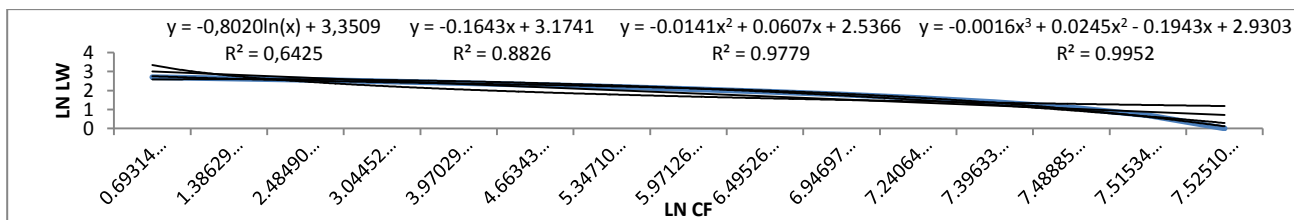


Fig. 6. Dependence of the logarithm of length of words (LN LW) from the logarithm of cumulative frequency (LN CF). Similar factors have dependences of logarithms of lengths of words on the logarithm of their frequency and logarithms of length of words on cumulative frequency

### References

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# Ranking distribution of lengths of words, frequencies and quantities of words in poems of the poet of the beginning of XX century of M.A. Kuzmin

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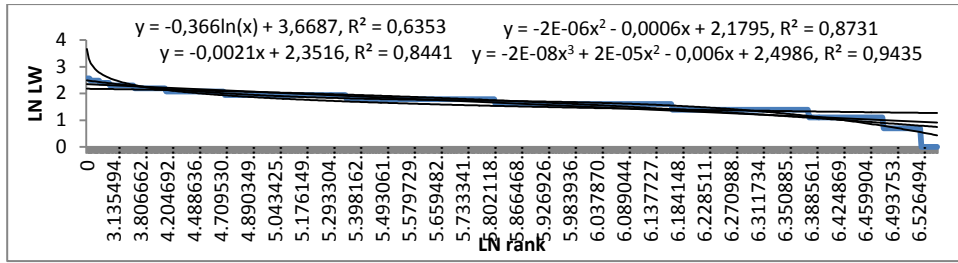
## Abstracts

The total of words in M.A.Kuzmin's poems [1] is made 698, and with their frequency - 982 by a technique [2] with the general number of ranks 3905. The cumulative length of a word has made 3905, and cumulative frequency - 982. Are investigated ranking distributions: the logarithm of lengths of words from the logarithm of a rank of the logarithm of length of a word from the logarithm of cumulative frequency, the logarithm of length of a word from the logarithm of cumulative length of a word, the logarithm of cumulative length of a word from the logarithm of a rank, and also distribution of the logarithm of cumulative frequency of a word from the logarithm of a rank, the logarithm of cumulative length of a word from the logarithm of length of words and dependence of the logarithm of cumulative length of a word on frequency. For reception of adequate mathematical dependences experimental data resulted to кумуляте and represented as logarithms. It is shown, that the length of a word is inversely proportional to its frequency, cumulative frequency, cumulative quantity of words and logarithms: Frequencies of words, cumulative quantity of words and cumulative frequency of words. The specified dependences investigated on the linear, sedate, logarithmic equations and polynoms of the second and third degrees. Dependences of the logarithm of lengths of words on the logarithm of a rank and dependence of the logarithm of length of a word on the logarithm of cumulative length of a word are described by the identical equations. Dependence of the logarithm of length of a word on the logarithm of cumulative frequency is described by polynoms of the second and third degrees with average length of a word on the linear equation 2.3516. Dependence of the logarithm of cumulative length of a word on the logarithm of a rank is submitted by the sedate equation, polynoms of the third degree and the logarithmic equation with average cumulative length of a word on the linear equation 6,4043 and relative speed of cumulative length of a word on the sedate equation 0,1243. Dependence of the logarithm of cumulative frequency of a word on the logarithm of a rank polynoms of the third degree and the logarithmic equation with average cumulative length of a word on the linear equation 4,0658. Dependence of the logarithm of cumulative length of a word on the logarithm of length of words and dependence of the logarithm of cumulative length of a word on frequency are approximated by the identical equations: a polynom of the second degree, the sedate equation and a polynom of the third degree with average cumulative frequency on the linear equation 6,4043 and relative speed of cumulative length of words 0,1243. Relative speed in sedate dependence for the given dependences can be positive or negative and serves for an estimation of the concrete text. Logarithms of lengths of words change from 2,5649 up to 0, logarithms of frequency of words - from 1,0986 up to 4,4308, logarithms of quantity of words - 1,0986 up to 2,6391, cumulative frequency- 1,0986 up to 6,8895 and cumulative quantity(amount) of words - from 1,0986 up to 6,5482. At ranking distribution curves of logarithms of cumulative frequency and logarithms of cumulative quantity of words from logarithms of length will not be imposed against each other and the curve of logarithms of cumulative quantity of words will be above a curve of cumulative frequency

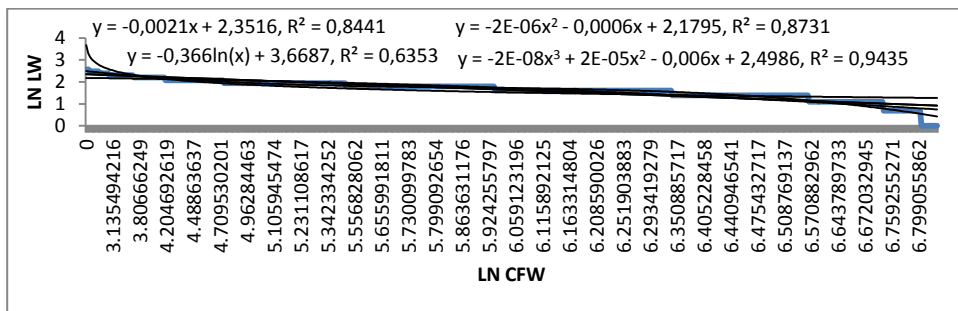
**Keywords:** quantity of words, frequency of words, length of words, dynamics of quantity of words, dynamics of length of words, average length of words, cumulative quantity of words, cumulative frequency of words, modeling, linear dependence, sedate dependence, logarithmic dependence, polynoms of the second degree, polynoms of the third degree

The total of words in M.A.Kuzmin's poems [1] is made 698, and with their frequency - 982 by a technique [2] with the general number of ranks 3905. The cumulative length of a word has made 3905, and cumulative frequency - 982. Dependences of the logarithm of lengths of words on the logarithm of a rank (Figs 1), and dependence of the logarithm of length of a word on the logarithm of cumulative length of a word (Figs 2) are described by the identical equations:  $y = -0,366 \ln(x) + 3,6687$ ,  $R^2 = 0,6353$ ;  $y = -0,0021x + 2,3516$ ,  $R^2 = 0,8441$ ;  $y = -2E-06x^2 - 0,0006x +$

2,1795,  $R^2 = 0,8731$  and  $y = -2E-08x^3 + 2E-05x^2 - 0,006x + 2,4986$ ,  $R^2 = 0,9435$  with average length of a word on the linear equation of 2,3516 (Figs 1).

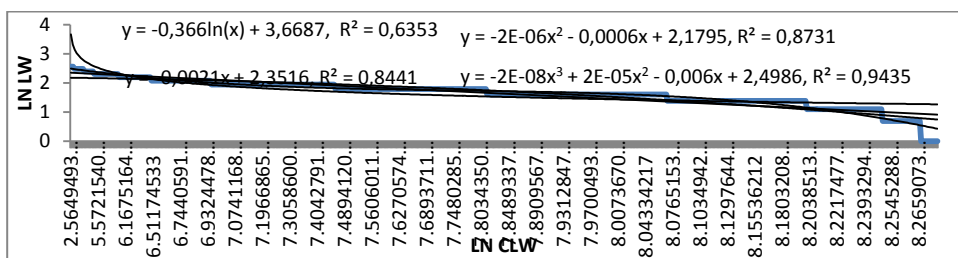


Figs 1. Dependence of the logarithm of lengths of words (LN LW) on the logarithm of a rank (LN rank)



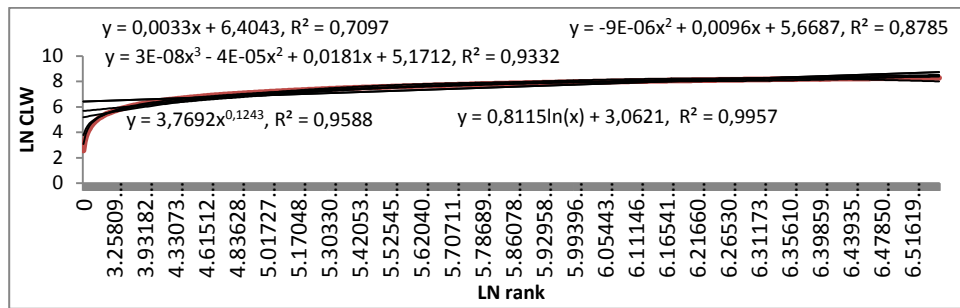
Figs 2. Dependence of the logarithm of length of a word (LN LW) on the logarithm of cumulative frequency of a word (LN CFW)

Dependence of the logarithm of length of a word on the logarithm of cumulative frequency (Figs 3) is described by the equations:  $y = -0,0021x + 2,3516$ ,  $R^2 = 0,8441$ ;  $y = -0,366\ln(x) + 3,6687$ ,  $R^2 = 0,6353$ ;  $y = -2E-06x^2 - 0,0006x + 2,1795$ ,  $R^2 = 0,8731$ ;  $y = -2E-08x^3 + 2E-05x^2 - 0,006x + 2,4986$ ,  $R^2 = 0,9435$  with average length of a word on the linear equation 2.3516.



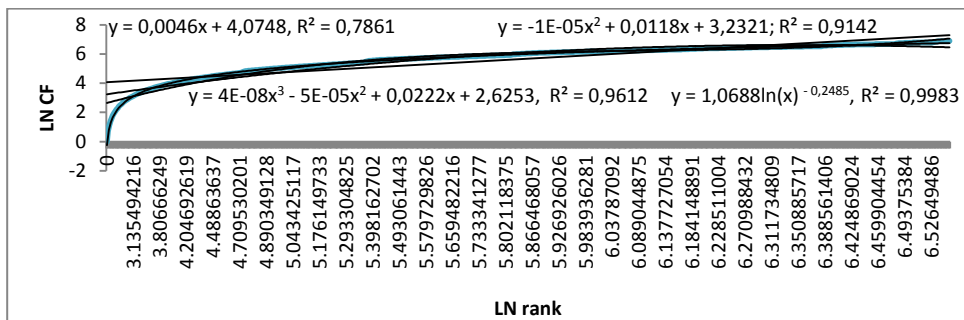
Figs 3. Dependence of the logarithm of length of a word (LN LW) on the logarithm of cumulative length of a word (LN CLW)

Dependence of the logarithm of cumulative length of a word on the logarithm of a rank (figs 4) is submitted by the following equations:  $y = 0,0033x + 6,4043$ ,  $R^2 = 0,7097$ ;  $y = -9E-06x^2 + 0,0096x + 5,6687$ ,  $R^2 = 0,8785$ ;  $y = 3E-08x^3 - 4E-05x^2 + 0,0181x + 5,1712$ ,  $R^2 = 0,9332$ ;  $y = 3,7692x^{0,1243}$ ,  $R^2 = 0,9588$  and  $y = 0,8115\ln(x) + 3,0621$ ,  $R^2 = 0,9957$  with average cumulative length of a word on the linear equation 6,4043 and relative speed of cumulative length of a word on the sedate equation 0,1243.



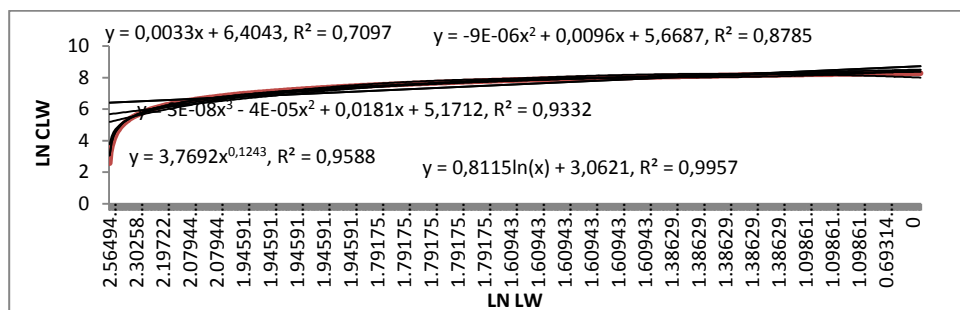
Figs 4. Dependence of the logarithm of cumulative length of a word (LN CLW) on the logarithm of a rank (LN rank)

Dependence of the logarithm of cumulative frequency of a word on the logarithm of a rank (Figs. 5) it is described by the equations:  $y = 0,0046x + 4,0748, R^2 = 0,7861$ ;  $y = -1E-05x^2 + 0,0118x + 3,2321; R^2 = 0,9142$ ;  $y = 4E-08x^3 - 5E-05x^2 + 0,0222x + 2,6253, R^2 = 0,9612$  and  $y = 1,0688\ln(x) - 0,2485, R^2 = 0,9983$  with average cumulative frequency on the linear equation 4,0658.

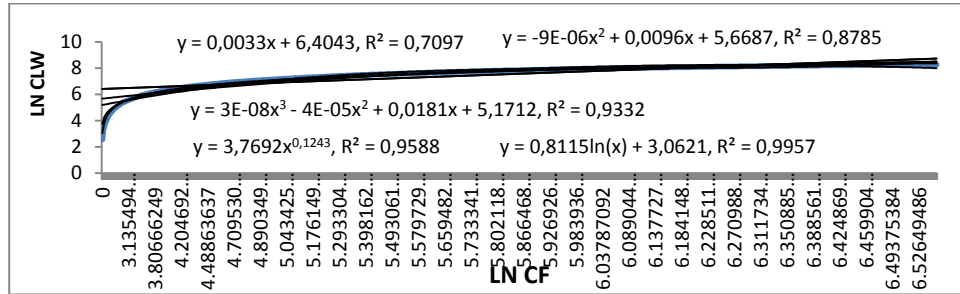


Figs. 5. Dependence of the logarithm of cumulative frequency of words (LN CFW) on the logarithm of a rank (LN rank)

Dependence of the logarithm of cumulative length of a word on the logarithm of length of words (Figs 6) and dependence of the logarithm of cumulative length of a word on frequency (Figs 7) are approximated by the identical equations:  $y = 0,0033x + 6,4043, R^2 = 0,7097$ ;  $y = -9E-06x^2 + 0,0096x + 5,6687, R^2 = 0,8785$ ;  $y = 3E-08x^3 - 4E-05x^2 + 0,0181x + 5,1712, R^2 = 0,9332$ ;  $y = 3,7692x^{0,1243}, R^2 = 0,9588$  and  $y = 0,8115\ln(x) + 3,0621, R^2 = 0,9957$  with average cumulative frequency on the linear equation 6,4043 and relative speed of cumulative length of words 0,1243.



Figs 6. Dependence of the logarithm of cumulative length of a word on the logarithm of length of words



Figs 7. Dependence of the logarithm of cumulative length of a word on the logarithm of cumulative frequency

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# *Hapax legomena* in A.S. Pushkin, B.L. Pasternak, A.A. Ahmatova and I.A. Brodsky's verses

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## *Abstract*

Distinction of volumes of dictionaries and texts on hapax legomena in A.S. Pushkin, B.L. Pasternak, A.A. Ahmatova and I.A. Brodsky's poetic products is shown. And volumes of dictionaries exceed volumes of texts from 3.05 (I.A. Brodsky verses 1957 - till winter of 1963) up to 1.07 times (A.A. Ahmatova "Plantain"). It is necessary to note, that verses 1957 - till winter of 1963. I.A. Brodsky under the relation of volume of the dictionary to volume of the text exceeds all investigated poetic products. It concerns and to a poem «The Fairy tale on tsar Saltan» A.S. Pushkin that confirms I.A. Brodsky and A.S. Pushkin's genius that is marked in our early works. Under the relation of volume of the dictionary to volume of the text it is possible to reveal similarity of poetic language of the investigated poets: A.S. Pushkin - I.A. Brodsky, A.A. Ahmatova - A.S. Pushkin, A.A. Ahmatova - A.S. Pushkin - I.A. Brodsky, A.S. Pushkin - A.A. Ahmatova, B.L. Pasternak - A.S. Pushkin, B.L. Pasternak - A.A. Ahmatova - A.S. Pushkin, B.L. Pasternak - A.A. Ahmatova and A.A. Ahmatova - B.L. Pasternak. The riches of the dictionary of poems of A.S. Pushkin "The Fairy tale on tsar Saltan" and "Ruslan and Lyudmila" are higher than collections of verses of B.L. Pasternak, A.A. Ahmatova and I.A. Brodsky. It concerns and to A.A. Ahmatova's poem "At the most dark blue sea" in comparison with collections of verses of A.A. Ahmatova and B.L. Pasternak.

**Key words:** volume of the dictionary, volume of the text, the attitude (relation) of volume of the dictionary to volume of the text, A.S. Pushkin, B.L. Pasternak, A.A. Ahmatova, I.A. Brodsky, Russian poetry,

The purpose of research – definition of quantity and properties of disposable words – *hapax legomena* in A.S. Pushkin, B.L. Pasternak, A.A. Ahmatova and I.A. Brodsky's verses for definition of riches of the dictionary and the text and revealing of conducting poets.

Data acquisition is lead by a technique [1], and their processing under program Excel.

The received results are resulted in tab. 1.

Table 1

№	The name	$N(F=1)/V$	$N(F=1)/N$	№	The name	$N(F=1)/V$	$N(F=1)/N$
1	A.S. Pushkin verses 1813-1817	0.6972	0.2761	21	B.L. Pasternak "Verses of different years"	0.8460	0.5097
2	A.S. Pushkin verses 1817-1820	0.7752	0.3841	22	A.A. Ahmatova «Anno Domini»	0.8090	0.4355
3	A.S. Pushkin verses 1820-1824	0.7112	0.2978	23	A.A. Ahmatova "Evening"	0.7959	0.4638
4	A.S. Pushkin verses 1823-1826	0.7458	0.3536	24	A.A. Ahmatova "Plantain"	0.9197	0.8597
5	A.S. Pushkin verses 1827-1830	0.7717	0.3910	25	A.A. Ahmatova "Flight of time"	0.7725	0.3484
6	A.S. Pushkin verses 1831-1834	0.7464	0.3468	26	A.A. Ahmatova "The Poem without the hero»	0.8327	0.4932
7	A.S. Pushkin verses 1835-1836	0.8313	0.5027	27	A.A. Ahmatova a verse "By the all ground»	0.8701	0.7111
8	A.S. Pushkin a poem "The Bakhchisarai fountain"	0.8073	0.5133	28	A.A. Ahmatova "Requiem"	0.8402	0.5730
9	A.S. Pushkin a poem "Ruslan and Lyudmila"	0.7109	0.3258	29	A.A. Ahmatova "The Seventh book»	0.7962	0.4154
10	A.S. Pushkin a poem "The Fairy tale on tsar Saltan"	0.6542	0.2350	30	A.A. Ahmatova "Reed"	0.8398	0.5435
11	B.L. Pasternak a poem "Lieutenant Schmidt"	0.8703	0.5470	31	A.A. Ahmatova a verse "At the most dark blue sea"	0.8164	0.5125

12	B.L.Pasternak "By early trains"	0.8741	0.5469	32	A.A.Ahmatova "Are precise"	0.7560	0.4069
13	B.L.Pasternak a poem "1905"	0.8804	0.5919	33	I.A.Brodsky verses 1957-till winter of 1963.	0.6767	0.2221
14	B.L.Pasternak "Themes and variations"	0.8559	0.5084	34	I.A.Brodsky verses from winter 1963 till 1964	0.7197	0.2856
15	B.L.Pasternak "Rebirth"	0.8439	0.4860	35	I.A.Brodsky verses 1964 - 1968	0.7368	0.2868
16	B.L.Pasternak "High illness"	0.8704	0.6034	36	I.A.Brodsky verses of 1968-1972	0.7593	0.3205
17	B.L.Pasternak "When will clear up"	0.8469	0.5137	37	I.A.Brodsky verses 1973 - 1981	0.7537	0.3461
18	B.L.Pasternak "Initial is time"	0.8620	0.6113	38	I.A.Brodsky verses of 1981-1992	0.7703	0.3572
19	B.L.Pasternak "Atop of barriers"	0.8580	0.5231	39	I.A.Brodsky verses 1993 - <1990th>	0.7873	0.3880
20	B.L.Pasternak "The Sister - my life"	0.9843	0.5779				

Volumes of dictionaries  $N(F=I)/V$  and texts  $N(F=I)/N$  A.S. Pushkin, B.L. Pasternak, A.A. Ahmatova and I.A. Brodsky's products

So, on volume of the dictionary of poems and A.S. Pushkin's poems settled down, since the greatest size, as follows: verses 1835 - 1836 (0.8313), a poem "The Bakhchisarai fountain" (0.8073), verses of 1817 - 1820 (0.7752), 1827 - 1830 (0.7717), 1831 - 1834 (0.7464), 1823 - 1826 (0.7458), 1820 - 1824 (0.7112), a poem "Ruslan and Lyudmila" (0.7109), A.S. Pushkin 1813-1817 (0.6972) and a poem "The Fairy tale on tsar Saltan" (0.6542).

The greatest volume of the dictionary of poems and A.S. Pushkin's poems concerned to verses of 1835-1836 and to a poem "The Bakhchisarai fountain", and the least - to a poem "The Fairy tale on tsar Saltan".

And on volume of the text of a poem of A.S.Pushkin settled down, since the greatest size, as follows: a poem "The Bakhchisarai fountain" (0.5133), verses of 1835 - 1836 (0.5027), 1827 - 1830 (0.3910), 1817 - 1820 (0.3841), 1823 - 1826 (0.3536), 1831-1834 (0.3468), a poem "Ruslan and Lyudmila" (0.3258), 1820 - 1824 (0.2978) A.S. Pushkin 1813-1817 (0.2761) and a poem "The Fairy tale on tsar Saltan" (0.2350).

The greatest volume of the text of poems and A.S. Pushkin's poems concerned to a poem «the "The Bakhchisarai fountain" and to verses 1835 - 1836 and the least - to a poem "The Fairy tale on tsar Saltan".

So, on volume of the dictionary of a poem of B.L. Pasternak settled down, since the greatest size, as follows: "The Sister - my life" (0.9843), a poem "1905" (0.8804), "By early trains" (0.8741), "High illness" (0.8704), a poem "Lieutenant Schmidt" (0.8703), "Initial is time" (0.8620), "Atop of barriers" (0.8580), "Themes and variations" (0.8559), "When will clear up" (0.8469) and "Rebirth" (0.8439).

The greatest volume of the dictionary of poems and B.L. Pasternak's poems concerned to "The Sister - my life" and the least - "When will clear up" and "Rebirth".

And on volume of the text of a poem of B.L. Pasternak settled down, since the greatest size, as follows: "Verses of different years" (0.8460), "When will clear up" (0.6113), "Rebirth"

(0.6034), "By early trains" (0.5919), "Atop of barriers" (0.5779), "Verses of different years" (0.5470) the poem "Lieutenant Schmidt" (0.5469), "Initial is time" (0.5231), "High illness" (0.5137), "The Sister - my life" (0.5097), a poem "1905" (0.5084) and "Themes and variations" (0.4860).

The greatest volume of the text of poems and B.L. Pasternak's poems concerned to "Verses of different years", and the least - to "Themes and variations" (0.4860).

So, on volume of the dictionary of a poem of A.A. Ahmatova settled down, since the greatest size, as follows: "Plantain" (0.9197), verse "At the most dark blue sea" (0.8164), "Anno Domini" (0.8090), "The Seventh book" (0.7962), "Evening" (0.7959), "Flight of time" (0.7725) also "Are precise" (0.7560).

The greatest volume of the dictionary of poems and A.A. Ahmatova's poems concerned to "Plantain" at and to a verse "By the all ground".

And on volume of the text of a poem of A.A. Ahmatova settled down, since the greatest size, as follows: "Plantain" (0.8597), a verse "By the all ground" (0.7111), "Requiem" (0.5730), "Reed" (0.5435), a verse "At the most dark blue sea" (0.5125), "The Poem without the hero" (0.4932), "Evening" (0.4638), "Anno Domini" (0.4355), "The Seventh book" (0.4154), "Are precise" (0.4069) and "Flight of time" (0.3484).

The greatest volume of the text of verses and A.A. Ahmatova's poems concerned to "Plantain" at.

So, on volume of the dictionary of a verses of I.A. Brodsky settled down, since the greatest size, as follows: verses 1993 - <1990th> (0.7873), 1981 - 1992 (0.7703), 1968 - 1972 (0.7593), 1973 - 1981 (0.7537), 1964 - 1968 (0.7368), from winter 1963 - up to 1964 (0.7197) and 1957 - till the winter 1963 (0.6767).

The greatest volume of the dictionary of poems of I.A. Brodsky concerned to verses 1993 - <1990th>, 1981 - 1992, 1968 - 1972, 1973 - 1981, 1964 - 1968. And on volume of the text of a verses of I.A. Brodsky settled down, since the greatest size, as follows: verses 1993 - <1990th> (0.3880), 1981 - 1992 (0.3572), 1973 - 1981 (0.3461), 1968 - 1972 (0.3205), 1964 - 1968 (0.2868), from winter 1963 - up to 1964 (0.2856) and 1957 - till the winter 1963 (0.2221).

The greatest volume of the text of verses of I.A. Brodsky concerned to verses 1993 - <1990th>, 1981 - 1992, 1973 - 1981 and 1968 - 1972.

Let's lead the comparative analysis of volume of dictionaries under formula  $N(F=I)/V$  A.S. Pushkin, B.L. Pasternak, A.A. Ahmatova and I.A. Brodsky's investigated poems, since the greatest

size: B.L. Pasternak "The Sister - my life" (0.9843), A.A.Ahmatova "Plantain" (0.9197), B.L. Pasternak a poem "1905" (0.8804), "By early trains" (0.8741), "High illness" (0.8704), a poem "Lieutenant Schmidt" (0.8703), A.A. Ahmatova a verse "By the all ground" (0.8701), "Initial is time" to B.L. Pasternak (0.8620), «Atop of barriers» (0.8580), «Themes and variations" (0.8559), "When will clear up" (0.8469), "Rebirth" (0.8439), A.A. Ahmatova "Requiem" (0.8402), "Reed" (0.8398), "The Poem without the hero" (0.8327), A.S. Pushkin verses 1835-1836 (0.8313), A.A. Ahmatova a verse "At the most dark blue sea" (0.8164), "Anno Domini" (0.8090), B.L. Pasternak "Verses of different years" (0.8460). A.S. Pushkin a poem "The Bakhchisarai fountain" (0.8073), A.A.Ahmatova "The Seventh book" (0.7962), "Evening" (0.7959), I.A. Brodsky a verses 1993 - <1990th> (0.7873), A.S. Pushkin verses 1817-1820 (0.7752), A.A. Ahmatova "Flight of time" (0.7725), A.S. Pushkin verses 1827-1830 (0.7717), I.A. Brodsky verses 1981-1992 (0.7703), 1968-1972 (0.7593), A.A.Ahmatova "Are precise" (0.7560), I.A. Brodsky verses 1973 - 1981 (0.7537), A.S. Pushkin verses 1831-1834 (0.7464), 1823-1826 (0.7458), I.A.Brodsky verses 1964 - 1968 (0.7368), From winter 1963 up to 1964 (0.7197), A.S. Pushkin verses 1820-1824 (0.7112), a poem "Ruslan and Lyudmila" (0.7109), A.S. Pushkin verses 1813-1817 (0.6972), I.A. Brodsky verses 1957 - till the winter 1963 (0.6767) and A.S. Pushkin a poem "The Fairy tale on tsar Saltan» (0.6542).

Most close products on volume of dictionaries are observed:

B.L. Pasternak "The Sister - my life", A.A. Ahmatova "Plantain";

B.L. Pasternak a poem "1905", "By early trains", "High illness", a poem "Lieutenant Schmidt", A.A. Ahmatova a verse "By the all ground", "Initial is time" to B.L. Pasternak, "Atop of barriers", "Themes and variations", "When will clear up", A.A.Ahmatova "Requiem", "Reed", "The Poem without the hero", A.S. Pushkin verses of 1835-1836, A.A.Ahmatova a verse "At the most dark blue sea", B.L. Pasternak "Verses of different years", "Rebirth", A.A. Ahmatova "Anno Domini" and A.S. Pushkin a poem "The Bakhchisarai fountain";

A.A. Ahmatova "The Seventh book", "Evening", I.A. Brodsky verses 1993 - <1990th>, A.S. Pushkin verses of 1817-1820. A.A. Ahmatova "Flight of time", A.S. Pushkin verses of 1827-1830. I.A. Brodsky verses of 1981-1992, verses of 1968-1972, A.A. Ahmatova "Are precise", I.A. Brodsky verses 1973 - 1981, A.S. Pushkin verses of 1831-1834, 1823-1826, I.A. Brodsky verses 1964 - 1968, verses from winter 1963 till 1964, A.S. Pushkin verses of 1820-1824, a poem "Ruslan and Lyudmila", A.S. Pushkin verses of 1813-1817 and I.A.Brodsky verses 1957 - till winter of 1963 and A.S. Pushkin a poem "The Fairy tale on tsar Saltan".



Let's lead the comparative analysis of volume of texts under formula  $N(F=1)/N$  the investigated poems and A.S. Pushkin, B.L. Pasternak, A.A. Ahmatova and I.A. Brodsky's poems, since the greatest size: A.A. Ahmatova "Plantain" (0.8597), A.A. Ahmatova a verses "By the all ground" (0.7111), "Initial is time" to B.L. Pasternak (0.6113), B.L. Pasternak "High illness" (0.6034), B.L. Pasternak a poem "1905" (0.5919), B.L. Pasternak "The Sister - my life" (0.5779), A.A. Ahmatova "Requiem" (0.5730), B.L. Pasternak a poem "Lieutenant Schmidt" (0.5470), B.L. Pasternak "By early trains" (0.5469), A.A. Ahmatova "Reed" (0.5435), B.L. Pasternak "Atop of barriers" (0.5231), B.L. Pasternak "When will clear up" (0.5137), A.S. Pushkin a poem "The Bakhchisarai fountain" (0.5133), A.A. Ahmatova a verses "At the most dark blue sea" (0.5125), B.L. Pasternak "Verses of different years" (0.5097), B.L. Pasternak "Themes and variations" (0.5084), A.S. Pushkin a verses 1835-1836 (0.5027), A.A. Ahmatova "The Poem without the hero" (0.4932), B.L. Pasternak "Rebirth" (0.4860), A.A. Ahmatova "Evening" (0.4638), A.A. Ahmatova «Anno Domini» (0.4355), A.A. Ahmatova "The Seventh book" (0.4154), A.A. Ahmatova "Are precise" (0.4069), A.S. Pushkin a verses 1827-1830 (0.3910), I.A. Brodsky verses 1993 - <1990th> (0.3880), A.S. Pushkin verses 1817-1820(0.3841), I.A. Brodsky verses 1981-1992(0.3572), A.S. Pushkin verses 1823-1826 (0.3536), A.A. Ahmatova "Flight of time" (0.3484), A.S. Pushkin verses 1831-1834 (0.3468), I.A. Brodsky verses 1973-1981 (0.3461), A.S. Pushkin a poem "Ruslan and Lyudmila" (0.3258), I.A. Brodsky verses 1968-1972 (0.3205), A.S. Pushkin verses 1820-1824 (0.2978), I.A. Brodsky verses 1964 – 1968 (0.2868), verses From winter 1963 till 1964. (0.2856), A.S. Pushkin verses 1813-1817 (0.2761), a poem "The Fairy tale on tsar Saltan" (0.2350) and I.A. Brodsky verses 1957-till the winter 1963 ( 0.2221).

Most close products on volume of the text are observed:

B.L. Pasternak "Initial is time" and "High illness";

B.L. Pasternak "The Sister - my life" and A.A. Ahmatova "Requiem";

B.L. Pasternak a poem "Lieutenant Schmidt", "By early trains" and A.A. Ahmatova "Reed";

B.L. Pasternak "Atop of barriers", "When will clear up", A.S. Pushkin a poem "The Bakhchisarai fountain" and A.A. Ahmatova a verse "At the most dark blue sea", B.L. Pasternak "Verses of different years", "Themes and variations" and A.S. Pushkin verses of 1835-1836;

A.A. Ahmatova "The Poem without the hero" and B.L. Pasternak "Rebirth";

A.S. Pushkin verses of 1827-1830. I.A. Brodsky verses 1993 - <1990th>, A.S. Pushkin verses of 1817-1820;

I.A. Brodsky verses of 1981-1992, A.S. Pushkin verses of 1823-1826, A.A. Ahmatova "Flight of time", A.S. Pushkin verses of 1831-1834 and I.A. Brodsky verses 1973 - 1981;

A.S. Pushkin a poem "Ruslan and Lyudmila", I.A. Brodsky verses of 1968-1972 and A.S. Pushkin verses of 1820-1824 and verses of 1813-1817;

I.A. Brodsky verses 1964 - 1968, verses from winter 1963 till 1964;

A.S. Pushkin a poem "The Fairy tale on tsar Saltan" and I.A. Brodsky verses 1957-till winter of 1963.

Table 2

The relation of volumes of dictionaries to volume of texts of poetic products of A.S. Pushkin, B.L. Pasternak, A.A. Ahmatova and I.A. Brodsky

The name	V/N	The name	V/N
I.A. Brodsky verses 1957-till winter of 1963.	3,0468	A.A. Ahmatova "Evening"	1,7160
A.S. Pushkin a poem "The Fairy tale on tsar Saltan"	<b>2,7838</b>	B.L. Pasternak "The Sister - my life"	1,7032
I.A. Brodsky verses 1964 - 1968	2,5690	A.A. Ahmatova "The Poem without the hero"	1,6884
A.S. Pushkin verses 1813-1817	<b>2,5252</b>	B.L. Pasternak "Themes and variations"	1,6835
I.A. Brodsky verses from winter 1963 till 1964	2,5200	B.L. Pasternak "Verses of different years"	1,6598
A.S. Pushkin verses 1820-1824	<b>2,3882</b>	A.S. Pushkin verses 1835-1836	<b>1,6537</b>
I.A. Brodsky verses of 1968-1972	2,3691	B.L. Pasternak "When will clear up"	1,6486
A.A. Ahmatova "Flight of time"	2,2173	B.L. Pasternak "Atop of barriers"	1,6402
A.S. Pushkin a poem "Ruslan and Lyudmila"	<b>2,1820</b>	B.L. Pasternak "By early trains"	1,5983
I.A. Brodsky verses 1973 - 1981	2,1777	A.A. Ahmatova a verse "At the most dark blue sea"	1,5930
I.A. Brodsky verses of 1981-1992	2,1565	B.L. Pasternak a poem "Lieutenant Schmidt"	1,5910
A.S. Pushkin verses 1831-1834	<b>2,1522</b>	A.S. Pushkin a poem "The Bakhchsarai fountain"	<b>1,5728</b>
A.S. Pushkin verses 1823-1826	<b>2,1092</b>	A.A. Ahmatova "Reed"	1,5452
I.A. Brodsky verses 1993 - <1990th>	2,0291	B.L. Pasternak a poem "1905"	1,4874
A.S. Pushkin verses 1817-1820	<b>2,0182</b>	A.A. Ahmatova "Requiem"	1,4663
A.S. Pushkin verses 1827-1830	<b>1,9737</b>	B.L. Pasternak "High illness"	1,4425
A.A. Ahmatova "The Seventh book"	1,9167	B.L. Pasternak "Initial is time"	1,4101
A.A. Ahmatova "Are precise"	1,8580	A.A. Ahmatova a poem "By the all ground"	1,2236
A.A. Ahmatova "Anno Domini"	1,8576	A.A. Ahmatova "Plantain"	1,0698
B.L. Pasternak "Rebirth"	1,7364		

Thus, distinction of volumes of dictionaries and texts on *hapax legomena* in poetic products A.S. Pushkin, B.L. Pasternak, A.A. Ahmatova and I.A. Brodsky (tab. 2) is shown.

Under the relation of volume of the dictionary to volume of the text it is possible to reveal similarity of poetic language of the investigated poets: A.S. Pushkin – I.A. Brodsky, A.A. Ahmatova – A.S. Pushkin, A.A. Ahmatova – A.S. Pushkin – I.A. Brodsky, A.S. Pushkin – A.A. Ahmatova, B.L. Pasternak – A.S. Pushkin, B.L. Pasternak – A.A. Ahmatova – A.S. Pushkin, B.L. Pasternak – A.A. Ahmatova and A.A. Ahmatova – B.L. Pasternak.

And volumes of dictionaries exceed volumes of texts from 3.05 (I.A. Brodsky verses 1957 - till winter of 1963) up to 1.07 times (A.A. Ahmatova "Plantain").

It is necessary to note, that verses 1957 - till winter of 1963. I.A. Brodsky under the relation of volume of the dictionary to volume of the text exceeds all investigated poetic products. It concerns and to a poem "The Fairy tale on tsar Saltan" A.S. Pushkin that confirms I.A. Brodsky and A.S. Pushkin's genius that is resulted in our early works [2-3].

The riches of the dictionary of poems of A.S. Pushkin "The Fairy tale on tsar Saltan" and "Ruslan and Lyudmila" are higher than collections of verses of B.L. Pasternak, A.A. Ahmatova and I.A. Brodsky. It concerns and to A.A. Ahmatova's poem "At the most dark blue sea" in comparison with collections of verses of A.A. Ahmatova and B.L. Pasternak.

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# SOCIAL CONDITIONS FORMED IN JALOLIDDIN RUMIY'S IDEAS

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## *Abstract*

Great scientist Jaloliddin Rumiyy's life and activity is pedagogically analyzed in this article. It studies the period of Rumiyy's life and his mentors who taught him.

**Keywords:** mutazaliys, science of kalam, mentor, education, psychological and spiritual power, poetry, contemplation.

The great representative of the XIII century Sufism, popular mentor of his period Jaloliddin Rumiyy stands before our eyes as spiritually great teacher of his period. It is necessary to study the role of mentors and social conditions in his becoming so great scientist and creating invaluable literary works.

Jaloliddin Rumiyy's real name is mentioned as Muhammad ibn Muhammad bin Husayn al-Balkhiy. His friends appreciated him as Mavlono, at the same time he had several pen-names like "Jaloliddin", "Rumiyy", "Mavlaviy. Mavlono was born in 604 of hijria, in the sixth day of Rabbiulavval (1207, September 30) in "Ummul-bilod" ("Mother of cities") which meant Balkh. His father Bahouddin Muhammad (Bahovalad) was a famous speaker of the city. Aflokiy wrote that his father called him "Khudovandigor". "Khudovandigor" means "sir", "master" and usually replaced "Khodja" to express high spirituality and social respect towards the man. Pen-name "Mavlono" given to Rumiyy in arabian stands for "sir", "khodja". The root of the word is "mavlo", and in plural it is "mavoliy". [6, 7]

Rumiyy created and left to his generation five permanent and invaluable literary works. They are: "**Devoni kabir**", ("**Devoni Shamsi Tabriziy**", "**Devoni shamsul**

**haqoyiq**) which include his famous gazals and rubai. "**Masnaviyi ma'naviy**" – highly appreciated literary educational work consisted of 51400 lines. "**Fiyhi ma fiyhi**" - philosophical book which contain Mavlono's conversations. The title means that everything in mind should be in. "**Mavoizi majolisi sab'a**" - this book contains Rumi's seven advices and teachings. "**Maktubot**" – collection of Mavlono's letters written to his contemporaries in different times.

Speaking about Rumi, his life and literary activity in "Mahbub ul-qulub", Navai divided writers into three groups, and underlined that Rumi belongs to the first one. Navai said that as a great creator of his period Rumi was a talented diver into the sea of knowledge and he appreciated God as a ruler of earth and sky, together with a man as his messenger in the land. [1, 24 – 25]

It is important to know contemporary social, cultural, scientific, political and other conditions and setting together with personage before beginning to study the life of any outstanding or ordinary person. Jaloliddin Rumi's life and literary activity, his social, philosophical and pedagogical thinking is closely connected with the period of Muhammad Khorazmshoh' reign (1199-1221) and his fight against Chingizkhan (1161-1227) who tried to build Mongolian state, and also with that period when scientific circles in Muslim world tried to give smart evidence and comparison to clever motions of that time.

Mongolian invasion stopped financial and spiritual civilization for some hundred years. The main theme of people interest and tries became the limitless hatred to Mongolian invaders, cursing them, and appreciating great humanistic features. All these found their expression in folkloric and historical works of that time. By that century there were no conditions for literary representatives to create any literary or historical work. Those who survived of Mongolian terror by a chance left their countries and had to find a roof over their head in another countries. Most of them moved to India, Iran, Turkey, Egypt and other countries of near East. Poets and writers from Central Asia made their own contribution in the development of other countries culture and literature. Most of the writers and poets of that period had chosen Sufism as the main

direction of their creations, all scientific circles and thinking actions became concretely devoted to finding smart evidences and comparisons. It became an ordinary necessity for scientists and other people of science to bring examples of smart evidence and philosophical introductions to prove a real truth in their works. That's why contemporary Kalam science (analytical study of "Koran") and philosophy (science of thinking) dominated all other sciences of that period. Nothing can be done without these two sciences. Educational system of that period was closely connected with "Koran" teaching and learning hadis simultaneously with studying instructions given in hadis. Advice, given in "Koran" and hadis, influenced works and creations of scientists and writers of the time. Main features of Muslim as honesty, generosity, kindness, charity, shame, science, tutor-student relationship, rules of treatment, criteria of up-bringing and others find their reflection in those works. They also had an influence on East literature, especially, on educational and upbringing works. Educational and upbringing works were created according the ideas given in hadis.

Studying Mavlonο Jaloliddin Rumi'y's life and literary activity, we can mention many features that can have an impact on man's personality. The head of those features was his father Bahouddin Valad, famous statesman and scientist of his time and country. Also he was called "sultan of scientists". Jaloliddin Rumi'y's father Bahoudin Valad criticizes that kind people of that time didn't appreciate mankind; they became slaves of greed and vanity. In his report, named "Maorif" he wrote that he had debates with Khorazmshoh, Fakhriy Roziy in Balkh, and said, "You are just prisoners of simple reality and you are too far of understanding a real truth." [6, 9]

That period was the weakened time of love to life, calmness of heart, inner believe and devotedness. Islamic world needed a person who could give new inspiration to the society with his clean heart, conscious and support. That man should be a person who would be able to correct the mistakes of such brain and mind subjects as philosophy, who could untie the thrombs and give believe to hearts. That person appeared in the face of Mavlonο Jaloliddin Rumi'y. Jaloliddin Rumi'y "appeared on the field of life which rejected the personality of man and neglected his estimation and

Mavlono Rumi could awaken the motion of buried humanity with his world known poetry which flourished among the ruins of contemporary literature.” [3,120-121]

As legends say, Jaloliddin’s mother Mumina Xotun was a daughter of Balkh Emir Rukniddin, her predecessors were the same of Mohammed prophet, his father’s side was closely connected with the first khalif of Islam Abu Bakr Siddiq. In his “Nasoyim ul-muhabbat” Alisher Navai wrote that mother of Bahouddin Valad was a daughter of Khorasan shah Alouddin Mohammed Khorazmshah”. It is also written that prophet gave him hint in his dream to give his daughter to Husayn khatib (Bahouddin’s father). The title of Sultan ul-ulamo was given to Bahouddin valad in his dream by prophet Mohammed. [2, 324]

Bahouddin Valad was known and deeply respected not only in Balkh, where his predecessors were great calligraphers of contemporary life, but also in Khorasan, Maveraunnahr, Iraq, Bagdad. Bahouddin Valad and Sheikh Majiddin Bagdodiy, who was killed by Khorazmshah, were taught by Sheikh Najmiddin Kubro (1154-1226) (Sheikh Valiytarosh – person upbringing saint people) and understood sufferings of ordinary people. During his reign Khorazmshah Muhammad could not get on with Chingizkhan and made several mistakes in managing the country, but the reason of all those mistakes was his mother Turkon Khatun. Because people of the country were of different generation and the government was divided between Khorazmshah Muhammad and his mother Turkon Khatun. [8, 314]

In 1212 when Muhammad Khorazmshah had a battle with Sultan Usmon and invaded Samarkand, Bahouddin Valad lived there with his family. Those years many scientists and intelligent people of Khorasan and Iraq had to leave the territory of Khorazmshah sultanate. Jaloliddin’s father Sultan Valad, while leaving from Balkh with his students and family, asked his student Said Burhoniddin to help in taking into the carriage volumes of hadis – books of legends and myths about prophet, law of Islam, works of shariat scientists, poetic volumes of Mutannabiy, Soniy, Attor, literary works of Gazzoliy and Al-Khorazmiy written in nastaliq script. There, in the leading city of

Khorasan, in Balkh all valuable works of Islam world copied by talented calligraphers of Herat, Kharezm, Bukhara, Samarkand, Damask and Basra, speeches of Balkh orators and scientists bounded in leather or wood, hard bounded or bounded in glimpses and collected by intelligent people of that time, moved from generation to generation, from libraries to libraries all over the world could be seen in that carriage [15, 5] That spiritual treasure was the first step in Jaloliddin Rumiyy's world of spiritual development.

It was proved by Husomiddin Chalabiy and Davlatshoh Samarqandiy – the first predictors of that time that Rumiyy coming into the world of Sufism was foretold by Sheikh Fariduddin Attor (1151-1221). Alisher Navai described Rumiyy's meeting with Attor in the following way: “on the way to Mecca in Nishopur he received Sheikh Fariduddin Attor's conversation. Sheikh presented him his book entitled “Asrornoma”. He always kept that book together with himself.” [2, 327-328] During the meeting Attor was touched by the conversation with young man and said to latter's father: “Very soon your son will give relief to hurt hearts.”. [6, 116] Even Attor and Rumiyy's meeting became a legend of long ago history, it is still considered as the spiritual closeness and meeting of two saint representatives. Rumiyy mentioned several times about Attor and his thinking in his works, especially, in “Masnaviy”. He also gave some examples of his educating works. Rumiyy achieved such a great spiritual power thanks to the traditions of the century and, personal Sufistic approach. Rumiyy's mentor Said Burhoniddin, who taught him reading and writing, at the end of each lesson read him Attor's stories and asked student's opinion about them. [15, 426] Rumiyy studied in the medressehs of Damask and Bagdad, leading mentors of that time taught him; he learnt Persian, Tadjik, Arabian, and Turkic languages. Bahouddin Valad moved from Nishopur to Bagdad, and later through Kufa he moved to Kabaa. After the Hadj process on his way back he visited Shom. Then he came to Larende through Malatiya, Erzinjon, Sivas, Kaysari, Nigde.

In 1225 Mavloni Rumiyy married Gavhar khanum, Sharafiddin Lolo's daughter. After that marriage Mavloni Rumiyy had sons named Bahouddin Muhammad famous by



the name Sultan Valad and Alouddin Muhammad. Gavhar khanum died after several years and Mavlonno married a widow Kira khanum who had a child. “Biographers, who always wrote about life of famous people, described Kira khanum, Hazrat Rumiyy’s second wife who was of Christian “Robiya the second” or “a woman like Mother Maryam” [16, 87] From his second marriage Mavlonno Rumiyy had a son named Muzaffariddin and a daughter Malika khanum.

At that times the greatest part of Onadoli was under the invasion of Saljukids. Saljukid Sultan with poetic nature and educated man Alouddin Kayqubod (1219 - 1236) was ruling the state. Saljuk Turkic men invaded the lands of Byzantine Empire in Little Asia, and organized Sultania of Kunia in the XI century. The reign of Sultan Kayqubod was a flourishing period of Byzantine Empire. Ko’nyo was a capital of that Empire. Ko’nyo was famous with its art, scientists and other people. Shortly saying, Saljukids were living in there flourishing period and the head of the government invited Bahouddin Valad to Ko’nyo and wanted him to settle there. At that times Ko’nyo was far from danger, and that’s why scientists, artists, astrologists of the East went there to be save because Mongolian invaders greatly hurt Muslims. That’s why hard intellectual and religious life was leading in Ko’nyo. The state language was Persian one and Greece and Turkic were local dialects.

Bahouddin Valad accepted Sultans invitation and on the third of May in 1228 came to Ko’nyo with his family and friends. Sultan Alouddin Kayqubod met them with great respect and gave them place from Oltinapa medresseh. Bahouddin Valad died in Ko’nya in 1231, January, 12. He was buried in Gulbog’cha of Saljukids castle. “Maorif” by great enlightener Bahouddin Valad became the reason of Rumiyy’s being an outstanding scientist and good speaker of his time. After Bahouddin Valad’s death his spiritual works and deeds were continued by his son and pupil Jaloliddin Rumiyy. Sultan Valad said the following about that event: “When Bahouddin Valad died, all men and women came to his funeral ceremony and asked his son Jaloliddin Rumiyy to continue his father’s deeds, as Jaloliddin was also as wise as his father.” [13, 2]

Up to Mavlono's period of creation Kalam became permanent subject of the time. But scientists in Kalam kept hard the words of the predecessors and never wanted to change anything in the science. There was no way to draw back of those sayings, if it were, they considered it as a sin. Time passed, but nobody dared to include any new things even for people's comfort. But Mavlono was that who could dare to find a solution of all those problems and he was a chief mentor in Ko'nya medresseh for several years. His literary works show us that he had a very deep knowledge in Koran, Hadisi Sharif, problems of shariat and the history of Islam. After father's death Rumi's mentor was Burhoniddin Mushaqqiq, his father's khalif. [4, 40-41] "Said Biuhoniddin Husayn Mishaqqiq Termiziy was from Termez, Maveraunnahr, in Khorasan, Termez and Bukhara he was known as Sayyid Shirvon (Sirdon)". [5, 43] Rumi wrote following about his mentor Said Burhoniddin "When Said Burhoniddin was speaking one man came up to him and said: "I have heard about you". Said Burhoniddin said: "Well, what man is he? Does he really know me? If he knows me through my words, then he doesn't know me. Because voice, mouth, lips...pass. they all are symbols. If he knows me through my deeds, it is again the same. If he knows me by my practice, than he really knows me. Only in this case he can make a compliment for me, and I can know that this praise concerns me. [10, 25]

At the end of his life Said Burhoniddin made Jaloliddin to live far from people for forty days. At the end of this forty days' test he entered to see how his pupil was and suddenly remembered ayat from Koran, which said "It is a lesson for you, but you don't know about it". Jaloliddin answered in the following way:

Narsa yo'qkim, khoriji olam erur,

Har ne istarsan, o`zingda jam erur. [15, 154]

(Nothing can be in the price of world's treasure

Everything you want, you have.)

Having heard that sheikh understood that "Mavlono had no vanity and selfishness, he was in the degree of being a good teacher for other muslims" [6, 186], that's to say Rumi became a great scientist who had a deep knowledge in Kalam

science and could take part in debates on that subject. In Damask Rumiyy was taught by great scientist on religion Ibn al-Adim, in Halab he was taught by Umar binni Ahmad binni Hibbatulloh, a famous scientist on hadis, philosophy, Kalam and ba'de. But those sciences were too far from reality, they consisted of just words and were limited by language and mind.

According the legend, given by Davlatshoh Samarqandiy, in one of four madrassahs, where Mavlono taught, forty attendants took part in his one lesson. [6, 196] Rumiyy made a great revolution in the world of Kalam science with his poetic volume which was famous under the title "Masnaviyy ma'naviyy". "When we speak about "Masnaviyy" our mind accepts it as "Mavlono's Masnaviyy". Speaking about Mavlono we always think of Hazrat Rumiyy..." [4, 597] According the demands of that time and coming out from his talent Rumiyy paid his all attention to poetry in giving information in his works. It was a fashion of that time to create poetic volumes in Persian in the scientific circles. That method was suitable according the traditions of that time. It was dominating other methods. People also had a talent to be interested and to appreciate poetic works. The famous representatives who had lived and created there works before Rumiyy's activity had chosen the same method. Their works famous in the world of Islam were written in Persian and poetic style. One of them was Sanoiy Gaznaviyy's (1048 – 1140) outstanding work "Hadoyiq al haqiqat" ("Gardens of Truth"). The second one was Rumiyy spiritual mentor Sufistic poet Fariduddin Attor's (1145 – 1221) "Mantiq ut tayr". Those two books influence on society was more stronger than other simple philosophical and scientific books. People always read those two books with great astonishment. "Hadoyiq al haqiqat" and "Mantiq ut tayr" were lovely and wide-spread books of Islam world.

Critics, who analyzed and studied Mavlono Jaloliddin Rumiyy's life and literary activity, wrote that his student Hisomiddin Chalabiy, and those two books were reason, source and brochure for creating "Masnaviyy". Gazzoliyy, Muhammad bin Munavvar, Sa'labiyy's works, Rudakiyy, Firdavsiyy, Anvariyy, Haqoniyy's poems and odes were also used in the book. There is also some words about great poet and scientist Hakim Sanoiy

in “Masnaviy”: “If Muslims could see the greatness of Sanoiy, they surely take their hats off.” [11, 62] Iranian scientist Taqiy Purnomdoriyon wrote: “At the end of the XI century Sanoiy began writing irfoni poem which was completely formed by Attor in the XIII century, and flourished with the works of Mavlaviy.” [14, 3]

Mavloni Rumiy’s meeting with Shamsiddin Tabriziy and his studying in Tabriziy hands brought great changes in Rumiy’s life. “Mavloni’s connection with Shams is like a fan pupil’s connection with his dream.” [12, 15] Shams Tabriziy was one of the well-known sheikhs under the penname Shamsuddin. His real name was Muhammad ibn Aliy, he was born in Tabriz, the city in the north-west of Azerbaijan. Shams Tabriziy met Mavloni in the 26 of November, 1244 in Marja al-bahrayn in Ko’nyo. Since that meeting Shams Tabriziy changed Mavloni Jaloliddin Rumiy’s world outlook and Mavloni began to call him “my shah”, “padishah gadoyi”. Since th at meeting Mavloni got deeply interested in poetry, and began to criticize Kalam science and philosophy. As a great scientist he began working hard on poetry in madrassah under the pennames “Rumiy” and “Khomush”. He wrote: “I swear with God that I was never interested in poetry before, and for me there was nothing worse than poetry.” [7, 234]

Rumiy, especially criticizes their useless tries to prove religious beliefs only by emotions and mind. Mavloni underlined that denying the existence of one thing because of not seeing or feeling it was not enough for neglect. Rumiy mentioned about Shams in some of his works, he showed Shams as vigilant man and good orator, also wrote he knew the sciences of shariat and philosophy too. [6, 216]

Rumiy wrote:

Ul chirog’i Shamskim ravshan erur,  
Dema, bois piltayu ravg’an erur. [11, 246]

(Shams lamp is always bright

Don’t say that it is because of oil and line of lamp.)

“Attending the meetings of scientists and teachers of his contemporary epoch, Shams saw that their knowledge was taken a little from one place, from another, and

their evidence was only from hadis. It never told that learning the science opened by predecessors is not enough. But it said that sciences moving from generation to generation should be learnt carefully, new grade of knowledge should be based on them, on thinking and mind, and especially on time. [6, 22] After getting acquainted with Mavlono Shams made him stop repeating predecessors sayings and even reading Bahouddin Valad, his father's "Maorif". By that method he opened the way to new ideas, thoughts, new words in Mavlono's mind, and made success. [6, 21] Jaloliddin Rumi announced that Shamsiddin Muhammad Tabriziy his spiritual mentor. Tabriziy taught Mavlono philosophy, especially Sufism for three years. "Shams taught Mavlono the ways of getting rid of mind's force. Because the territory of mind was known, an exact place which was called ignorance. The territory of heart was infinity. It's relaxing was knowing." [9, 17] Rumi himself in one of his poems wrote the following about Tabriziy: "Attor developed my spirituality, Shams Tabriziy gave a key to world secrets." By Tabriziy influence Rumi rejected mind researches. It brought dissatisfaction among the scientists and students of Rumi and because of their tries Tabriziy was killed. Rumi was shocked by that tragedy, becoming touched by death of his mentor he began writing poems under his name and created poetic volume "Devoni Shams Tabriziy".

There are such moments in person's life which are worth the whole life. Conversation and connection of Mavlono and Tabriziy were of such moments. Shams made an overturn in debates and talks of Mavlono with his students. As mentor and sheikh Mavlono was different from other mentors and sheikhs. Being a great mentor Mavlono always kept himself as a student. [6, 30] After Shams death Mavlono lived alone for several years. In 1249 his students and supporters Salohiddin Zarkubiy and Husomiddin Chalabiy appeared in Mavlono's life and began to fulfill that emptiness and replace Tabriziy.

"Such spiritual treasure developed Jaloliddin. In some nights Rumi felt to ecstasy and trans, wore rocky hat and danced some under the Rubab and boob music, and told poems and gazals without stopping. Rumi's talent and fame collected many Sufy round him. Ko'nya became Mecca of Sufism." [7, 234] "Rumi glorified a man with beautiful

and clear language which was full of belief and support. At last, the society began to resuscitate. Mankind began to understand deeply the estimation and value of himself.”. [3, 123]

Rumiy said:

Sharq haqni topdi, dunyodan kechib,  
G’arb dunyo topdi, Oллоhdan kechib... [12, 18]  
(East found the truth rejecting the world  
West found the world rejecting God.)

Mavlono died in the 17<sup>th</sup> of December, 1273, on Sunday. He concluded his life saying: “I was unripe, then I ripe, and was kindle.” The day of death Mavlono always accepted as the day of rebirth. He said that he would reach his beloved – God as soon as he died. That’s why Mavlono said that the day of death was the day of wedding or “Shabi Arus” – the night when the bride came and never wanted his friends or relatives to cry for him after his death. Before his death great poet said: “I always had Koran in my hands, my now I am carrying the torch of love in my hands.”

The grade of a man cannot be identified according the power and wealth of his family. But seeing him off to his final place can easily show what kind of a man he was. There are following writings connected with Rumiy’s death in Radiy Fish’s novel “Jaloliddin Rumiy”: “Turkic peoples, peoples from Khorasan, Greece, Armenians, orthodox and Jutes – people of almost all nationalities came to say goodbye to poet, and all fare welled in the own style.” One of imams asked Amir Mininiddin Parvona to send away all Christians and orthodox. But it was useless. Christian priest said: “Mavlono brightened the whole mankind with his intelligence as the sun brightens with its light. The sun is everybody’s property!”. Jutes rabbi said: “Mavlono is like bread. We all need bread. My Amir, where have seen faints turning their faces off bread?. [15, 187]

We can conclude our ideas as the following:

The first: even religious ideas in Mavlono Rumiy’s creations developed on the base of Islam, he had an independent position in his contemporary society. It can be

found in his stories and poems in masnaviy genre which are rich with Islam and Sufism spirituality and philosophical approach.

The second: Jaloliddin Rumi's poetry has a great spiritual content, the spiritual ideas in them serve as self understanding and closely connect people with each other, they connect also the ways between peoples' hearts, show permanent spirituality and lead people to perfect.

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## ABOUT INEFFECTIVE USE OF MATERIAL RESOURCES

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### **Abstract**

This paper presents the identified causal waste of material resources and the proposed approach of the author to address them.

**Keywords:** material resources, reduction, efficiency.

Just as in any task to implement it is necessary to clearly identify the reasons that led to this result. Only after identifying the causes can act according to the planned activities, monitoring and adjusting the process of its implementation. Scientists V.Ya.Gorfinkel, V.A.Shvandar, V.I.Titov, G.V.Savitskaya, A.I.Ilin, A.A.Kanke studying the problem of efficient use of material resources, tools of analysis, do not attach identification of significant value and justify the reasons waste of material resources, and does not offer specific measures to reduce the consumption of material resources for their effective use. This situation was the basis for writing this article.

The textbook V.Ya.Gorfinkelya, V.A.Shvandar "Business organizations" are the results that can be achieved with rational use of working capital, the reserves are in the work of saving material resources, divided into three groups: general economic, cross-industry, - internal. However, there is no justification in the book and detailing provisions of these groups, and not offered the possible options to improve the efficiency of the use of material resources. [1, c.195]

The textbook V.I.Titova "Business Economics" is a classification of material and technical resources and the emphasis placed on the valuation methodology consumption of material resources, to identify the needs of businesses in every kind of material resources. The reasons for their irrational use and ways to reduce the consumption of material resources in the V.I.Titova omitted. [5, c.94]

The textbook A.I.Ilina "Business Economics" reflects the economic substance of current assets, their structure is a system of performance indicators of material resources for the purpose of quantification. However, the specific reasons for the inefficient use of material resources, and ways to enhance their effectiveness in the textbook is not represented. [2, c.34] The textbook G.V.Savitskoy "Economic Analysis" and the textbook A.A.Kanke "Analysis of financial and economic activity of the enterprise," the focus relative to the material resources paid to the performance of their use. Ways to improve the data as indicators of novelty options in the traditional system of indicators in the work is not offered. [3, c.146; 4, p.194]

Based on the above, the author presents in this article are the most compelling reasons that affect the change in indicators of effective use of material resources, and on the basis of their analysis suggests possible options to address them. The main causes of wastage of material resources are the following.

1) Weak control system.

Imperfect sequence for incoming , current and final control leads to inappropriate regulations and directions of flow of material resources. As a result, performance indicators of material resources is particularly limited.

2) Sub-optimal use consumption rates.

Quality standards developed determines how the data is associated norm level of scientific and technical progress , the conditions of production in the target company . Norms depends on the quality of the effectiveness of the use of material resources. The better the rate , the better use of resources , and vice versa.

3) Inadequate technical base.

Rational consumption of resources depends on the use in production of items of technical equipment ( machinery, equipment, auxiliary units ) . Technical equipment is improved in order to reduce the consumption of materials for the manufacture of one product.

4) The imperfection of the process.

The technological process is a list of successive stages of processing the workpiece from its arrival at the workplace and to finished products.

5) Inadequate organization of production.

Providing quality of progress on the transfer of workpieces between production stages , the development of optimal location of jobs affects the economy of material resources in the process of production. Therefore, enterprises should pay more attention to creating the optimal organization of production as one of the elements in the system of management.

6) Imperfection of logistics .

The quality of incoming material at the stage of process technology resources affect their rational consumption in the process of production , is consistent with the standards of the company .

7) Lack of the enterprises whose products are characterized as material- , special departments to streamline production.

These departments will organize all of the work on tracking the frequency of occurrence of defects in products, the frequency of exceeding the planned consumption rates and total consumption of material resources to plan for the production of products, graphing eliminate excessive regulations , the development of new forms of production , new ways of production, the introduction of energy saving technologies. The listed causes wastage of material resources are common to most enterprises, firms and are subject to detailed review to explore options to address them. Every enterprise , identifying specific list identified in its manufacturing process defects , deviations from targets that result in deterioration of the efficient use of material resources , developing a system of measures , their proposals for addressing the identified causes of wastage of material resources.

The author of this article as such offers is the following .

1) The analysis of scientific and technological innovations .

2) Implementation of the system of monitoring of performance indicators of material resources.

3) Economic- mathematical modeling.

4) Parallelism processes.

5) Asystem of algorithms .

6) The introduction of co- production cycles of several enterprises pair of " material supplier - manufacturer of the finished product ."

7) Establishment of venture capital firms in the region with the direction of innovation.

Thus, the list of identified main causes of inefficient use of material resources for the enterprise is a " veil " that covers the ways to improve the financial condition, and the proposed measures allow me to break this " veil " and the organization of the production

process on the principle of optimization of material resources. To investigate the effectiveness of the use of material resources used operating procedure , including a system of indicators and methods of factor analysis. However, this method of estimating the effective use of material resources has , in our opinion, some of the shortcomings . Here they are:

- 1 ) the lack of a factor representing the speed and dynamics of the consumption of material resources in the production process ;
- 2 ) the lack of an indicator on the use of material resources for the planned purpose;
- 3) The limitations of the system of indicators in the calculation of lost profits as a result of inefficient use of resources;
- 4) the limitations of the system parameters in the direction of identifying the dynamics of the value of stocks of material resources in the initial and final stages of the production process ;
- 5 ) the lack of a factor representing the efficiency of the use of material resources with regard to their applicability and terms of use;
- 6 ) the lack of a universal method of factor analysis applied to all types of factor models and providing ease of calculation and accuracy of the economic interpretation of the final results ;
- 7 ) lack of standardization in the consumption of material resources considering the level of scientific and technological development , the probability of loss of material resources and their deviations from the planned target ;
- 8) the lack of structural schemes of the level of material intensity and the factors that influence its dynamics ;
- 9) lack of development of the optimization model the effective use of resources;
- 10) the lack of development of an econometric model of effective use of material resources through the application of specific correlation and regression analysis.

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**THE STUDY OF ACID-BASE PROPERTIES OF 5-(4-METHOXYPHENYL, 3,4,5-TRIMETHOXYPHENYL)-1,2,4-TRIAZOLE-3-THIOACETIC ACIDS AND THEIR SALTS**

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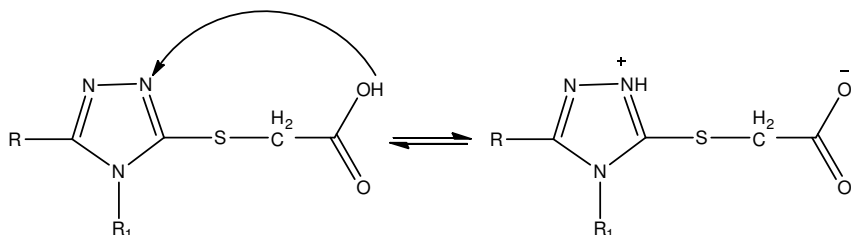
*Abstract*

New S-derivatives of 1,2,4-triazole have been synthesized, namely 2-(5-(4-methoxyphenyl-(3,4,5-trimethoxyphenyl))-1,2,4-triazole-3-ylthio)acetic acids. Theoretical and practical determination of ionization constants of some 2-(4-R-4H-1,2,4-triazole-3-ylthio)acetic acids and its salts have been set. Following the discussion, the influence of the presence and nature of substituents at C5 atom in 1,2,4-triazole nucleus on acidity and basicity of compounds has been set.

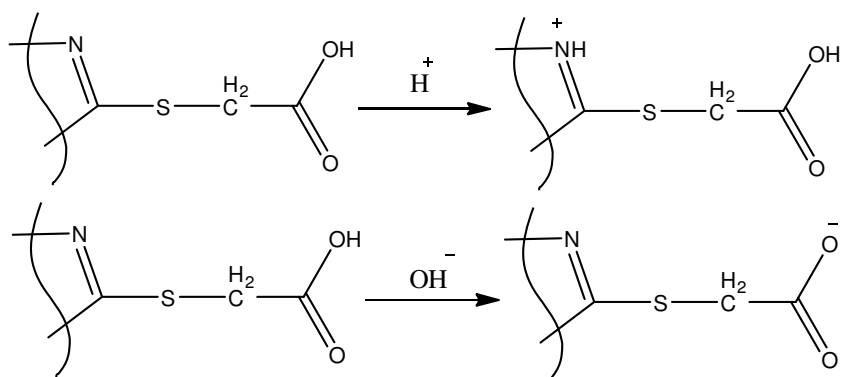
Working on synthesis of 1,2,4-triazole-3-ylthioacetic acids and also salts, complex esters, amides, hydrazides, ylidene- and acyl hydrazides, based on them, we see that the study of physical and chemical properties of the synthesized compounds in order to study biological activity of the obtained compounds and to implement original drugs into medical practice is necessary both from theoretical and practical point of view [1, 3].

The ascertainment of ionization constants of compounds is one of the most important aspects of the study of physical and chemical properties [1, 4, 5, 6]. These figures are extremely important both from theoretical and practical points of view. For example, the reaction of esterification of carboxylic acids is catalyzed by free hydrogen ions. Wherein carboxylic acids that dissociate completely or almost completely, will engage in these reactions more active, and we can get higher yields of desired products of the reaction [3, 4, 6]. From biological point of view ionization constants of compounds will correctly detect the part of the gastrointestinal tract where will the suction of a substance be in case of oral medications, and also make assumptions about compound's overcoming of the blood-brain barrier [1, 5].

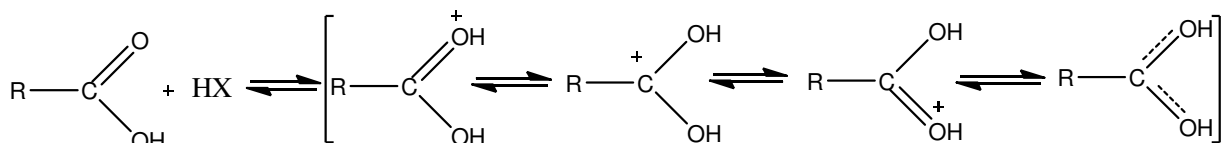
Working on 1,2,4-triazole-3-ylthioacetic acids it is necessary to note that they have amphoteric properties, i.e., the simultaneous presence of both acidic (-COOH) and basic (N: in cycle) centers. So we should assume the presence of equilibrium in this class of compounds, which can be represented as follows:



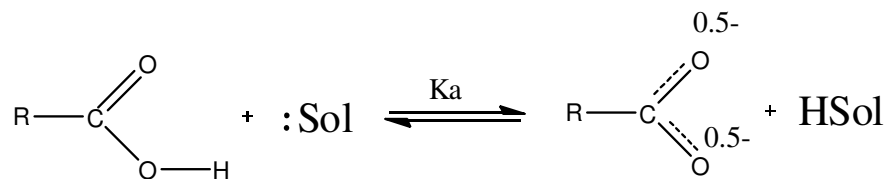
Depending on pH the accumulation of 2 products in ionized form is possible:



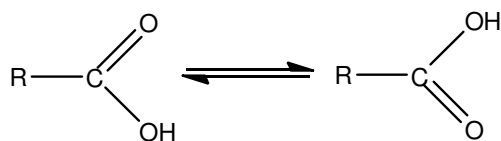
In the absence of the nitrogen atom, or while adding big amount of strong mineral acids, the protonation of both oxygen atoms of carboxyl groups may also take place:



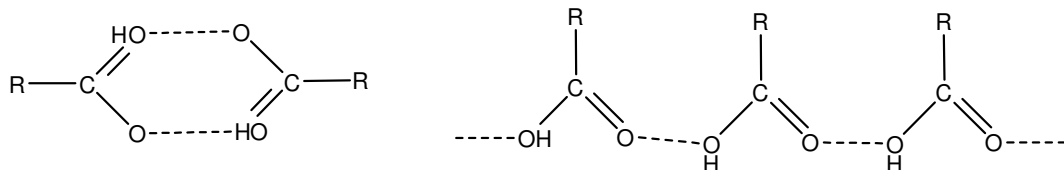
If to talk about solvation of carboxylic acids, this process can be represented as follows:



or:



Thus compounds containing carboxyl groups can exist as dimers and have a tendency to association:



Calculations of ionization constants of compounds was carried out by Spikmen and Bates methods [Speakman J.C. //J.Chem.Soc.-1940.- P.855-858; Бейтс Р. Определение рН. Теория и практика. -Л.: Химия, 1972. - 400 с.] [William O. Foye, Thomas L. Lemke, David A. Williams (2008). Foye's principles of medicinal chemistry. Walters Kluwer: Lippincott Williams & Wilkins. pp. 78–81., Mannhold, Raimond (2008). Molecular drug properties: measurement and prediction. Weinheim: Wiley-VHC Verlag GmbH & Co.KGaA. p. 426.] using computer site <http://www.chemicalize.org/>.

Experimental determination of ionization constants of salts of 2-(5-(4-methoxyphenyl, 3,4,5-trimethoxyphenyl)-1,2,4-triazole-3-ylthio)acetic acids has been carried out at the Department of physical-colloidal chemistry at Zaporozhye State Medical University by potentiometric titration of samples in aqueous solution [Альберт А. Константы ионизации кислот и оснований [ пер. с англ. Порай-Кошица Б. А.] / А. Альберт, Е. Сергент. – М. : Химия, 1964. – 180 с.; Визначення констант іонізації 2-R-4(3H)хіназолінтіонів у змішаному розчиннику методом потенціометричного титрування / А. І. Авраменко, Т. М. Калугіна, В. О. Нікітін [та ін.] // Актуальні питання фармацевтичної та медичної науки і практики. – Запоріжжя, 2008. – Випуск XXI. – С. 6-10. ]. The point of equivalence has been determined with using device for measuring ions ЭВ-74 using glass (ЕСЛ6307) and silver chloride (ЕВЛ1193) electrodes.

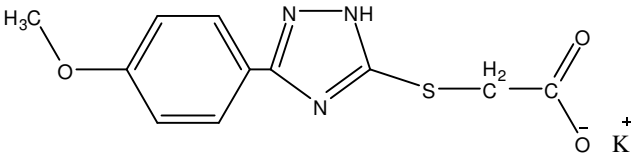
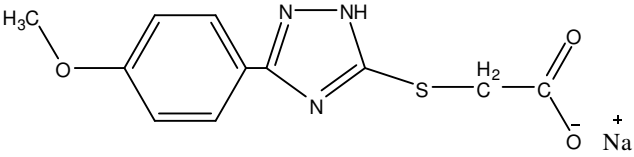
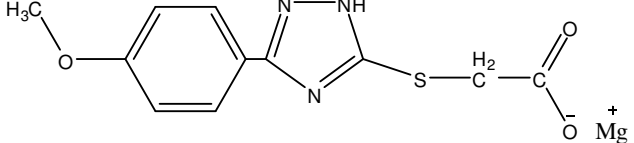
Measurements have been performed in cell that has been thermostated to the standard (20°C) temperature. To determine the ionization constants 0.01 M solutions of the compounds (1-16, table 1) have been titrated with 0.1 M solution of hydrochloric acid and parallel with solution of 0.1 M potassium hydroxide, every ten portions of 0.25 ml each using a pipette dosing Π-1 with measuring pH after each addition of titrant. Constants have been calculated using formula (1) by the average of experiments with deviations not exceeding 0.05 units.

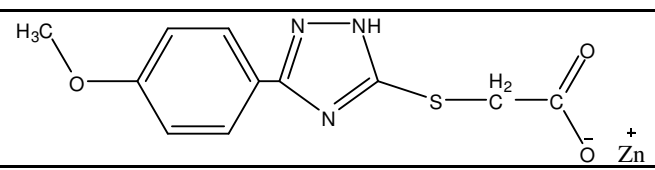
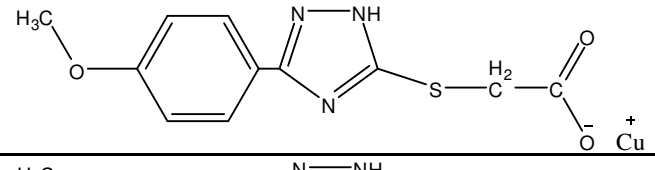
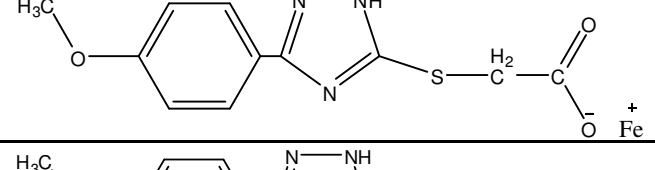
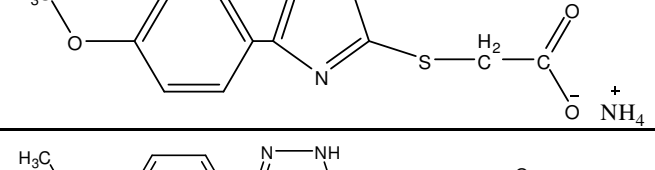
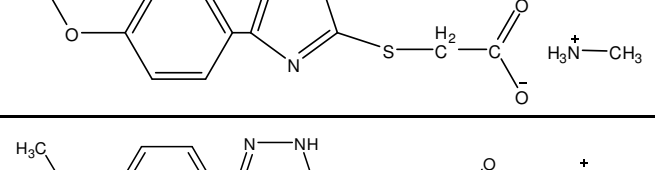
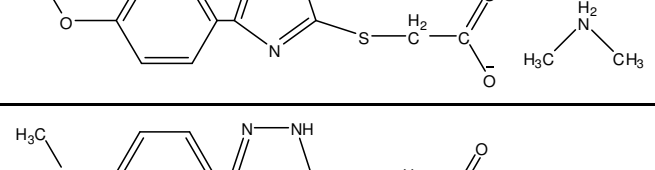
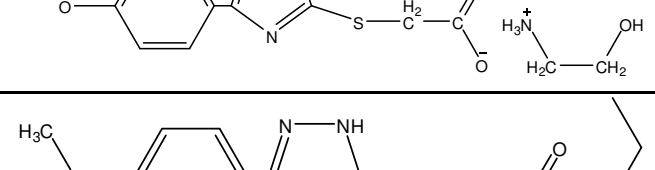
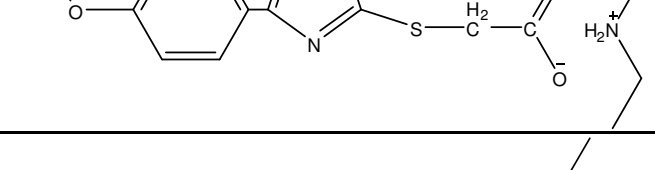
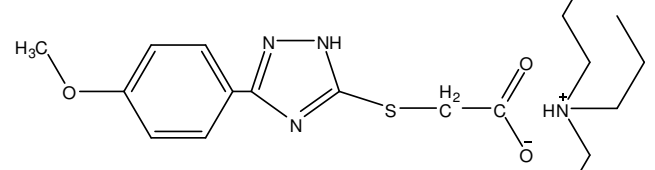
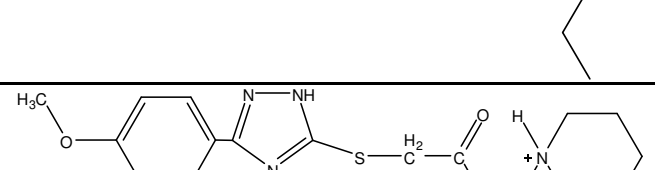
$$\text{pKa} = \text{pH} + \lg ([A] / [B]) \quad (1)$$

where [A] - equilibrium concentration of acid, mol/L, [B] - base equilibrium concentration, mol/L.

Thus calculations of the ionization constants of 2-(4-H-5-(4-methoxyphenyl)-4H-1,2,4-triazole-3-ylthio)acetic acid and 2-(4-(3,4,5-trimethoxyphenyl)-4H-1,2,4-triazole-3-ylthio)acetic acid have been calculated. These acids are slightly soluble in water, so in order to determine their ionization constants water-soluble salts have been used. The results of calculations and experimental determination are shown in Table. 1.

### Ionization Constants of 2-(4-(4-methoxyphenyl, 3,4,5-trimethoxyphenyl)-4H-1,2,4-triazole-3-ylthio)acetic acids and its salts

№ Compound	Formula	calculated pKa	found pKa
1		8,21/3,54	8.4
			3,50
2		8,21/3,54	8.6
			3.40
3		8,21/3,54	8,35

		3,45
4		8,45
5		3,50
6		8,30
7		3,40
8		8,40
9		3,50
10		8,25
11		3,30
12		8,25
13		3,35
		7,8
		3,25
		8,2
		3,40
		8,40
		3,45
		8,35
		3,80
		8,4



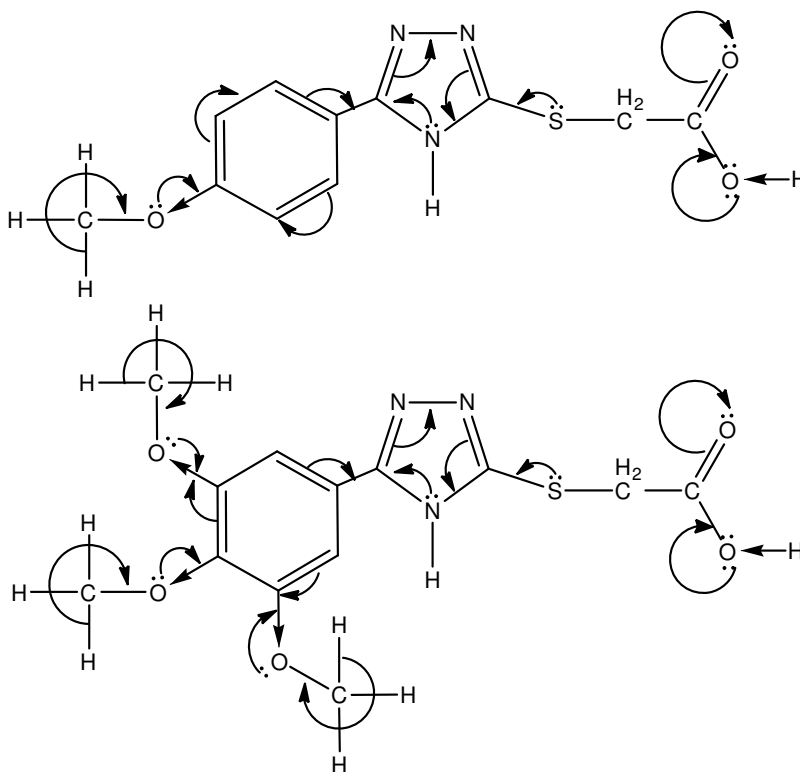
			3.85
14			7.8
			3.75
15		8,12/3,01	7.90
			3.10
16			8.05
			3.15

The calculations (Table 1) confirm the assumption that 1,2,4-triazole-3-ylthioacetic acids have two distinct centers - weakly basic center - hydrazine nitrogen atom of 1,2,4-triazole cycle and weakly acid center - carboxylic group. Ionization constants obtained by experiment within errors do not differ from the calculated one. It is also necessary to note the pattern of changes in both calculated and experimentally determined values. Thus there is little difference in constants of various salts, which are derivatives of the same acid. Differences between calculated pKa and experimentally determined one is observed only in salts (compounds 7-14) which contain an organic cation. This fact can be explained by slight shift of pH to the base value, caused by hydration of organic cation that appears because of dissociation. Potassium (1, 15), sodium (2, 16), magnesium (3), zinc (4) Copper (5) and iron (6) salts do not hydrolyze in a short time thus their pH values do not differ from each other and from pH obtained by calculation.

Starting the discussion of the results it should be noted that the existence and nature of substituents and their position in the chain of electronic conjugation

influence the strength of carboxylic acids affect. It is known that the presence of electron-acceptor groups increases the acidity especially when they are located close to the carboxyl group. The presence of electron-donor groups conversely reduces the acidity of substances. For aromatic acids the position of substituents also has significant impact. So the greatest impact is felt in ortho-acids [1, 3, 7].

As to determined ionization constants of discussed 2-(5-R-4H-1,2,4-triazole-3-ylthio)acetic acids it should be noted that the acidity of compounds is influenced by methoxyphenyl radicals at C<sub>5</sub> atom of 1,2,4-triazole cycle. Yes 2-(4-N-5-(4-methoxyphenyl)-4H-1,2,4-triazole-3-ylthio)acetic acid has smaller acidity than 2-(4-H-5-(4-methoxyphenyl)-4H-1,2,4-triazole-3-ylthio)acetic acid and 2-(4-(3,4,5-trimethoxyphenyl)-4H-1,2,4-triazole-3-ylthio)acetic acid. The distribution of electron density of mentioned acid molecules can be represented as follows:



Methoxy group is electron-donor substituent which participates in p, $\pi$ -conjugation of molecule, shows positive mesomeric effect (+M) and theoretically should reduce the acidic properties of compounds. But next to the positive

mesomeric effect of this functional group negative inductive effect (-I) also exhibits. Despite the fact that usually mesomeric effect is higher than the inductive and the last one dies in the chain of conjugation, in our case, the introduction of additional methoxy groups conversely increases the acidity of the carboxyl and NH-groups.

Comparing values of ionization constants (calculated and determined experimentally) we should assume, that discussed acids and their salts by oral administration will be more actively absorbed in the stomach (pH 1-3) or colon (pH=8) [С. А. Куценко Основы токсикологии // Санкт-Петербург, 2002 г. том 4, 119 стр.]. Therefore, these compounds are recommended in the form of tablets for oral administration.

### **Conclusions:**

1. Theoretical and practical determination of ionization constants of some 2-(4-R-4H-1,2,4-triazole-3-ylthio)acetic acids and its salts has been done.
2. It is found out that the data obtained by theoretical calculations correlated with experimental one.
3. Following the discussion, the influence of the presence and nature of substituents at C<sub>5</sub> atom in 1,2,4-triazole nucleus on acidity and basicity of compounds has been set.
4. Suggestion that discussed acids and their salts in oral administration will be more actively absorbed in the stomach or colon has been made basing on the results.

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