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Տեղեկագիրը հրատարակվում է Ակադեմիկոս Ի.Վ.Եղիազարովի ջրային հիմնահարցերի և հիդրոտեխնիկայի ինստիտուտի, Հիդրավլիկական հետազոտությունների հայկական ազգային ասոցիացիայի, Երևանի կապի միջոցների գիտահետազոտական ինստիտուտի և Շուշիի տեխնոլոգիական համալսարանի կողմից: Հիմնադրվել է 2016թ.: Լույս է տեսնում տարեկան 2 անգամ:

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CALCULATION OF PARAMETERS OF THE CHANNEL EROSION IN TRANSITION SITES OF THE MOUNTAIN RIVER ZONE

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When erecting river structures, the planned outline of the channel changes in certain area. In these transition areas the correct estimation of channel erosion parameters is important. Existing methods for the calculation of these parameters have a number of serious shortcomings. On the basis of a universal mathematical method, a method for its particular application has been developed. It gives opportunity to obtain regularities in determining the parameters of channel erosion in transitional areas of sub mountai rivers. On their basis, it is possible to calculate the hydraulic flow characteristics and the coordinates of the new channel bed in the bridge crossing, formed after the stabilization of the erosion process. The developed method can be used by specialists in the design of river structures, as well as in making up recommendations for safe exploitations.

Key words: *river, channel, transition area, erosion, calculation of parameters.*

Introduction: When building channel structures, the planned outline of the river often changes: the width of the channel widens, but mostly it often narrows. Such transitional areas are mainly created by installing supports for bridges and for other communications, bank-protecting walls, etc. In bridge crossings, the change in the outline of the channel occurs both onshore and intermediate supports. In any case, the narrowing or widening of the channel width leads to a change in the characteristics of the flow, in particular, to a decrease or increase in its velocity field. Because of this, sedimentation begins in some cases in the transition area, in others –in the bed bottom erosion. It is very important to predict correctly possible deformations, since the trouble-free operation of channel structures, including bridge supports and bank-protecting dams, is determined by the reliability of establishing the depths of erosion. Thus, the determination of the position of the final, stabilized surface of channel erosion is relevant, especially in the areas of establishment of river structures, both scientifically and from a practical point of view. Existing methods, including numerical solutions for calculating the deformation of transitional sections of mountain streams, have a number of serious shortcomings. This is due both to the establishment of the initial characteristics of the drainage and the boundary conditions of the problems, and to the choice of the formula for calculating the sediment flow rate.

The aim of the work is to develop a method for predicting possible channel deformations in transitional sections of mountain streams and calculating flow and channel parameters on the example of bridge crossing.

Research results. In the works [1, 2] the existing methods and formulas are analyzed for determining the parameters of channel erosion in bridge crossing and in transition areas. The main shortcomings of the existing offers are estimated and mentioned here, the tasks of following researches are pointed out.

The author of the research has worked out the universal theory of channel formation, passing to a stabilized, balanced phase [3]. It characterizes also the hydro-dynamic processes rather well, which occur in the river areas, where the bridge crossings are. According to this theory, for the formation of coordinates of stabilized surface of deformations the following dimensionless equation is resulted:

$$\frac{d\bar{z}}{d\bar{x}} + \frac{d\bar{h}}{d\bar{x}} - \frac{Fr_0}{\beta_0\ \bar{A}^3}\ \frac{d\bar{A}}{d\bar{x}} = i_0\ \bar{d}_{OT}^{1/3}\ \bar{A}^{(4a-10)/3}, \tag{1}$$

where the scale of boundlessness is to be the width of channel b_0, for example, $\bar{\bar{z}} = z/b_0$;

$\bar{\bar{z}}$ - is the required dimensionless coordinate of the stabilized surface of the bed bottom in the deformed transition region;

$\bar{h}$ - is the depth of the flow in the new channel with the surface of live section $\bar{A}$.

Besides the three mentioned unknown the remaining quantities of equation (1), including the relation $\beta_0 = b_0 / h_0$ and number of Freud - Fr_0 in the channel area with curve i_0 are either given or are determined by familiar methods. (The scale of boundlessness is accepted the width of b_0 . (Here and after the parameters with index “0” relate to the channel area where sediment ability of the flow gets ultimate meaning).

In the conditions of observing sediment balance in work [4] the following dimensionless regularity between the area of the live section and the wetted perimeter of the flow was obtained:

$$\bar{\chi} = \bar{A}^a \tag{2}$$

In this paper it is indicated that for mountain and mudflows the indicator *a* varies in the interval 3 ... 4. In further developments for mountain rivers *a* = 7/2 occurs. Then equation (1) can be written as:

$$\frac{d\bar{z}}{d\bar{x}} + \frac{d\bar{h}}{d\bar{x}} - \frac{Fr_0}{\beta_0\ \bar{A}^3}\ \frac{d\bar{A}}{d\bar{x}} = i_0\ \bar{d}_{OT}^{1/3}\ \bar{A}^{4/3}, \tag{3}$$

Equation (3) is solved in the presence of regularities between the hydraulic parameters of the transition. For simplicity, the shape of the channel in the section of the bridge is assumed to be rectangular. Consequently:

$$\bar{A} = \bar{\bar{b}}\ \bar{h}\ \beta_0 \tag{4}$$

$$\bar{\chi} = (\bar{b} + 2\bar{h})\frac{\beta_0}{\beta_0 + 2} \tag{5}$$

From the expression (5) follows that

$$\bar{\chi} = \frac{\beta_0}{\beta_0 + 2}\bar{b}\left(1 + 2\frac{\bar{h}}{\bar{b}}\right) = \frac{\beta_0}{\beta_0 + 2}\ \frac{\beta + 2}{\beta}\ \bar{b}, \tag{6}$$

where the coefficient $\beta = \bar{b} / \bar{h} = b / h.$

Accordingly from *a* = 7/2 cooperative solution of dependences on (2), (4) и (6), we get:

$$\bar{h} = \left(\frac{\beta + 2}{\beta_0 + 2}\ \frac{\beta_0}{\beta}\right)^{2/7} \cdot \frac{1}{\beta_0}\ \frac{1}{\bar{b}^{5/7}}. \tag{7}$$

Viewing the possible meaning of coefficients β_0 and β in practice, the equation (7) can be presented in the following way without any notable omissions:

$$\bar{h} = \frac{1}{\beta_0 \, \bar{b}^{5/7}} \quad . \tag{8}$$

The final solution of the task may be given more strictly, however, further equations may occur transcendental. Thus the difference between the results of both solutions in practical relation is slight.

From the dependents (4) and (8) for the area of live section we have as follows:

$$\bar{A} = \bar{b}^{2/7} \, . \tag{9}$$

The obtained universal equation (3), regularities (8) and (9) can be applied for solving problems on the calculation of parameters characterizing channel erosion in transitional sections of mountain rivers. For this, alongside the indicated expressions, it is necessary to use the boundary conditions of the given problem.

Suppose that on a certain segment of a mountain river with a width B_p and bed curve of i_p bridge supports are installed with length of l_0 and width of bridge pass $b_м$ (fig. 1). Flow rate Q is obtained from hydrological calculations. For the river section, where the stream acquires the ultimate channel forming capacity, the channel characteristics i_0 and b_0 are established. On their basis, the classical method determines the hydraulic parameters of the cross section of the flow A_0, h_0, β_0. These values are the starting points for the prediction of deformation of a bridge crossing through mountain rivers.

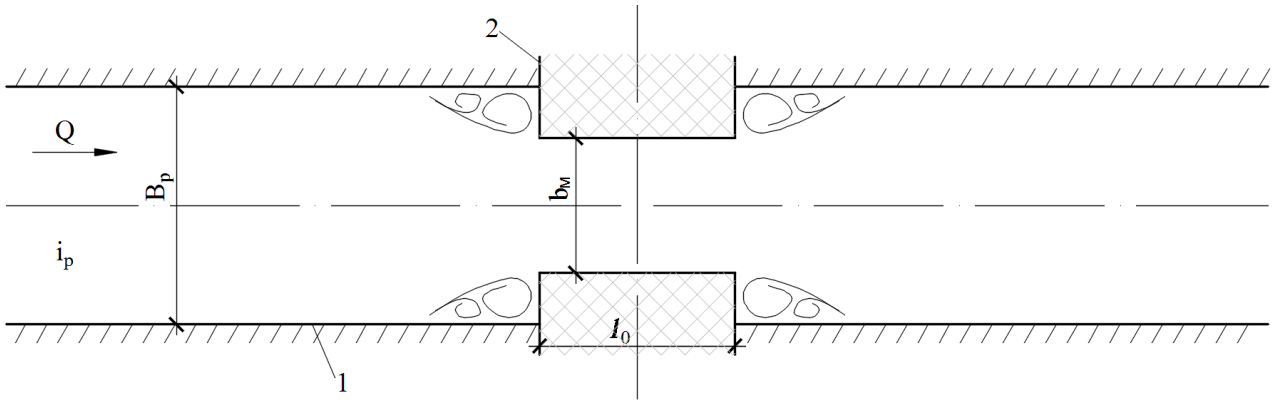

Figure 1. Planned drawing of bridge crossing
1 – natural channel, 2 – bridge supports.

After the establishment of bridge bases in the cross section area the regime of movement changes. The vortex zones forming in the support angles fall out of the general smoothly changing motion, and the planned outline of the lateral lines of the newly formed flow within the transition becomes narrower, and after the supports - the expanding form (fig. 1, 2). Therefore, for a channel width, a suitable approximating relationship (linear or curvilinear) can be chosen. For both cases the problem is solved. The paper presents the developments for the case with a linear change in width b within the transition (fig. 2): in the range $x = -(L_1 + l_0/2)$, channel width $b = B_p$. Further it begins to decrease and before the support ($x = -l_0/2$) is equal to the width of the bridge aperture $b_м$. Within the supports ($-l_0/2 \leq x \leq l_0/2$) we have $b = b_м$. After the supports, within the limits $l_0/2 \leq x \leq l_0/2 + L_2$, the flow expands and at the end of the section ($l_0/2 + L_2$) we again have $b = B_p$.. In this case, the reduction angles θ_1 and the

expansion θ_2 for smoothly changing motion should be less than 12^0 [5]. For simplicity, we can take $\theta_1 = \theta_2 = \theta$, then we get $L_1 = L_2 = L$ (fig. 2). For the pointed forms of bridge section the method of calculating the deformations of channel is worked out (fig.3). This method is applicable for other forms of planned drawings of channel section areas as well.

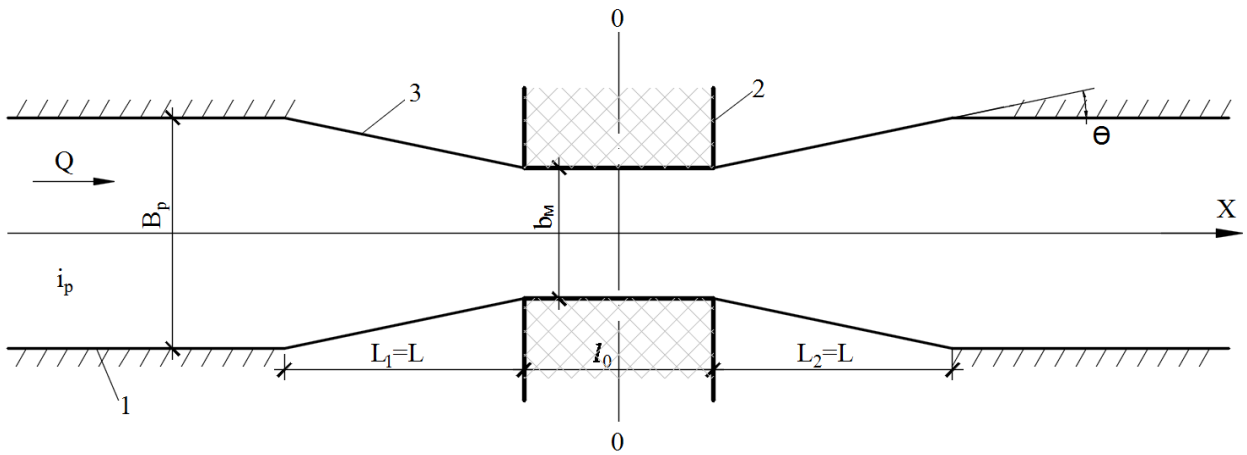

Figure 2. Calculating scheme of planned drawing of bridge crossing.
1 – natural channel, 2 – bridge supports, 3 – cross area of channel.

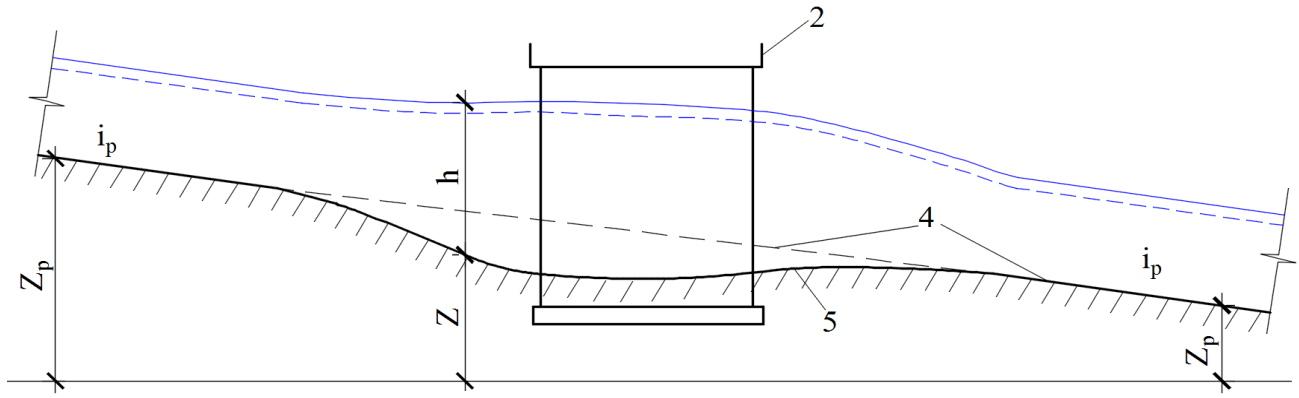

Figure 3. Prolonged profile of bridge crossing after erosion end.
2 – bridge support, 4 – channel bed before erosion, 5 – bed of channel after stabilization.

It is clear that, because of the decrease in the channel width, the flow velocity will increase and soil erosion will begin. During the erosion process, the bottom of the channel is deepened and the speeds will decrease. Simultaneously, the process of erosion gradually dies out, i.e. the balance of sediments along the length of the bed is restored, including in the bridge crossing. Therefore, for the analytical description of such a process, the above mentioned equations and regularities (3), (8), (9) can be used, together with the corresponding dependence by definition of the width of the transition area. Thus, in the channel section $-(L+l_0/2) \le x \le -l_0/2$, we have:

$$b = b_м + 2(x + l_0/2)\,tg(\pi - \theta)\ , \tag{10}$$

when $x = -(L+l_0/2)$, we have $b = b_м + 2L\,tg\,\theta = B_p$, when $x = -l_0/2$, we get $b = b_м$, in channel section $-l_0/2 \le x \le l_0/2$, we have:

$$b = b_м\ , \tag{11}$$

in the channel section $l_0/2 \le x \le l_0/2 + L$, we have:

$$b = b_м + 2(x - l_0/2)\,tg\,\theta\ , \tag{12}$$

When $x = l_0/2$, we have $b = b_м$, when $x = L + l_0/2$, we get $b = b_м + 2L\,tg\,\theta = B_p$.

Expressions (10), (11) and (12) are shown in the way of boundlessness (scale of boundlessness is the width b_0). In this case for the given three sections of transition area we correspondingly get:

$$\bar{b} = \overline{b_м} + 2(\bar{x} + \bar{l}_0/2)\,tg(\pi - \theta), \tag{13}$$

$$\bar{b} = \overline{b_м}, \tag{14}$$

$$\bar{b} = \overline{b_м} + 2(\bar{x} - \bar{l}_0/2)\,tg\,\theta. \tag{15}$$

After differentiation of the expressions (13), (14) and (15) we will have:

$$\frac{d\bar{b}}{d\bar{x}} = -2\ tg\,\theta, \tag{16}$$

$$\frac{d\bar{b}}{d\bar{x}} = 0, \tag{17}$$

$$\frac{d\bar{b}}{d\bar{x}} = 2\ tg\,\theta. \tag{18}$$

Simultaneously from the dependences (8) and (9) follows:

$$\frac{d\bar{h}}{d\bar{x}} = -\frac{5}{7\beta_0\,\bar{b}^{12/7}}\frac{d\bar{b}}{d\bar{x}}. \tag{19}$$

$$\frac{d\bar{A}}{d\bar{x}} = \frac{2}{7\,\bar{b}^{5/7}}\frac{d\bar{b}}{d\bar{x}}. \tag{20}$$

Accordingly with the dependents (9), (19) and (20) the universal equation (3) will get the following calculating way:

$$\frac{d\bar{z}}{d\bar{x}} - \frac{5}{7\beta_0\,\bar{b}^{12/7}}\frac{d\bar{b}}{d\bar{x}} - \frac{2\,Fr_0}{7\beta_0\,\bar{b}^{11/7}}\frac{d\bar{b}}{d\bar{x}} = i_0\ \bar{d}_{OT}^{1/3}\ \bar{b}^{8/21}. \tag{21}$$

Joint solution of the resulting equation (21) and final conditions (13)…(18) lets us differentiate the coordinates of new depth on every transition area of bridge crossing dependent on x (fig.3), formed after the stabilization of erosion process.

Conclusion. The developed method for determining the coordinates of a stabilized deformation surface allows us to establish the depth of occurrence of the bases of bridge supports and other river structures in transitional sections of mountain streams. The method can be used by designers and operating personnel.

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ՀՈՒՆԱՅԻՆ ՈՂՈՂՈՒՄՆԵՐԻ ՊԱՐԱՄԵՏՐԵՐԻ ՈՐՈՇՈՒՄԸ ՆԱԽԱԼԵՌՆԱՅԻՆ ԳԵՏԵՐԻ ԱՆՑՈՒՄԱՅԻՆ ՏԵՂԱՄԱՍԵՐՈՒՄ

Պ.Հ. Բալջյան, Գ.Գ. Մադաթյան, Հ.Գ. Քելեջյան

Հայաստանի ազգային պոլիտեխնիկական համալսարան

Գետային կառուցվածքի տեղակայման դեպքում որոշակի տեղամասում փոխվում է հունի հատակագծային տեսքը: Այդ անցումային տեղամասերում կարևոր է ունենալ հունային ողողումների պարամետրերի ճիշտ գնահատումը: Համակիրառելի մաթեմատիկական մոդելի հիման վրա մշակվել է դրա մասնավոր կիրառման մեթոդ: Այն հնարավորություն է տալիս նախալեռնային գետերի անցումային տեղամասերում ստանալ հունային ողողումների պարամետրերի որոշման օրինաչափություններ: Դրանց օգնությամբ կարելի է հաշվարկել կամրջային անցման հիդրավլիկական պարամետրերը և այն հունի հատակի կորդինատները, որը ձևավորվել է ողողումների երևույթի կայունացման արդյունքում: Մշակված մեթոդը կարող է օգտագործվել գետային կառուցվածքների նախագծման ժամանակ, ինչպես նաև մասնագետների կողմից՝ կառուցվածքի անվտանգ շահագործման հայտարարագրեր կազմելիս:

Բանալի բառեր. գետ, հուն, անցումային տեղամաս, ողողում, պարամետրերի հաշվարկ

РАСЧЕТ ПАРАМЕТРОВ РУСЛОВОГО РАЗМЫВА В ПЕРЕХОДНЫХ УЧАСТКАХ РЕК ПРЕДГОРНОЙ ЗОНЫ

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При возведении речных сооружений плановое очертание русла на определенном участке меняется. В этих переходных участках важна правильная оценка параметров руслового размыва. Существующие методы по расчету этих параметров имеют ряд серьезных недостатков. На основе универсальной математической модели разработан метод ее частного применения. Он дает возможность получить закономерности по определению параметров руслового размыва в переходных участках предгорных рек. На их основе можно рассчитать гидравлические характеристики потока и координаты нового дна русла в мостовом переходе, образованного после стабилизации размывного процесса. Разработанный метод может быть использован специалистами при проектировании речных сооружений, а также при составлении рекомендаций по безопасной эксплуатации.

Ключевые слова: река, русло, переходный участок, размыв, расчет параметров

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ON DETERMINATION OF STABLE LONGITUDINAL PROFILE OF THE RIVER CHANNEL

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[2]*"Pascal" LLC*

One of the main problems of channel processes' prediction is the determination of a stable longitudinal profile of the channel of river. Related to it there are also problems of rivers` meandering. The proposed method of forecasting the channel processes is based on determination of the stable longitudinal profile of a river and its comparison with the actual longitudinal profile. Comparison of these two profiles enables evaluating the entire description of the channel deformations in the given section of the course of river. It is also reasoned in what case it is advisable to carry out the corridor of the rivers, and in what case should it be limited to taking bank-protection measures on the old channel of the river.

Key words: *ground, channel, river-training, channel wash up, hydrograph, bank-protection measures, hydraulic size*

Introduction

River channels are steadily subject to changes until the stable state of the channel is reached. In addition, the wash-up depends on characteristics of the current and channel, as well as the channel's soil composition.

The term "stable channel" is often used with different meanings.

According to K.V. Grisanin [1, 2], defined the term "stable channel" as a prismatic channel of stable gradient and insensitive to small excitations with a solid bottom formed by unbound particles.

Static stability is the time invariability of hydromorphological parameters of the channel in the course of time. The stability of the channel refers to some sections of a certain length where cross-sections shape and width remain unchanged for a long period of time. Considering that such an approach does not take into consideration the channel bed fluctuation caused by movement of carried down and deposited earth, gravel, rock (lat. Fluctuatio: fluctuatio, fluctuatio variation, random variation of any magnitude and index), this paper suggests replacing the term "time stability of the channel" by the concept of "time pseudo-stability of the channel".

The channel processes taking place in the mountainous rivers essentially differ from the channel processes taking place in lowlands. If the size of the soil particles in the lowland rivers form the channel of the rivers does not exceed 1 mm, then in the mountainous rivers they reach several hundred millimeters. Moreover, if the dimensions of particles in the lowland river channels are not practically subject to change along the current, then in the mountainous streams self-evenning process creates rearrangement of particles according to their size. The slopes and hydrographs of the mountainous and plains rivers are very different.

The complicated morphology and current fluctuations of natural channels pose many problems, from which K.V. Grishan [1], as important, underlined the following two of them.

1) How long the average velocity of the stream can practically remain constant along the length of the river course.

2) Can the condition $\frac{du}{dx} = 0$ remain independent of the free surface fluctuations?

If in a plane problem the stability of a straight slope channel is disturbed by a random excitation hiving a wavelength equivalent to the stream depth, then in the case of a three-dimensional problem, the stability of the prismatic channel bed of a straight slope is disturbed by excitation having

a wavelength proportional to the channel width [1]. From here, one can arrive to a conclusion that the average velocity of the channel along the run can be practically constant in a section proportional to the channel width. It has been proved that if the free surface fluctuations occur sufficiently slow, then the water movement in the prismatic channel of the constant gradient angle, regardless of the stream depth remains quasi-constant, that is, it can only be changed if the output is changed [1].

Conflict settings

To implement bank-protection and channel training measures a problem is posed to develop a technique able to predict channel deformations.

Research results

The method for determining a stable longitudinal profile involves in a system of differential equations characterizing the channel processes equations of the nonuniform flow of the fluid and the deformations of the channel [3, 4]. Thus, we get

$$\frac{dh}{dx}+\frac{dz}{dx}=-\frac{d}{dx}\left(\frac{U^2}{2g}\right)-\frac{U^2}{C^2h}, \tag{1}$$

$$\frac{dG}{dx}=0:$$

To solve this system it is necessary to have G output expression of the solid particles. A good many empirical dependence devoted to the solution of this problem are available in the special literature. Analyzing these dependences K.V.Grishanin [1] found that all formulae determining output of the solid particles are the same in the sense that they all point to the same factors affecting the amount of silt, such as flow kinetics, particles' mobility, hydraulic resistance of the channel, etc. [1]. For the G output expression we have

$$G\sim Fr\left(\frac{V_*}{W_0}\right)^n\left(\frac{C}{\sqrt{g}}\right)^m \tag{2}$$

The size of the fixed particles and the resistance of the channel are mutually depend. As a proof of that is revelation of regular alteration of ***n*** index as compared with the ***m*** one. For example, formulae having a high value of ***n*** index have a lower value of ***m*** index. And since all of these formulas the indices are determined empirically, their correlated changes reflect the objective reality. Based on this, K.V.Grishanin obtained that interrelationship directly [2]

$$n=1.25-0.25m: \tag{3}$$

When the channel bed is assumed stable in the current of solid particles should take place sedimentation. That is, the hydraulic size of the moving particles should become equal to the hydraulic size of the bottom silts. When ***n*** = 0, then m = 5. In this case, the following relationship can be used to determine the output of solid particles

$$G\sim Fr\left(\frac{C}{\sqrt{g}}\right)^5: \tag{4}$$

or taking into consideration the following dependence

$$G\sim K_1\left(\frac{h}{d}\right)^{1/6}: \tag{5}$$

for solid particles, we get

$$G\sim\frac{U^2}{d(h/d)^{1/6}}: \tag{6}$$

Taking into account Eq.(6) in case of stationary flow the equation of the channel deformation will have the following view

$$u^2=kd({}^{h}/_{d})^{1/6} \tag{7}$$

The velocity determined by Eq.(7) is the non-washing-up velocity measure of unbound particles of ***d*** diameter on the channel bottom at the ***h*** depth. Therefore, to ensure stability of the

channel it is necessary that the flow velocity be not greater than that measure. In that case, taking into account Eq.(5) and (7), we get

$$\frac{dz}{dx} = \frac{d}{dx}\left[-h - \frac{k}{2g} d \left(\frac{h}{d}\right)^{1/6} - \frac{k}{k_1^2}\int_0^x \frac{d(x)dx}{h(^h/_d)^{1/6}}\right]: \tag{8}$$

Integrating Eq.(8), we have

$$z = -h - \frac{k}{2g} d \left(\frac{h}{d}\right)^{1/6} - \frac{k}{k_1^2}\int \frac{d(x)dx}{h(x)(^h/_d)^{1/6}} + k_2 \tag{9}$$

Let us assume that in the source course of the river the average depth of the stream and the self-evenning diameter of the solid particles are the following

$$x = 0; z = z_0; h = h_0; d = d_0. \tag{10}$$

Taking into account Eq.(9) and (10), we get the equation of the stable channel's cross-section

$$z = z_0 + (h_0 - h) + \frac{k}{2g}\left[d_0 \left(\frac{h_0}{d_0}\right)^{1/6} - d\left(\frac{h}{d}\right)^{1/6}\right] - \frac{k}{k_1^2}\int \frac{d(x)dx}{h(x)(^h/_d)^{1/6}} \tag{11}$$

The obtained relationships show that the stable shape of longitudinal cross-section of the channel being washed-up depends not only on the change in the depth of the current along the course, but also on the self-leveling diameter of the solid particles and the change of roughness of the channel. Given the regularity of these magnitudes change in accordance of the river length, we will get the longitudinal section of the channel.

In particular, when the depth of the current and the self-evenning diameter of solid particles along the length do not change, whereas do in lowland rivers, from Eq.(11) one can arrive at a conclusion that the longitudinal cross-section of the stable channel bottom is a straight line and its gradient is determined by the equation of the water uniform movement.

The flow in the mountainous rivers is always nonuniform. Some researchers suggest taking it constant [1], that is

$$h = h_0 : \tag{12}$$

Such an approach is unacceptable and leads to sensible errors.

The average diameter of self-evenning solid particles can be determined from the following regularity

$$d = d_0 e^{-\alpha x} \tag{13}$$

Taking into consideration Eqs.(12) and (13) for a stable channel longitudinal cross-section we have

$$z_p^* = z_0 + \frac{k}{2g} d_0 \left(\frac{h_0}{d_0}\right)^{1/6} (1 - e^{-\frac{5}{6}\alpha x}) - \frac{6k}{7\alpha k_1^2}\left(\frac{d_0}{h_0}\right)^{7/6} (1 - e^{-\frac{7}{6}\alpha x}) \tag{14}$$

The movement of the mountain in the mountainous rivers is uneven. On the other hand, the slopes of these rivers, as a rule, are smaller and the width increases. As a result, the depth of power decreases in length. Given that we use the exponential connection to determine the bottom self-evenning particles (13), from the point of view of convenience, a similar connection can be used to determine the depth of the current

$$h = h_0 e^{-\beta x} \tag{15}$$

The analysis of experimental results enables to conclude that there always is the following inequality $\alpha > \beta$, that is diameters of self-evenning particles are decreasing more quickly than the current depth. As a result, when Eqs(13) and (15) are taken into account and some simplifications are made Eq.(11) will have the following view

$$z_p^* = z_0 + h_0\left(1 - e^{-\beta x}\right) + \frac{k}{2g} d_0 \left(\frac{h_0}{d_0}\right)^{1/6} \left(1 - e^{-\frac{(5\alpha+\beta)}{6}x}\right) - \frac{6k}{7(\alpha-\beta)k_1^2}\left(\frac{d_0}{h_0}\right)^{7/6}\left(1 - e^{-\frac{7(\alpha-\beta)}{6}x}\right) \quad (16)$$

In this case, one more β index is added to previous conditions set for the river.

Conclusion

1. The suggested technique enables to predict possible channel deformations while implementing bank-protection and river training measures. In the latter case, as a rule, the bottom gradient of channel increases.
2. In designing it is necessary using a calculation method to determine the gradient of the stable channel bottom and compare the obtained results with original values. At the same time if data on current depth change along the water run then one can make use of Eq.(16), and in case of absent of such data – of Eq.(`4).
3. Taking into account that when the channel's time stability is evaluated and the fluctuation caused by the channel bottom movement is neglected, it is suggested to use the "time pseudo-stability of the channel" concept.

Used designations

u- average flow velocity
C- Shezy coefficient
R- hydraulic radius
n- roughness factor
Fr- Froud's number
Q - fluid outlet
G- output of solid particles
h- average depth of the stream
h_0 - depth of the stream at the beginning of the section
d - average self-evenning diameter
d_0- diameter at the beginning of the section
x- axis
U_0 - not wash-up speed
g- free fall acceleration
Z_{p*}- calculated height of the bottom, in case of variable depth;
Z_p - calculated height of the bottom, in case of unchanged depth
Z_H- calculated actual height of the bottom
Z_0- the height of the bottom at the beginning of the section
α - degree of self-absorbing particles
β- degree of the stream depth decrease
V_* - average hydraulic size of bottom silts
W_0 - average hydraulic size of moving particles;
K, K_1, a- constants.

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ՀՈՒՆԻ ԿԱՅՈՒՆ ԵՐԿԱՅՆԱԿԱՆ ՊՐՈՖԻԼԻ ՈՐՈՇՄԱՆ ՄԱՍԻՆ

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1- Շուշիի տեխնոլոգիական համալսարան
2- “Պասկալ” ՍՊԸ

Հունային գործընթացների կանխատեսման հիմնական խնդիրներից է հունի կայուն երկայնական պրոֆիլի որոշումը: Դրա հետ են կապված նաև գետերի միանդրացման խնդիրները: Հունային գործընթացների կանխատեսման առաջարկվող մեթոդը հիմնված է տվյալ տեղամասում գետի կայուն երկայնական պրոֆիլի և իրական երկայնական պրոֆիլի հետ համեմատության վրա: Այս երկու պրոֆիլների համեմատումը թույլ է տալիս գնահատել, գետի տրված տեղամասում, հունային դեֆորմացիաների ամբողջ նկարագիրը: Հիմնավորվում է,թե որ դեպքում է նպատակահարմար իրականացնել գետերի հուների ուղղում, իսկ որ դեպքում է պետք սահմանափակվել հին գետի հունի վրա ափապաշպան միջոցառումներով:

Բանալի բառեր. գրունտ, հուն, հունի ողողում, հիդրոգրաֆ, ափապաշտպան միջոցառում, հիդրավլիկական խոշորություն

ОБ ОПРЕДЕЛЕНИИ ПРОДОЛЬНОГО ПРОФИЛЯ УСТОЙЧИВОГО РУСЛА

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Одной из основных задач прогнозирования русловых процессов является определение продольного профиля устойчивого русла. С этим связаны также вопросы меандрирования рек. Предлагаемый метод прогнозирования русловых процессов основан на сравнении продольного профиля устойчивого русла со существущим профилем дна, что позволяет оценивать русловые деформации на данном участке реки. Обоснованы случаи, когда предпочтительно проводить выпрямление русла река, и когда можно обойтись берегозащитными мероприятиями.

Ключевые слова: грунт, русло, гидрограф, берегозащитные мероприятия, гидравлическая крупность

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THE INFLUENCE OF THE WEAR OF THE TOOL CUTTING EDGE ON THE DEFORMATION OF THE SURFACE DETAIL LAYER

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Computing possibilities of estimating the deformation of the surface layer are considered in processing of details with cutting tools at different levels of the wear. Experimental results of the modification of the deformation intensity in the depth of the surface layer for plates with different wear of cutting edge during the process are given. The methods of the estimation of influence of the deformation intensity on the parameters of vibro acoustic signal are shown.

Key words*: surface layer, deformation, tool wear, the vibro-acoustic signal, the spectrum of vibrations.*

Introduction

In modern engineering, many parts have to work in conditions of high temperatures, in contact with corrosive media, in the presence of high static and dynamic stresses. All these factors lead to the appearance of various defects on the surface of the part. Most often, the birth of such defects occurs in a thin near-surface layer, which is largely formed by the implementation of the appropriate processing technology. Practice established a close relationship between the properties of the surface layer of parts and their performance properties, including strength and durability. You can note the reasons for this connection:

- when the parts are being loaded, the surface layer turns out to be in more difficult conditions in comparison with the core. There are unbalanced atomic bonds there, the yield of dislocations is facilitated, less energy is needed to generate dislocations;
- risks and irregularities, formed on the surface and inherent in each technology of processing parts, are stress concentrators, centers of formation and development of fatigue cracks;
- at the earliest stages of plastic deformation, the interaction of dislocations leads to the formation of micro cracks of an atomic scale, which causes the formation of micro cracks at deformation degrees of about 6…8%, accompanied by a drop in resistance to their propagation [1];
- Using the methods of strain hardening, it is possible to form favorable compressive stresses in the surface layer and to improve the roughness class. However, when the critical temperature is exceeded during the operation of the part, material without strength hardening begins to possess advantages in terms of strength, plastic and elastic properties. The more the material was deformed, the lower the temperature is, the advantage is obtained by the material without strain hardening [2];
- the resistance of parts to corrosion-mechanical destruction depends on the processing technology applied at the finish, because it determines the strength and plastic properties of the surface, the chemical and structural-phase composition, diffusion mobility of atoms, thermodynamic stability etc.
- when applied to the surface of protective coatings, their performance depends largely on the properties of the surface acting as a substrate (micro geometry, cold work, residual stresses, structures);
- the relaxation rate of the properties of the surface layer and its softening during the operation of the part are in close correlation with the applied manufacturing technology.

It should be added to the above said the problem of wear of the cutting tool, because with the blade surface treatment, the wear of the cutting edge leads to an increase in the plastic deformation of the surface layer. In the conditions of automated production, the detection of the moment of attaining

critical wear at which deformation of the surface layer becomes higher than the permissible values is an actual problem.

Statement of the question

The purpose of the present studies is to create an integrated system for ensuring the quality of the surface layer during blade processing. Its implementation involves the solution of the following tasks:

- study of the possibilities of calculation methods for evaluating the effect the wear on the blade tool on the deformation of the surface layer of the work piece;
- carrying out experimental studies to identify the patterns of change in the quality of the surface layer at different levels of tool wear;
- the development of a system for diagnosing the state of the cutting tool in the process of cutting to ensure a stable quality of the surface layer.

Results of the study

In the cutting zone, a complex stress-strain state arises, the structure of which depends on the properties of the material being processed, on the initial geometry of the cutting tool and the shape of its wear, the processing regimes. To study deformations of the surface layer by calculation methods, the finite element method (FE) is the most acceptable. For comparison, among the calculated parameters, the strain intensity (ε_{int}), was chosen, which is determined by the formula [1] for three-dimensional space:

$$\varepsilon_{int} = C_\mu \left[\left(\varepsilon_y - \varepsilon_\tau\right)^2 + (\varepsilon_\tau - \varepsilon_x)^2 + \left(\varepsilon_x - \varepsilon_y\right)^2 + 1{,}5\left(\gamma_{y\tau}^2 + \gamma_{\tau x}^2 + \gamma_{xy}^2\right) \right]^{0{,}5}, \quad (1)$$

where C_μ is a constant depending on Poisson's ratio; ε and γ - linear and angular deformations along the corresponding axes *x*, *y* and *z* and in the respective planes *yz*, *zx* and *xy*.

For a simpler planar model in the formula deformations with the index "*z*" equate to zero. Graphical representation of the stages of formation of the distribution field ε_{int} in the cutting zone during the formation of chips is shown in Fig. 1.

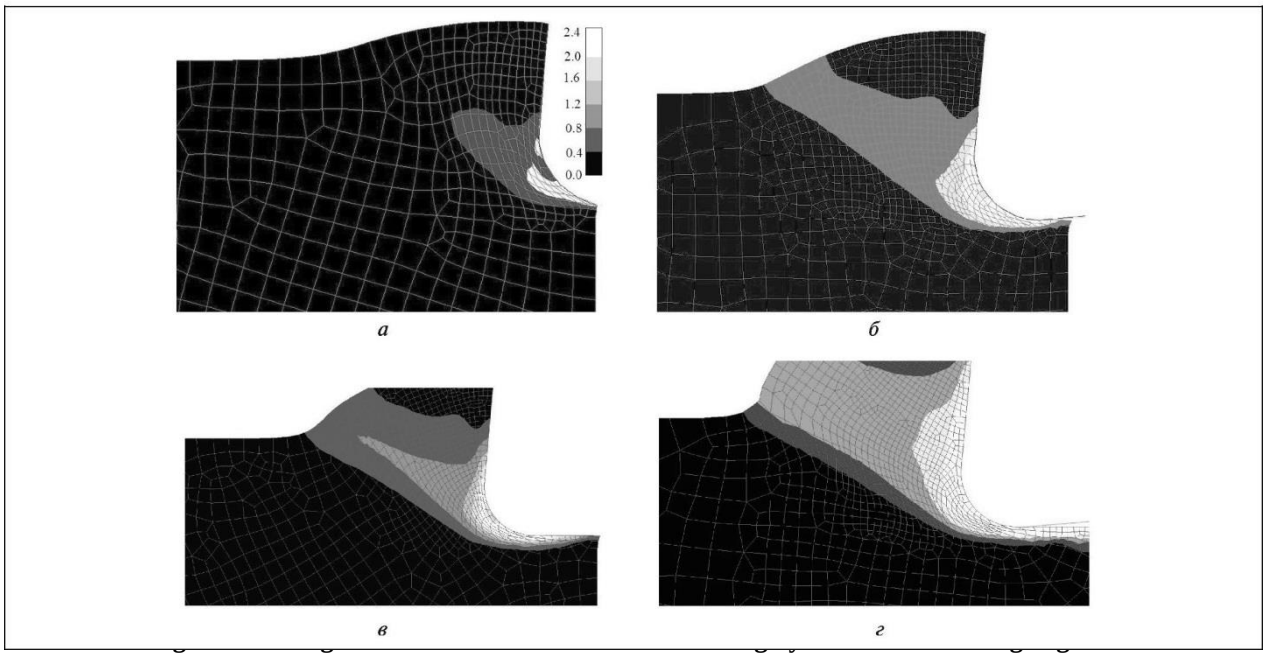
We see a gradual increase in the zone of high values of (ε_{int}), which is formed in the vicinity of the conventional shear plane, as the edge is inserted into the material. The volume of this zone is largely determined by the radius of the rounding of the cutting edge. The larger the radius, the greater the proportion of the material "jammed" by the back surface of the tool is, the greater the depth of penetration is required to start chip formation [4]. Accordingly, shown in Fig. 1, the deformation of the surface layer is much smaller than the deformations of the chips, but it also increases with the introduction of the cutting wedge and increases with increasing of edge radius. It is possible to trace the formation of a crack separating the chips from the results of examining the field of the intensity of the strain rates, the values of which are determined by analogy with expression (1), but instead of the values of deformations, their velocities are substituted into it.

The influence of the geometry of the cutting part of the tool on the intensity of deformations of the surface layer and the depth of their penetration δ is shown in Fig. 2.

To Fig. 2, the following observations can be made:

- with a sharp cutting edge, the deformation of the surface layer changes little when the front and rear angles change. This result corresponds to practical observations, when even with large wear on the back edge of the tool while retaining the sharp cutting edge, the cutting forces change insignificantly. At a depth of 0.3 mm. the strain intensity becomes relatively small, but its values for different angles differ by several times which raises the problem of estimating the uncertainty of computations in the region of small deformations;
- with increasing radius of the rounding radius of the cutting edge the value of ε_{int} increases regularly, but at r = 0,12 mm large deformations of the uppermost layers are observed with minimal deformations at depths greater than 0.2 mm. This anomalous situation requires further comprehension,

but it is difficult to verify, since in practice such radii do not occur when the tool is worn out.



а **– stage of elastic deformations;** ***б, в*** **– transfer of elastic deformations to plastic;** ***г*** **– start of distortions**

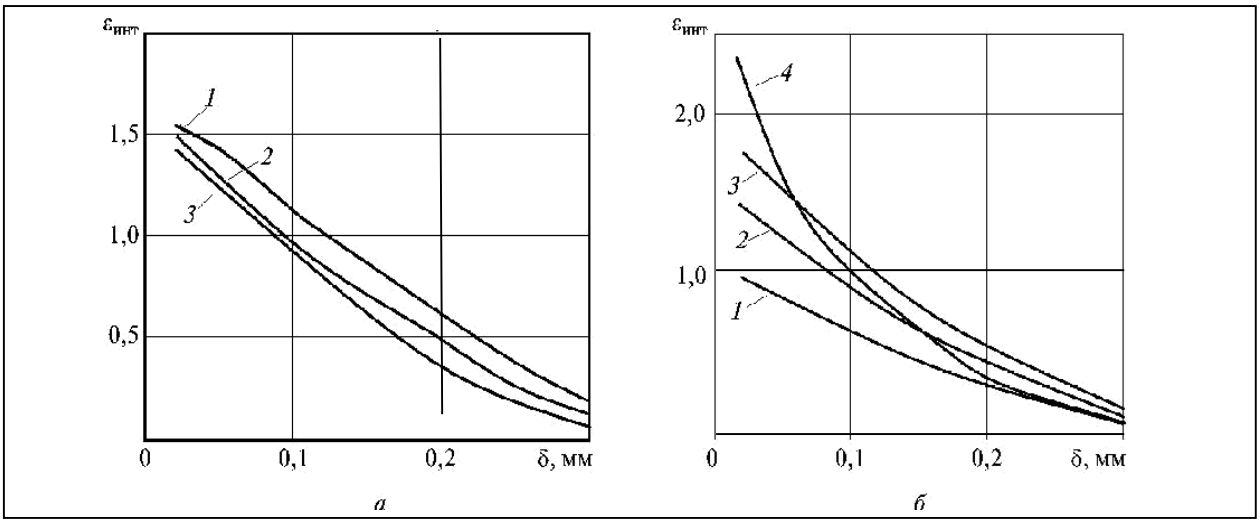


Figure 2. Change of $\varepsilon_{инт}$ according to the depth of surface layer :
а **– in different front and back angle:** $\mathbf{1-\gamma=0^0, \alpha=0^0, 2-\gamma=5^0, \alpha=5^0, 3-\gamma=15^0, \alpha=10^0}$**, ; б – in different radius of rounding: 1 - r = 0,02 mm; 2 - r = 0,05 mm; 3 - r = 0,09 mm; 4 - r = 0,12 mm**

However, the most difficult moment in modeling the shape of wear of the cutting edge is the approximation of the shape of wear in the contact zone by a portion of the circle of radius r. This approach assumes that as the wear chamfer develops over the back surface of the tool, the front surface and the cutting edge itself gradually degrade. As a result, there should be a resemblance of the radiused surface of the cutting edge, the radius of which is the greater, the greater the wear facet on the back face is. Unlike the radius, the size of the chamfer wear is simple to control. A similar approach takes place in tribology [4], where the relative depth of introduction of the indenter, which plays an important role in estimating the moment of transition of external friction to micro cutting (geometric factor), is determined by the ratio of the penetration depth *h* to the radius *r* of the indenter itself. Under some conditions of unevenness in frictional contact and tool wear areas, this approach is acceptable, but it is often necessary to observe a wide variety of geometric forms of wear of a carbide tool.

Sometimes, with wear, one can observe even a decrease in the radius of the rounding of the cutting edge. Such a phenomenon, for example, occurs at high cutting speeds, when wear on the back edge outruns the destruction of the edge from the front face side and there is an effect of self-sharpening.

For the experimental evaluation of the influence of wear on the cutting edge on the deformation of the surface layer, five cutting inserts were used in different stages of wear (Figure 3), which was formally estimated from the width h_3 of the chamfer of wear along the back edge:

1 - h_3 = 0 mm; *2* - h_3 = 0,6 mm; *3* - h_3 = 0,68 mm; *4* - h_3 = 1,1 mm; *5* - h_3 = 0,8 mm. It should be noted that the 2nd sample had almost the same size of the chamfer of wear as the third one, but it had practically a whole cutting edge, and the third sample had traces of destruction (Fig. 3, a). The fourth sample had the largest dimension of the facet of wear (Figure 3, b), but the broken edge had comparatively sharp edges, which was associated with the development of the wear lining along the front face. In the fifth sample (Fig. 3c), the wear face and the volume of fractures are smaller, but the cutting edge smoothly passes into the negative front angle and is closer to the radial shape. Fig. 3 shows the tops of the used specimens of the cutting inserts with the greatest wear.

Cutters equipped with plates with different degrees and forms of wear treated steel billets on planning and turning machines.

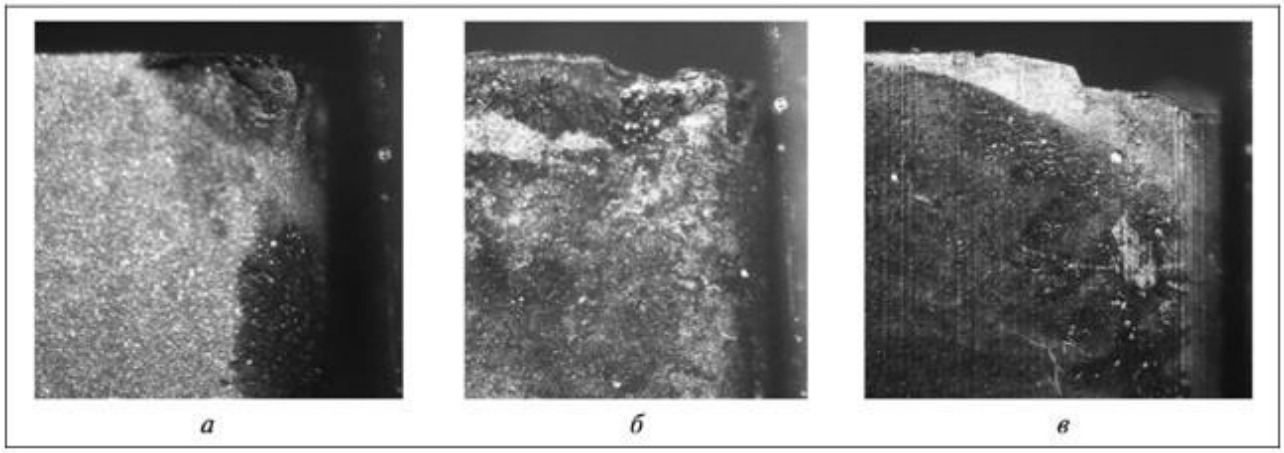


Figure 3. Samples of worn out tops of cutting edges:
***а* - h_3 = 0,68 mm; *б* - h_3 = 1,1 mm; *в* - h_3 = 0,8 mm**

Fig. 4 shows the change in the intensity of deformation along the depth of the surface layer for the described variants of wear of the cutting edge.

On the graphs of Fig. 4 we see that the main deformations are observed in the surface layer located up to a depth of 100 m/km. There is a regular growth of deformations with increasing wear of the cutting edge. The exception is plate number 5, which has a smaller wear dimension on the back face compared to plate number 4, but the deformation of the surface layer when it is used is 35% larger. This indicates that the deformation of the surface layer is determined mainly by the shape of the cutting edge. As another anomaly, we can note plate No. 3, deformations from which at a depth of more than 0.4 mm even slightly exceed the deformations from plate No. 5. As with calculations at depths of more than 0.3 mm, ε_{int} is considerably smaller in comparison with depths of up to 50 microns, but they are characterized by the fact that with little wear, they are almost imperceptible, and with an increase in wear, they sharply increase several times. Judging from the graphs in Fig. 4, then the increase in deformation as the wear of the cutting edge develops at a depth of more than 0.3 mm develops abruptly. For plates No. 3-5 deformations at a depth of more than 0.3 mm are close, and they are several times larger than the deformations accompanying the work of plates No. 1 and No. 2. In contrast to the graphs in Fig. 3, decreasing in accordance with a law close to linear, the graphs in Fig. 4 decrease according to a law resembling a hyperbola. This phenomenon can be explained by the fact that the calculation program did not fully take into account the temperature factor, which has a

complex effect on the mechanical properties of the material. The listed features and anomalies suggest that the calculation methods, although they build a qualitatively similar picture of deformation development with increasing tool wear, give higher values of the ε_{int} and can not take into account all the features of the change in the shape of the cutting edge and their effect on deformations of especially deep layers of the treated surface. Without taking into account the surface temperature and temperature gradients that affect the changes in the mechanical characteristics of the material being processed, errors in calculations will be exacerbated. In this section, the issue of monitoring the state of the cutting edge becomes important in order to prevent unacceptable deformations of the surface layer [5].

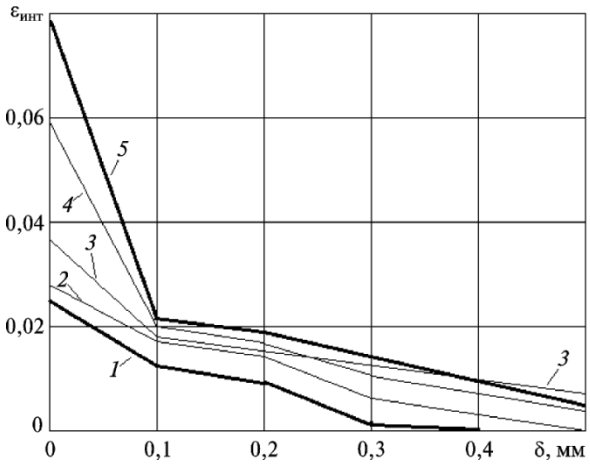


Figure 4. Change of deformations intensity according to the depth of surface layer for plates with different wears of cutting edges: *1* - h_3 = 0 mm; *2* - h_3 = 0,6 mm; *3* - h_3 = 0,68 mm; *4* - h_3 = 1,1 mm; *5* - h_3 = 0,8 mm

It is known that the destruction of the cutting edge, which causes intensive deformation of the treated surface, leads to an increase in the energy consumed, corresponding to an increase in cutting forces and the amount of heat released. The cutting force can be controlled by changing the active power consumed by the drives on the machine. However, in the final treatment regimes, the method does not always give satisfactory accuracy. This is particularly noticeable for finishing with a large ratio of the power of the applied motor and the amount of cutting power [6]. This situation is peculiar to the processing centers, where both roughing and finishing of parts from different materials and different configurations are carried out. Temperature control in the cutting zone is a difficult task even for laboratory conditions. The relationship between the vibro acoustic activity of the cutting process and the wear of the cutting tool is widely noted in the technical literature [6]. Vibro acoustic (VA) signals are comparatively easy to control with accelerometers, but the disadvantages of VA diagnostic methods include the difficulty of isolating useful information from a variety of parameters of VA signals accompanying cutting. The simplest parameters of VA signals, which are easily obtained in digital or analog form, are the effective amplitudes in the allocated frequency bands. Distortion of the shape of the spectrum of VA signals can be used as a diagnostic indication of the change in the state of the cutting tool [8]. It involves changing the ratio of effective amplitudes for different frequency ranges. The increase in heat release in the contact zone between the surfaces of the tool and the material being processed leads to a change in the mechanical properties in the friction pair, for example, a reduction in the hardness of the material being processed. In [6] it was shown that the amplitude of the high-frequency VA signal in frictional contact in the first approximation with increasing hardness of the softer element of the friction pair increases linearly. Thus, with increasing temperature (and a drop in the mechanical characteristics of the material being processed) in frictional contact under conditions of adhesive friction, the high-frequency components in the signal spectrum of

the signal should decrease. On the other hand, the growth of the load in the contact of the tool with the machined surface causes additional deformation of the technological system and increases its potential energy [5], making it less stable. The situation can be aggravated by a decrease in the bearing capacity of the cutting surface with an excessive increase in the contact temperature, which forms the undulation of the surface. When separating the chips, the balance of forces in the technological system is violated, which leads to the emergence of potential energy, the relaxation of elastic deformations with the appearance of oscillations at the natural frequencies of the technological system. From what has been said, it follows that with an increase in the potential energy determined by the cutting forces, oscillations in the technological system in the region of comparatively low frequencies will increase.

This growth is observed both at low and high frequencies in a wide frequency range, which is associated with the appearance of impact processes in contact, accompanied by a decrease in the temperature of the contacting surfaces and the restoration of their hardness. When the motion is sudden, the contact time of the irregularities becomes so small that the adhesive setting does not have time to develop. This determines the reduction in energy costs with relative movement of the contacting surfaces. Thus, in VA control of technological processes, it is necessary to include effective amplitudes in the areas of natural frequencies of the technological system in the number of informative parameters.

Conclusion

An experimental verification of the accuracy of the evaluation of the deformation of the surface layer of a part machined at different values of wear of the cutting edge with the help of computational models based on the CE method showed that the approximation of the shape of wear by a radius surface gives an excessive value of the strain intensity. In this case, there is a qualitative similarity of the results obtained. Comparison of experiments and calculations showed that the values of the deformations of the surface layer of the part are determined not so much by the dimensions of the chamfer of wear of the cutting insert as by the geometrical shape of the current fractures of the cutting edge, which in practice considerably differs from the radius. Without taking into account the effect of contact temperature on the mechanical characteristics of the material being treated, additional discrepancies arise between the results of calculations and experiments. To increase the reliability of the formation of a qualitative surface layer, constant monitoring of the tool state during processing is necessary. For these purposes, it is possible to monitor the active power of the drive under rough processing conditions and vibration signals during finishing.

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ԳՈՐԾԻՔԻ ԿՏՐՈՂ ԵԶՐԻ ՄԱՇՎԱԾՔԻ ԱԶԴԵՑՈՒԹՅՈՒՆԸ ԴԵՏԱԼԻ ԱՐՏԱՔԻՆ ՇԵՐՏԻ ԴԵՖՈՐՄԱՑԻԱՅԻ ՎՐԱ

Պ.Յու. Գասպարյան

Շուշիի տեխնոլոգիական համալսարան

Դիտարկված են մակերևութային շերտի դեֆորմացիաների գնահատման հաշվարկային հնարավորությունները՝ եզրային տարբեր աստիճանի մաշվածքի սայրային գործիքով դետալների մշակման դեպքում: Բերված են կտրման ժամանակ ըստ մակերևույթային շերտի խորության դեֆորմացիաների ինտենսիվության փոփոխման փորձարարական արդյունքները, կտրող եզրերի տարբեր մաշվածության սալիկների համար: Բերված են դեֆորմացիաների ինտենսիվության ազդեցության գնահատման մեթոդները վիբրոձայանային ազդանշանի պարամետրերի վրա:

Բանալի բառեր. Մակերևութային շերտ, դեֆորմացիաներ, գործիքի մաշ, թրթռաձայնային ազդանշան, տատանումների սպեկտր

ВЛИЯНИЕ ИЗНОСА РЕЖУЩЕЙ КРОМКИ ИНСТРУМЕНТА НА ДЕФОРМАЦИИ ПОВЕРХНОСТНОГО СЛОЯ ДЕТАЛИ

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Рассмотрены вычислительные возможности оценки деформаций поверхностного слоя при обработке деталей лезвийным инструментом с различным уровнем износа. Приведены экспериментальные результаты изменения интенсивности деформаций по глубине поверхностного слоя для пластин с разным износом режущей кромки при резании. Приведены методы оценки влияния интенсивности деформаций на параметры виброакустического сигнала.

Ключевые слова: поверхностный слой, деформации, износ инструмента, виброакустический сигнал, спектр колебаний

UDC 631.358:62.56

JUSTIFICATION OF FLAT TILLAGE HOE PARAMETERS

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This paper presents replacement of loosening and breaking up the soil by a cultivator chisel with universal center hoes in the process of loosening in the minimum tillage. The equations have been obtained for calculating the parameters characterizing geometric shape of flat-cut universal hoes and defined their optimal parameters. To solve the problem, the working surface of the center hoe is represented in the form of a three-sided wedge. In case of parameters obtained theoretically the resistance to cutting of a weedy earth mass by a cultivator equipped with a center hoe decreases sharply.

***Key words**: cultivator, cultivator center hoe, trihedral wedge, soil mass.*

Introduction

A large number of fundamental research and experimental works are available in literature on selection of machinery and systems used for cultivation of cereal crop. The attention of world scientists on land cultivation is explained not only by the necessity to create favorable conditions for intensive growth and development of the grains, but also the importance of rational solution of the problems related to land-processing technology and energy saving systems of technical means.

The statement of the problem It is well known that 30-40% of total energy used in agriculture is spent on land cultivation. crop production share of energy used for land cultivation amounts to 70 percent of the consumed total energy [1].

Since the beginning of the early 70s of the last century prices for fuel and agricultural machinery on the international market have seen continuous drastic rise issuing a serious challenge to scientists, researchers, experimenters, engineers and designers to develop land cultivation energy saving technology and create new generation of energy efficient agricultural machinery. As a result of carried out fundamental investigation and drastically taken measures gradually was developed and introduced a land minimum cultivation technology composed of cultivation, cultivation by such tools as discs and chisels components.

The selection of the above mentioned technologies designed for surface tillage depends on the soil physical-technological properties and structural behavior.

In case of irrigated agriculture, maximum grain yield is provided by up to 18 cm cultivation depth, therefore, it is reasonable to evaluate technological parameters of the cultivation hoes presently in use and to reveal apparent defects.

It is well-known that the minimum loosening process of the soil is performed by chisel crushers, of which technological process can be replaced by cultivator's loosening hoes. Consequently, our research is aimed at technological and energy analysis of the parameters describing the geometrical shape of flat-cut cultivation hoes.

Complicated technological process of weedy soil mass loosening by flat-cut centre-toes and simultaneous cutting of weeds using a milling cutter was developed by A.P.Tarverdyan [2,3].

According to analysis of results obtained by theoretical and experimental research it was confirmed that weedy soil mass cutting by a flat-cut knife edge consuming minimum energy can be achieved by oblique sliding motion providing $\alpha_{upp} = 20 \div 22^{o}$ transformed position angle. At the

same time, it is necessary to ensure coincidence of the cross-section plane of the stress-strain state and the trajectories of the main platforms.

Under these conditions, the material cutting process is transformed into a forced development of the crack, without the use of additional effort, thereby contributing to a drastic reduction in material resistance to cutting.

Results of the research

To solve the problem under discussion the half of the working surface of the center toe is represented by a triangle ABC three-edged wedge and is characterized by loosening α_1 angle, turn over β_1 angle, and side pushing γ_1 angle (Figure 1).

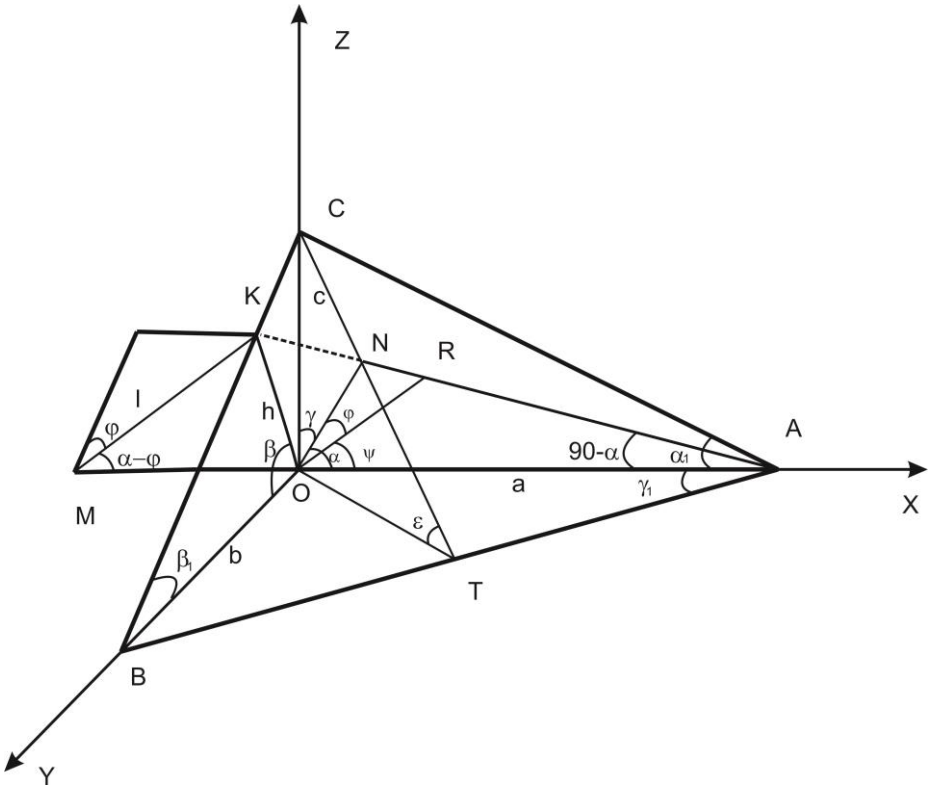

Figure 1. Principal scheme of a universal center hoe (three-edged wedge)

In Figure 1 A, B, C, the distance from the O reference point is equal to the line segments of a, b, c, respectively.

The angles between the normal (ON) to the working surface of the three-edged wedge of the flat-cut center hoes and coordinate axes are expressed with the following values:

$$\angle nox=\alpha,\ \angle noy=\beta,\ \angle noz=\beta:$$

Net reaction force R is deviated from the normal by friction angle φ. According to triangles made by α_1, β_1, γ_1, angles of the three-edged wedge their trigonometric relations are expressed as follows

$$\left.\begin{aligned} tg\alpha_1 &= tg\beta_1 tg\gamma_1 \\ tg\beta_1 &= tg\varepsilon cos\gamma_1 \\ tg\alpha_1 &= tg\varepsilon cos\gamma_1 \end{aligned}\right\} \quad (1)$$

The ABC equation $\frac{x}{a}+\frac{y}{b}+\frac{z}{c}=1$ of the wedge working surface is used to determine the values of direction cosines

$$cos\alpha = \frac{f_x'}{\sqrt{f_x'^2+f_y'^2+f_z'^2}} = \frac{1}{\alpha\sqrt{\frac{1}{a^2}+\frac{1}{b^2}+\frac{1}{c^2}}}$$

Now let us denote $\frac{1}{\sqrt{\frac{1}{a^2}+\frac{1}{b^2}+\frac{1}{c^2}}} = \Delta$, therefore, $cos\beta = \frac{f_y'}{\Delta}$, $cos\gamma = \frac{f_z'}{\Delta}$ and

$$\left.\begin{aligned} cos\alpha &= \frac{1}{a\Delta} \\ cos\beta &= \frac{1}{b\Delta} \\ cos\gamma &= \frac{1}{c\Delta} \end{aligned}\right\} \quad (2)$$

The values of angles α, β, γ, formed by the normal of the wedge working surface are necessary for determining the direction of the crack occurred in the soil mass.

According to the magnitude of maximum shearing stresses directions of a crack in the soil propagate in H_1 and H_2 planes, by which the furrow slice can be decomposed as a result of cast, and is deviated from the direction of the surface reaction resultant at $\pm\frac{\theta}{2} = \frac{40\div50}{2}$. Therefore, on the basis of the results obtained by experimental studies can be accepted and accepted that the direction of the crack coincides with the direction of the reaction resultant acting on the surface of the wedge to the surface of the wedge and is deviated from the normal at the friction φ angle [4].

For the purpose of the solution of the problem under consideration the direction of that angle on the three-edged wedge will be $\psi = \alpha - \varphi$, but we have 90-$\alpha = 22^o$, $\alpha = 68^o$, thus $\psi = 68 - \varphi$ (3)

On the basis of the problem formulation let us take the external friction factor soil tg φ= 0.5÷ 0.7 for clay sand and loamy, then φ=$26^0 \div 35^0$. Let us now take the design friction angle $\varphi = 30^0$ or $\psi = 68 - 30 = 38^0$.

Thus, according to Figure 1 we will get the following necessary data for calculation of the three-edged wedge:

• The length of the furrow slice crack (MK) from the reference point at the depth (M) h

$l = hctg(\alpha - \varphi) = hctg\,\psi = 1.28h$

- The length of the x coordinate of the three-edged wedge is

a=htg$\alpha = 2.475h$

Let us take h = 10 cm, then we get a = 25 cm, 680.

Now we have to calculate b and c coordinates f the three-edged wedge. Since this procedure refers to the minimal cultivated technology of the soil, therefore, some technological parameters are selected according to the hoes run depth [4; 5]. In the case the depth of the h_{oe} run depth exceeds 20 cm, from the energy viewpoint, based on the results of the experimental studies, it is recommended to select the angle of development as $\gamma_1 = 35 - 40^0$.

In this case for calculation of the wedge y = b coordinate we can write

$$b = \alpha \cdot tg\gamma_1 = htg\alpha tg\gamma_1 \quad (4)$$

Therefore, we get

$$b = 25 \cdot tg37 = 19\ uu\prime:$$

For calculation of loosening angle β_1 of the wedge we make use of the KOB triangle

$$sin\beta_1 = \frac{h}{b} = \frac{h}{h \cdot tg\alpha tg\gamma_1}\ or\ n\beta_1 = ctg\alpha \cdot ctg\gamma_1: \quad (5)$$

$$c = htg\alpha tg\gamma_1 tg[\arcsin(ctg\alpha ctg\gamma_1)]: \quad (6)$$

Now what remains from the wedge geometrical parameters to calculate is z = c coordinate and angle α_1, of which the following can be written $c = btg\beta_1$ or

$$c = htg\alpha tg\gamma_1 tg[\arcsin(ctg\alpha ctg\gamma_1)]: \quad (6)$$

Therefore, $c = 19tg32 = 12$ sm

$$tg\alpha_1 = tg\gamma_1 tg\,[\arcsin(ctg\alpha ctg\gamma_1)] \quad (7)$$

After the respective calculation, we have

$$\alpha_1 = 33^0$$

Thus, by the developed calculation theory geometrical shape and parameters of the working member of the cultivator meeting the requirements of the minimum soil tillage technology, relating it to the required shear stresses necessary to produce MK=l length of the crack.

Conclusion

The minimal loosening of the soil is performed by chisel crushers, of which technological process can be replaced by the universal hoes of the cultivator.

To justify the parameters of the center hoes of the cultivator their working surface is represented as a three-edged wedge.

By the developed theory, designed for grounding the geometrical shape and parameters of a cultivator working member satisfying land minimal preparation requirements, it is assumed as a basis that to make a crack in the soil of a certain length it is necessary to provide required stresses during operation of the cultivator.

For minimal energy consumption spent on the weedy soil mass cutting by a flat–cut knife edge it is necessary to implement cutting process by oblique slide of the knife, while simultaneously securing the transformed loosening angle at 20-22^0 degrees.

By theoretical studies the following optimal parameters of the loosening center hoe have been found – the loosening angle is 33^0, the furrow slice turn over angle is 32^0, and the cut mass side pushing angle is 35-40^0.

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ՏԵԽՆՈԼՈԳԻԱՊԵՍ ԲԱՐՁՐ ԵՎ ԷՆԵԳԱԽՆԱՅՈՂ ՀԱՐԹԱՀԱՏ ՀՈՂԱՄՇԱԿ ԹԱԹԻԿՆԵՐԻ ՊԱՐԱՄԵՏՐԵՐԻ ՀԻՄՆԱՎՈՐՈՒՄԸ

Ա.Մ. Եսոյան[1], Ա.Ս. Հակոբյան[2], Լ.Թ. Ավետյան[2], Ա.Ա. Պողոսյան[2]
[1]Հայաստանի ազգային ագրարային համալսարան
[2]Շուշիի տեխնոլոգիական համալսարան

Առաջարկվում է հողի նվազագույն մշակությամբ փխրեցման գործընթացում չիզելումը փոխարինել կուլտիվատորի ունիվերսալ սլաքաձև թաթիկներով: Տեսական հետազոտություններով ստացվել են կուլտիվատորային հարթահատ թաթիկների երկրաչափական ձևը բնութագրող պարամետրերի հաշվարկի հավասարումներ և որոշվել են դրանց օպտիմալ արժեքները:

Խնդրի լուծման նպատակով սլաքաձև թաթիկի բանվորական մակերևույթը ներկայացվել է եռեզր սեպի տեսքով:

Տեսականորեն ստացված պարամետրերի դեպքում կուլտիվատորի սլաքաձև թաթիկով հողամոլախոտային զանգվածի կտրման դիմադրությունը կտրուկ նվազում է:

Բանալի բառեր. կուլտիվատոր, սլաքաձև թաթիկ, եռեզր սեպ, հողամոլախոտային զանգված, կտրում

ОБОСНОВАНИЕ ПАРАМЕТРОВ ВЫСОКОТЕХНОЛОГИЧНЫХ И ЭНЕРГОСБЕРЕГАЮЩИХ ПЛОСКОРЕЗНЫХ ПОЧВООБРАБАТЫВАЮЩИХ ЛАП

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Предлагается в процессе рыхления минимальной обработки почвы чизелевание заменить универсалными стрельчатыми лапами.
Теоретическими асследованиями установлны уровнения расчета параметров, характеризующих геометрическую форму плоскорезных универсальных лап и определены оптимальные их параметры.

С целью решения задачи рабочую поверхность стрельчатых лап представлена в виде трехгранного клина. Сопративление подрезания почвосорняковой массы резко снижается при работе стрельчатых лап культиваторов с теоретически обоснованными параметрами.

Ключевые слова: культиватор, стреловидная лапа, трехгранный клин, почва-сорняковая масса, резание

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CALCULATION OF A KNIFE SETTING OF THE POTATO DIGGER'S ROTARY CLOD CRUSHER CONVEYOR

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Potato-digging machines operating under heavy ground conditions should be equipped with a clod-crusher-conveyors with dynamic properties. In the course of operation on the clod-crusher-conveyor circular belts knives are mounted angularly and the distance between them on the rotor should be taken into consideration for the crushed lump of soil not be clogged between neighboring knives. The relation of the distance between two neighboring knives and their number has been established. The installation of clod-crush-conveyors with oblique replaceable knives on potato-digging machines provides 96 percent of tubers separation from the soil.

***Key words**: potato digger, tuber, clod-crusher conveyor, bed, separation*

Introduction

Current potato diggers and combines are designed for operating in light and average clay, clay sand soils. They provide up to 85 percent of separated tuberous soil mass [1,2].

The most part of land under farming agriculture of the Republic of Armenia is of heavy type, which after irrigation are crusted over by thick layer. The number of machine-friendly areas good for potato cultivating is quite limited, because of that most cultural plants like tubers and root crops are cultivated in difficult land pieces.

Conflict settings

In potato harvesting up to now clod crushers do not provide necessary technological quality of the tuberous plants digging process. The entire tuber-and-soil mass of the bed is loaded on the digging machine due to which it is becoming overloaded, tubers cleaning process is worsening, as a result occurs a loss of machine productivity and rate of working, on the other hand expenditures on energy are increasing [3,4].

Machines working in bad conditions in terms of soil properties should become completed with clod crushers of dynamic characteristics. They should be installed in front of ploughs and embrace the whole profile of the tuber pit.

Research results

As a result of the study, it has been established that the executive organ of the clod-crusher conveyor operating in the design of the potato digging machine should have such a structure that parallel with the crushing of clods on the ridge it transports the crushed material to the furrow space and prevent the soil mass from entering the potato digging machine.

Application dynamically operating rotary clod-crushers on a potato digging machines will enable to essentially lighten the weight of machines and to lighten their work. The executive organ will perform better grinding of clods, will prevent soil degradation, will be possible effective separation of tubers and soil mass, and provide required technological quality of harvest.

To reduce the degree of tubers' mechanical damage and increase the intensity of clods crushing it is necessary during the development of the clod-crushing conveyor's design and substantiation of its

parameters it is necessary to take into account the geometrical shapes of the furrow and tuber pit and their dimensions and their relative position.

On the chain belts of the clod-crusher-conveyor cutting knives are fixed angularly relative to the direction of the machine movement. Trajectory of the knives is a cycloidal curve which plays a positive role in loosening of clods on the ridge surface. Due to obliquely mounted knives the loosened mass of the ridge surface the gradually is moved to the furrow space and is not entirely fed to separation unit. The clod-crusher-conveyor not only crushes clods on the surface of the ridge but also removed the cuttings aside [5].

Technological process of the clod-crusher of the executive organ consists of two consecutive operation – first, cutting the soil crust covering the ridge by the width equal to the amount of feed, second, throw it to the furrow space. Technologies used in these two operations differ greatly from one another, therefore, the structural and kinematic parameters of the of the executive organ should be grounded in such a way that the cutting of the soil crust and throw of cuttings are not performed on account of work quality .

Let us make a theoretical analysis of the technological process' two operations with the agreed substantiation of the main parameters .

Cutting off the ridge surface crust without pushing the front soil mass by the knife it is necessary to provide $\lambda > 1$ requirement of the kinematic index. This condition is necessary for providing the cuttings be thrown in the ridge's side furrow.

Therefore, ensuring of the ridge cleaning from the soil crust is satisfied by $\lambda > 1$ condition with $\lambda = \frac{\omega R}{V}$ reservation, where ωR member, simultaneously, should not influence too much diminution of cuttings width. The width of soil slice is equivalent to the feed $S = \frac{2\pi R}{\lambda z}$, where z is the number of knives installed on the roller o9f the executive organ. On the other hand the distant between knives on the perimeter of the roller should also satisfy the requirement that cut-off soil slice should not be stuck between neighboring knives.

The study of the above presented technological procedure suggests starting the solution of this problem from elimination of sticking of the soil slice in a space between knives.

According to studies carried out by S.S.Golushkevich [6] it was established that shear planes are not rectilinear (Figure 1,b). It should be noted that S.S.Golushkevich also found that within the range of the knife installation angle $\alpha \geq 90 - \varphi$ interaction of the deformator with the soil can be considered as an influence on the vertical wall. The crack in AC and DB sections is rectilinear, and in CD section has the appearance of a logarithmic spiral. As regarding this point Sh.M.Grigoryan [3] found that by slight deviations it can be assumed that $X = O''B = (2{,}5 \div 4)h$.

Proceeding from the above description it is possible to confirm that for the problem under study the distance between two neighboring knives is equal to $AB = \frac{2\pi R}{z}$, where z is the number of knives fixed on the perimeter of the roller. At the same time in the position $O'A$ of the next knife the edge of the previous knife is on the at the point B (Figure 1,b). Thus, for the reliable calculation the distance between knives should be

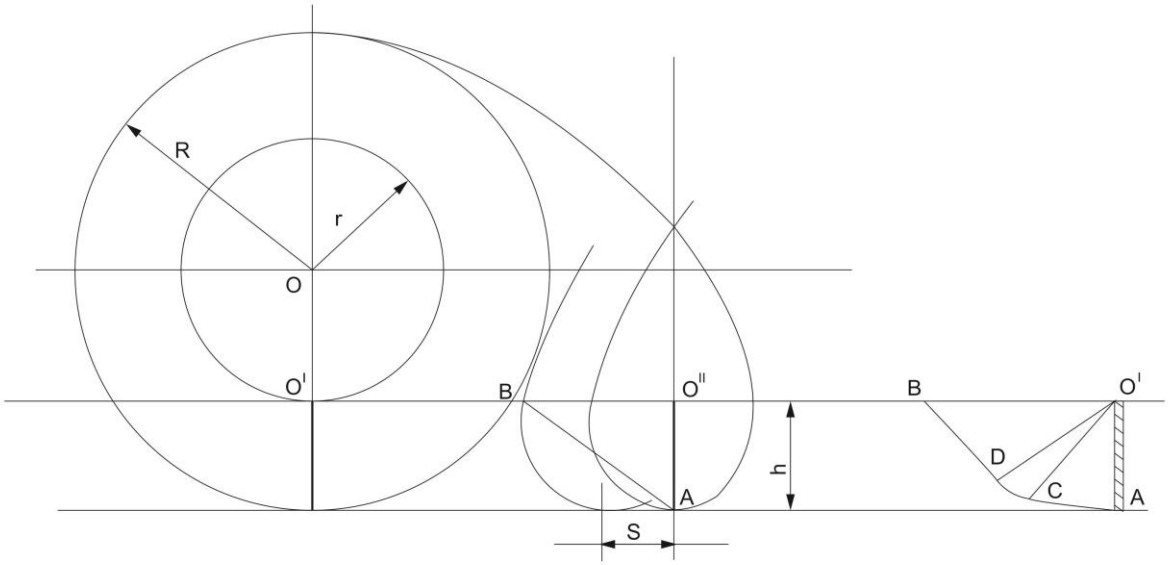
$$AB \geq \sqrt{h^2 + (2{,}5h)^2}, \text{ or}$$

$$AB \geq 2{,}69h: \tag{1}$$

Making use of Eq.(1) the number of knives on the will be

$$Z = \frac{2\pi R}{2{,}69h} \approx 2{,}33\frac{R}{h}: \tag{2}$$

The radius of the executive member's roller developed by the authors is $r = 13 \div 28$ cm. Calculating the value of $R = r + h = 20 + 12 = 32$ cm, ($h = 3 \div 12$ cm), we get $Z = 2{,}33\frac{R}{h} = 2{,}33\frac{32}{12} = 6{,}2$. Thus the number of knives will be $Z \approx 6$.



(a) **(b)**

Figure 1. (a) Calculation scheme for the distance between knives installed on the roller (b) scheme determining shear planes directions of the soil

The analysis of the designed magnitude of the knife installation angle shows that the optimal position of the knife within the range of turning angle of the rotor depends only on the kinematic parameters, which in case of driven rotor changes in the range of 0 to 1 and in the case of the driving one it is from 1 to 16.

Installation of rotary clod-crushing-conveyor with angled knives on potato digging machines will enable to perform clods breaking on furrow ridge and their cuttings` removal to the side, due to which almost 96 percent of tuber mass can be separated from soil just on the conveyor.

Conclusion

Ensuring the operation of cleaning the ridge from the soil crust meets the $\lambda > 1$ requirement. The width of the ground slice is equivalent to the feed. The distance between knives fixed on the roller's perimeter should satisfy the requirement that the cut-off soil slice not to be stuck between neighboring knives. The distance between two neighboring knives should be $AB \geq 2{,}69h$ which is necessary for carrying out the calculation. The number of angled knives installed on rollers of the clod-crusher-conveyor as a result of the study came out to be equal to 6. Installation of rotary clod-crusher-conveyors with angled knives on potato-digging machines ensures almost 96 percent of tuber mass separating from the soil.

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ԿԱՐՏՈՖԻԼԱՀԱՆ ՄԵՔԵՆԱՅԻ ՌՈՏԱՑԻՈՆ ԿՈՇՏԱՄԱՆՐԻՉ-ՓՈԽԱԿՐԻՉԻ ԴԱՆԱԿՆԵՐԻ ՏԵՂԱԿԱՅՄԱՆ ՀԱՇՎԱՐԿԸ

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Ծանր հողային պայմաններում աշխատող մեքենաները պետք է համալրվեն դինամիկական սկզբունքով աշխատող կոշտամանրիչներով: Դրանք պետք է տեղակայվեն խոփերից առաջ և ընդգրկեն պալարաբնի ամբողջ պրոֆիլը:

Դանակի տեղակայման անկյան հաշվարկային մեծության վերլուծությունը ցույց է տալիս, որ ռոտորի պտտման անկյան տիրույթում դանակի օպտիմալ դիրքը կախված է միայն կինեմատիկական պարամետրից: Կարտոֆիլահան մեքենաների վրա թեքադիր դանակներով ռոտացիոն կոշտամանրիչ-փոխակրիչների տեղակայումը հնարավորություն կտա իրականացնել մարգաթմբի մակերևույթի կոշտերի ջարդում և կողհեռացում, ինչի շնորհիվ փոխակրիչի վրա կապահովվի գրեթե 96% պալարահողային զանգվածի զտում:

Բանալի բառեր. կարտոֆիլահան մեքենա, պալար, կոշտամանրիչ-փոխակրիչ, մարգաթումբ, զտում

РАСЧЕТ УСТАНОВКИ НОЖЕЙ РОТАЦИОННОГО КОМКОИЗМЕЛЬЧИТЕЛЯ-ТРАНСПОРТЕРА КАРТОФЕЛЕКОПАТЕЛЯ

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Картофелекопательные машины работающие в тяжелых грунтовых условиях должны быть укомплектованы комкоизмельчителями работающими динамическим принципом. На круговых поясах комкоизмельчителя-транспортера под углом в отношении хода движения машины устанавлеваются ножи, отдаленность которых на роторе должна учитывать условия, чтобы разрезанная щепка не застревала между соседними ножами. Установлено расстояние между двумя соседними ножами и их количество. Установление комкоизмельчителей-транспортеров с косыми заменяемыми ножами на картофелекопательных машинах обеспечивают 96% очистки клубней от почвы.

Ключевые слова: картофелекопательная машина, клубень, комкоизмельчитель-транспортер, грядка, сепарация

UDC 542:54.084

APPLICATION OF LIQUID CHROMATOGRAPHY FOR "LOSARTAN POTASSIUM" HYPOTENSITIVE DRUG QUALITY CONTROL

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The authors of this paper have developed a method for determining the hypotensive pharmaceutical substance of losartan potassium and its normalized impurity in a substance and in a tablet form using reversed-phase high-performance liquid chromatography (RP HPLC) has been developed. The quantitative determination of losartan potassium and its impurity the external standard method was applied. The experimental data obtained with validation have confirmed the selectivity, precision, correctness and sensitivity of the proposed method. The presence of losartan potassium in medicinal agents can also be confirmed by reversed-phase thin-layer chromatography (TLC) using a mixture of phosphate buffer (pH = 3.6) eluent – acetonitrile of 60: 40% composition.

Key words: *receptor, hypotensive drug, metabolite, chromatographic experiment.*

Introduction. Currently, disease of the cardiovascular system is the most widespread and serious one in the world, moreover it is the leading cause of death worldwide. In connection with this, cardiovascular drugs (LS) of different classes presently are widely used. A special place among them is occupied by antihypertensive drugs. Angiotensin II receptor antagonists are one of the new most dynamically developing classes of antihypertensive drugs.

Losartan (Fig. 1) is the most known non-peptidic blocker of angiotensin II receptors.

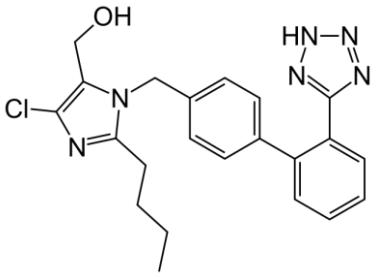


Figure 1. The structural formula of losartan

Blocking of the aforesaid receptors, losartan prevents and eliminates the vasoconstrictive effect of angiotensin II. This drug is characterized by a prolonged action (≥24 h), which is due to the formation of its active metabolite. Losartan is prescribed for patients with arterial hypertension, cardiac insufficiency, atrial fibrillation, patients with kidney pathology and who underwent myocardial infarction.

It is important to note that losartan prevents the development of myocardial hypertrophy, lowers the pressure in the pulmonary vessels, increases exercise tolerance in patients with heart failure. In order to achieve better solubility in the bio-environments and bioavailability, losartan is released in the form of potassium salt - "losartan potassium".

Production of losartan potassium in the Russian Federation is based on the use of foreign substances. Analytic control of substances and products made from them includes qualitative and quantitative analysis of both the main active substance and impurities. Despite the widespread use of losartan potassium in medical practice, in the Pharmacopeia of the Russian Federation [1] there are no regulatory methods for the analysis of this drug. In the American (USP) [2] and European (EP) [3]

pharmacopoeia, various methods (IR and UV spectrometry, potentiometric titration, high-performance liquid chromatography) are proposed to control the main active substance and impurities in the substance, which significantly increases the duration of analysis.

The aim of the work is the development of methods for determining the authenticity and quality of the drug "losartan potassium" using columnar (HPLC) and thin-layer (TLC) reversed-phase liquid chromatography.

Experiment. Objects of analysis, standard samples and reagents. The following have been used as objects of analysis: losartan tableted preparation (25 mg, Pranapharm Ltd., Russia), losartan potassium substance (San Pharmaceutical Industries LTD, India). Standard samples of potassium losartan and losartan impurities C were used to prepare standard and quantitative solutions in accordance with the US Pharmacopoeia (USP RS) catalog.

The following reagents have been used in this work: potassium phosphate monosubstituted (reagent-grade, produced by "Reactiv"), orthophosphoric acid (reagent-grade, production of "Reactiv"), acetonitrile (HPLC-grade, production of "Reactiv"), distilled water.
A standard solution was used to determine the quantitative content of the main component (potassium losartan of 0.4 mg/ml concentration).

To determine the impurity content, a standard solution of impurity C (impurity concentration C = 0.003 mg/ml) was used. To select the optimal conditions for chromatographic separation of losartan and its impurities, a standard solution of a two-component model mixture was used (concentration of losartan potassium - 1 mg/ml, concentration of losartan impurity - 0.003 mg/ml).

Sample preparation. To determine the quantitative content of the main component, the exact batch of powder of crumbled tablets, or the exact batch of the substance equivalent to 10 mg of potassium losartan, was placed in a 25 ml volumetric flask, 15 ml of distilled water was added, processed in an ultrasonic bath for 15 minutes, cooled to room temperature . The volume of the solution was adjusted to the mark with the same solvent, mixed, filtered through a membrane filter of 0.45 μm mesh, discarding the first portions of the filtrate (concentration of potassium losartan was 0.4 mg/ml).

In order to determine the quantitative impurity content, an accurate sample of the powder of crushed tablets or a substance equivalent to 25 mg of potassium losartan was placed in a 25 ml volumetric flask, then 15 ml of distilled water was added, mixed in an ultrasonic bath for 15 minutes, cooled, the volume of the solution was adjusted with the same solvent up to the mark, mixed and filtered through a membrane filter with 0.45 μm pore diameter, discarding the first portions of the filtrate (concentration of potassium losartan is about 1 mg/ml).

Chromatographic experiment. A liquid chromatograph "Knauer" was used with a UV detector, a thermostat of "Jet Stream II Plus" columns enabling elution in the temperature range 4 - 90^{0}C. A steel chromatographic column (250x4.6mm) filled with "Diaspher C18" sorbent of 5μm granulation ("BioChimMac ST", Russia) was used. The temperature of the column was 30^{0}C. Prior to each analysis, the column was washed with eluent for 15 minutes. Chromatography was carried out both in the isocratic and in the gradient elution modes. As eluents, mixtures of phosphate buffer pH 2.3 and acetonitrile with an acetonitrile concentration of 30-76% were used.

A chromatographic experiment in thin layer chromatography was carried out using reversed phase plates of Merk TLS aluminium sheets RP-18 F_{254} with an eluent of "phosphate buffer-acetonitrile" of **60:40%** v/v and pH of the original buffer was 3.6. Registration of the chromatogram on plates was carried out using the program "Sorbfil Videodensitometr TLC Quantitative Evaluation" (V. 1.7.0.216) ("Sopolymer", Russia).

The discussion of the results. Losartan or (2-butyl-4-chlorine-1 - {[2 - (1H-tetrazolium-5-yl) biphenyl-4-yl] methyl} -1H-imidazole-5-carbaldehyde ($C_{22}H_{21}ClN_6O$, M_r = 420,89) is a sufficiently hydrophobic compound and poorly soluble in aquatic environment. Therefore, both in substances and in finished drugs, losartan is in the form of potassium losartan. The structural formula of potassium losartan is potassium salt of 2-butyl-4-chlorine- 1 [p- (O-1H-tetrazol-5-yl) phenyl) benzyl] imidazole-5-methanol ($C_{22}H_{22}ClKN_6O$, M_r = 461.0) is shown in Fig. 2

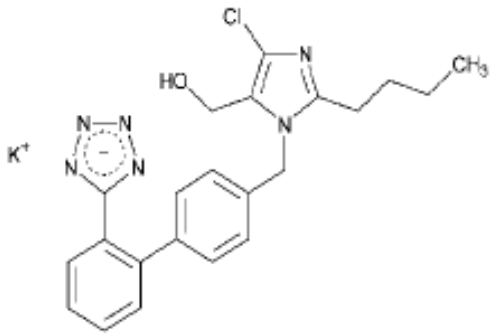


Figure 2. The structural formula of potassium losartan

Lozartan acts as an acid in the formation of salt with potassium. Since the chromatographic analysis was carried out in an acid medium, then dissociation of the salt in a water-acetonitrile medium leads to the formation of a predominantly molecular form of losartan. In this case, the potassium ions on the chromatogram are not recorded, since they do not absorb in the UV region of the spectrum.

In the isocratic mode of elution (30^0C), the effect of the composition of the mobile phase "phosphate buffer (pH = 2.50) - acetonitrile" on the retention of losartan on the nonpolar sorbent octadecylsilicagel C_{18} has been studied. The concentration of acetonitrile was varied from 40 to 76% v/v, which corresponds to a change in the mole fraction of this organic modifier in the mobile phase from X_M = 0.19 to X_M = 0.52.

Figure 3 shows the dependence of the logarithm of the retention factor (*lgk*) of losartan from the logarithm of the mole fraction of acetonitrile (lgX_M) in the eluent.

The linear dependence of *lgk* of lgX_M (R^2 = 0.974) indicates that the sorption of losartan on octadecylsilicagel under conditions of RP HPLC is described by the Snyder-Sochevinsky displacement model [4]:

$$lgk = a\text{-}n'X_M \quad (1)$$

where *n'* is the ratio of the areas of the sorbate molecule (losartan) and the most highly sorptive component of the mobile phase (acetonitrile) in the adsorption layer, and ***a*** is an empiric coefficient (-1.22).

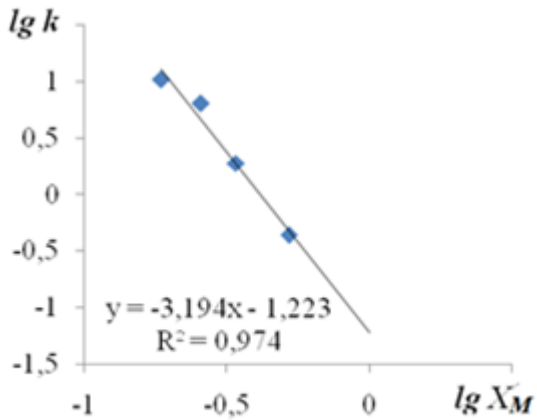


Figure 3. Dependence of the logarithm of the retention factor on the logarithm of the mole fraction of acetonitrile in the mobile phase "phosphate buffer (pH = 2.50) - acetonitrile": the column "Diaspher C18" (250x4.6 mm), 30^{0}C

For losartan, *n'* = 3.19, therefore, according to experimental data its molecule under competitive adsorption is capable to displace three molecules of an organic modifier from the surface of a nonpolar sorbent.

The Scott-Kuchera sorption model [4] is characterized by a linear dependence

$$1/k = A + BX_M \quad (2)$$

where *A* and *B* are empiric coefficients.

Both models of displacing (competitive) sorption do not take into account associative and solvation effects in the polar mobile phase.

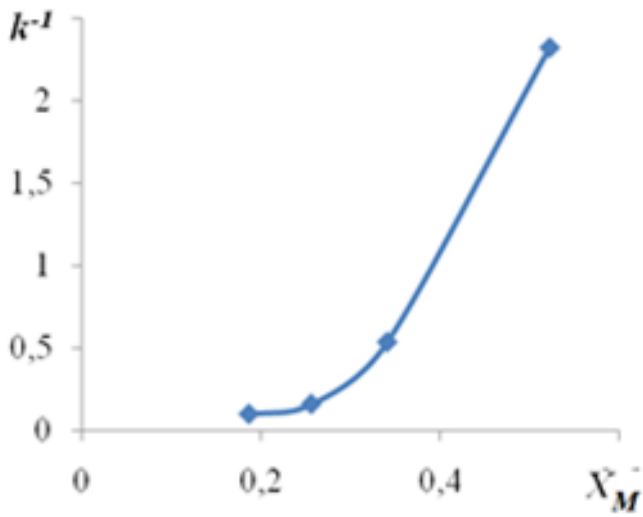


Figure 4. Dependence of the inverse retention factor on the mole fraction of acetonitrile in the mobile phase "phosphate buffer (pH = 2.50) - acetonitrile": the column " Diaspher C18" (250x4.6 mm), 30^{0}C

Figure 4 shows the *1/k* dependence of X_M for potassium losartan, from which it follows that with an increase in the acetonitrile content ($X_M > 0.3$), a rather sharp increase of the slope angle occurs which indicates the association of losartan molecules with acetonitrile molecules in mobile phase [4].

When developing conditions for the qualitative and quantitative determination of potassium losartan and its impurities in substances and tableted dosage forms, it is necessary to meet the requirements designed for carrying out examination of drugs [5]: the methodology should provide indicators of the efficiency of the chromatographic column; the asymmetry factor of the peaks of the main components and impurities should be minimized; a complete resolution of the peaks of the main components and impurities should be ensured; the relative deviation of peak areas should not exceed 5.0%; the limit of quantitative determination of impurities should not exceed the maximum admissible content of impurities in the corresponding test solution.

When conducting a chromatographic experiment in the isocratic mode, using the mobile phase "phosphate buffer (pH = 2.50) - acetonitrile" of various compositions, the separation of the peak of losartan from the peak of its normalized impurity C-2-butyl-5-chlorine-1- { [2 - (1H-tetrazol-5-yl) [1,1 (bifinyl) - 4-yl] methyl}-1-H-imidazole-4-methanol ($C_{22}H_{23}ClN_6O$).

In this connection, various regimes of the gradient supply of the eluent to the chromatographic column have been studied. Gradient elution was carried out using the eluents "phosphate buffer-acetonitrile, 30% v/v" (A) and "acetonitrile" (B). The gradient of the mobile phase composition is shown in Table 1. The flow rate of the mobile phase was 1.0ml/min. The volume of the introduced sample was 20 μm. Detection was carried out at λ = 230nm.

Table 1.

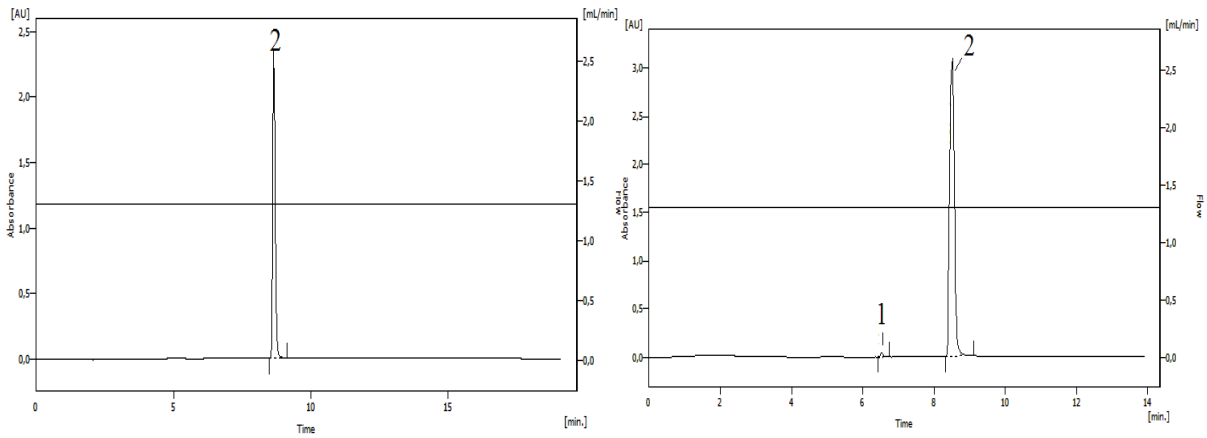
Gradient of the mobile phase composition (30^0C)

Eluent A (phosphate buffer-acetonitrile 70: 30% v/v)	Eluent B (acetonitrile), 100%	Time, min
90	10	0
10	90	15
90	10	30

The elution mode presented in Table 1 allows not only to separate losartan and impurity C, but also to return the eluent composition to the initial one for the purpose of reanalysis. Figure 5 shows chromatograms of the losartan substance (a), as well as a model mixture of the losartan standards and losartan impurities C (b) impurities, obtained under the selected conditions.

In spite of the fact that losartan (*logP* = 5.08) and losartan impurity C (*logP* = 4.90) have close values of lipophilicity and a chemically similar structure of molecules, it was possible to completely separate the peak of losartan potassium from the peak of impurity C, and also to achieve sufficiently good peak asymmetry. The order of the peaks is consistent with the increase in the lipophilicity of the molecules of these analytes.

It can be seen from Fig. 5 that the peaks corresponding to losartan and impurity C are well separated, have small asymmetry and slight erosion, which enables carrying out rapid analysis (less than 10 min) of the drug "losartan potassium". Chromatographic characteristics obtained using the developed conditions are presented in Table 2.



a) b)

Figure 5. Chromatograms of *losartan* potassium (substance) (a) and mixture of potassium losartan standards and impurity C (b): " Diaspher C18", 250x4.6mm, V_{probe} = 10 µl, λ = 230 nm, 30^0C; eluent "phosphate buffer (pH = 2.50) - acetonitrile", gradient supply of eluent, 1.5 ml/min; 1 - admixture C; 2 - losartan potassium

Table 2.

Chromatographic characteristics of the components of the model mixture containing potassium losartan and impurity C

Substance	Concentration, mg/ml	t_R, minute	Efficiency of the column T.T.(N)	Asymmetry of the peak	Signal/noise ratio
Losartan (peak 2)	1	8,5	23000	1,50	-
Losartan impurity C (peak 1)	0,003	6,5	15000	1,00	90

It can be seen from the above presented data that the chromatographic peaks have low asymmetry parameters (A≤1.5), and the sensitivity of the method is sufficient for the quantitative determination of the impurity in the tablet composition (signal to noise ratio for the impurity peak is > 20). The number of theoretical plates for losartan is N = 23000 and N = 15000 for impurity C, which indicates the high efficiency of the column.

The validation of the methods for the qualitative and quantitative determination of potassium losartan and its impurity C in tablets using the HPLC method was performed by the following characteristics: selectivity, linearity, accuracy, precision, detection limit, limit of quantitative detection, sample transfer [6-9]. Data obtained during validation, satisfy these requirements, confirm the selectivity, precision, correctness and sensitivity of the proposed methods (Table 3).

Table 3.

Results of validation of methods for the analysis of potassium losartan (RP HPLC)

Parameter of validation	Criteria of acceptability	Obtained values
Specificity	Losartan and impurity peaks should not overlap. Resolution between peaks of losartan and losartan impurity C should be not less than 2,0.	9,00

Linearity	Coefficient of correlation ≥ 0,980	0,996 (ident.) 0,999 (not ident.)
Convergence	Run 1: Coefficient of variation ≤ 5,0% (n≥6); Standard deviation for ident. impurity ≤ 0,02 %	3,38% 0,00506%
Intermediate precision	Run 2 (obtained by another researcher in another workday): Coefficient of variation ≤ 5,0%; Standard deviation for ident. impurity ≤ 0,02 %; Maximum deviation of the average value ≤ 10,0% For both runs (referred to the maximum value); F-criterion ≤ 5,05; t- criterion < 2,23	4,30% 0,00694 % 4,52%(1 run) 6,17% (2 run) 1,89 0,60
Accuracy	Response factor: The average value 95,0 – 105,0%; Coefficient of variation ≤ 5,0%; Confidence interval should include 100% of the value	101,53% (ident.) 100,32% (not ident.) 2,03% (ident.) 1,82% (not ident.) ±4,89 (ident.) ±4,32 (not ident.)
Detection limit	≤ 0,3 % (ident.) ≤ 0,3 % (not ident.)	0,04% 0,06%
Quantification limit	≤ 0,3 % (ident.) ≤ 0,3 % (not ident.)	0,12% 0,19%

The results of quantitative determination of potassium losartan and its admixture in tableted drug form ("LOZARTAN", 25 mg, "PRANAPHARM", Russia, Samara) are presented in Table 4.

Table 4.

Results of quantitative determination of potassium losartan and admixture

Tablets «LOSARTAN», 25 mg («PRANAPHARM), lot # 11114	Losartan	Losartam potassium	23,10 – 26,90 mg	25,44±0,23 mg
		Losartan admixture C	Not more 0,30%	0,19%±0,02%

Table 4 shows that the results obtained fit well into the norms presented in the quality certificates of this drug.

At present, thin-layer chromatography with densitometric detection of zones and computer data processing has become quite accurate, highly sensitive and does not require the use of sophisticated analytical equipment. Although the HPLC method is mainly used to determine the main component and impurities in drugs, the economical TLC method is often used to establish the presence of a major component of drugs in substances and dosage forms.

For the first time we have proposed to apply the reversed-phase TLC method to determine the potassium losartan in the drug. For this purpose, the eluent compositions were used, which were used under RP HPLC conditions. By varying the composition of the "phosphate buffer-acetonitrile" eluent and the pH of the initial buffer, it was found that the eluent "phosphate buffer-acetonitrile" of 60:40% v/v is most suitable for determining potassium losartan. with the pH of the original buffer 3.60. The chromatogram of potassium losartan, obtained by reversed-phase TLC, is shown in Fig. 6.

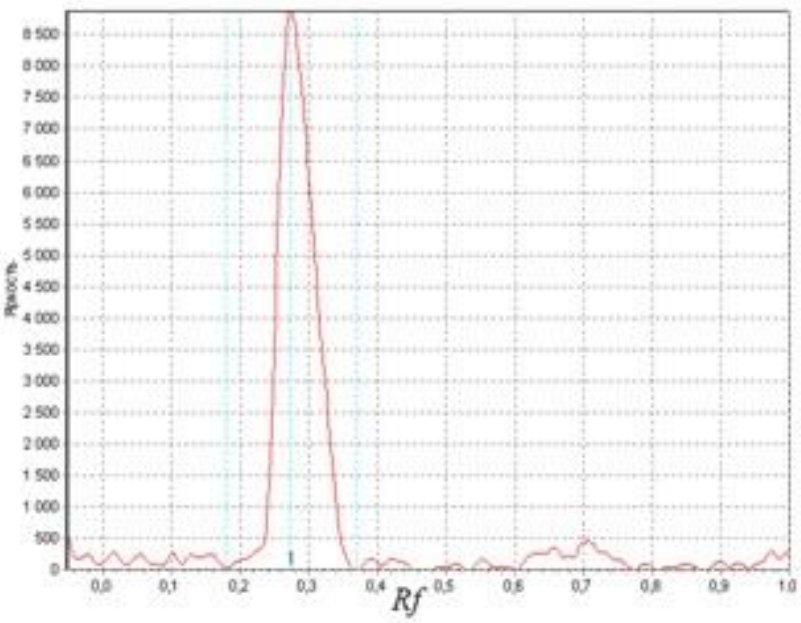


Figure 6. Chromatogram of the potassium losartan substance: Merk TLS aluminum sheets RP-18 F_{254}; mobile phase "phosphate buffer (pH = 3.60) - acetonitrile" of composition 60: 40% v/v.
Under the proposed analysis conditions, the value of the delay factor R_f = 0.28 of potassium losartan is a qualitative characteristic of this drug compound. The chromatographic peak has a low asymmetry index (*A* = 1.95) and small erosion

Conclusion

The procedure for determining potassium losartan and its normalized impurity in a substance and in tableted form by RP HPLC method has been developed and validated. The conditions of analysis are optimized in such a way that in a single cycle of analysis, a qualitative and quantitative analysis of both the main component and the impurity is carried out. For a quick assessment of the presence of potassium losartan in drugs, the TLC method has been proposed.

Acknowledgements

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ՀԵՂՈՒԿ ՔՐՈՄՈՏՈԳՐԱՖԻԱՅԻ ԿԻՐԱՌՈՒԹՅՈՒՆԸ ՀԻՊՈՏԵՆԶԻՎ ԴԵՂԱՆՅՈՒԹ ԿԱԼԻՈՒՄԻ ԼՈԶԱՐՏԱՆԻ ՈՐԱԿԻ ՎԵՐԱՀՍԿՄԱՆ ՀԱՄԱՐ

Լ.Ա. Օնուչակ, Մ.Բ. Վասիլևա

Սամարայի ակադեմիկոս Ս.Պ. Կորոլյովի անվան հետազոտությունների ազգային համալսարան

Մշակված է կալիումի լոզարտանի հիպոտենզիվ դեղանյութի, վերջինիս սուբստանցիայում նորմալացված խառնուրդի և դեղահաբային (հետադարձ-ֆազային բարձր արդյունավետությամբ հեղուկ քրոմոտոգրաֆիայի կիրառմամբ) տեսքով որոշման մեթոդոլոգիան:

Կալիումի լոզարտանի և խառնուրդի քանակաչափական որոշումն իրականացվել է արտաքին ստանդարտի մեթոդով: Փորձարկման արդյունքում ստացված տվյալները հաստատել են առաջարկված մեթոդիկայի սելեկտիվությունը, ճշգրտությունը և զգայունությունը:

Դեղանյութերի մեջ կալիումի լոզարտանի առկայությունը հնարավոր է նաև հաստատել նրբաշերտ քրոմոտոգրաֆիայի մեթոդով (ելյուենտ՝ ֆոսֆորային բուֆեր (p^H=3,6)-ացետոնիտրիլ,60:40% բաղադրությամբ):

Բանալի բառեր. ընդունիչ, հիպոտենզիվ պատրաստուկ, մետաբոլիտ, քրոմոտոգրաֆիական փորձարկում

ПРИМЕНЕНИЕ ЖИДКОСТНОЙ ХРОМАТОГРАФИИ ДЛЯ КОНТРОЛЯ КАЧЕСТВА ГИПОТЕНЗИВНОГО ЛЕКАРСТВЕННОГО ПРЕПАРАТА «ЛОЗАРТАН КАЛИЯ»

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Разработана методика определения гипотензивного лекарственного вещества лозартана калия и его нормируемой примеси в субстанции и в таблетированной форме с применением обращенно-фазовой высокоэффективная жидкостная хроматография (ОФ ВЭЖХ). Количественное определение лозартана калия и примеси проводили методом внешнего стандарта. Экспериментальные данные, полученные при валидации, подтвердили селективность, прецизионность, правильность и чувствительность предложенной методики. Наличие лозартана калия в лекарственных средствах может быть подтверждено также методом обращенно-фазовой тонкослойная хроматография (ТСХ) с применением элюента «фосфатный буфер(pH=3,6) -ацетонитрил» состава 60:40% об.

Ключевые слова: рецептр, гипотензивный препарат, метаболит, храмотографический эксперимент

UDC 338.22.021.2

THE ROLE AND IMPORTANCE OF ARMENIA IN THE EURASIAN INTEGRATION

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The article examines and analyzes some important economic indicators of the Republic of Armenia for more than 2.5 years after the country's accession to the EAEU, in particular, the dynamics of foreign trade, its structure, the volume of foreign investment and transfer inflows into the country. In the article is calculated the indicator of the openness of the country's economy, on the basis of which, based on the favorable geographical location and favorable geopolitical events, are substantiated the role and importance of the country in the region, especially in the context of the possible cooperation between the EU and the EAEU.

Key words: *EAEU, regional cooperation, competitive advantages, foreign trade turnover, foreign investments, transport and energy corridor North-South, unified digital territory.*

Introduction

It is accepted throughout the world that, for some economic or political reasons, friendly countries are entering into certain integration formations in order to achieve sustainability and synergy of their activities. In the case of economic integration the purpose of the union is the use of raw materials availability in one country and methods of processing - in another, a significant mutual export-import of these countries, and an increase in labor productivity. Today, the most "young" model of economic integration is the model of the Eurasian Economic Union (EAEU).

The Eurasian Economic Union is a regional organization of economic integration established on the basis of the Treaty on the Eurasian Economic Union on May 29, 2014, which entered into force in January 1, 2015, whose goal is to strengthen and modernize the economies of the member states of the Union, strengthen ties between them, enhance competitiveness of states in the world market. This is an economic union, but within the framework of the union cooperation is expected not only in economic, but also in political, social, financial, medical, environmental, cultural and other fields. In this sense, it is important to assess the mutual benefit of the EAEU as an integration unit, in particular for the member states of the union, as well as the current state of cooperation. It is necessary to mention that unlike the Customs Union, it sets not only trade rules, but also the most important economic aspects and standards, including tax, customs, etc. The members of the Union are Russia, Kazakhstan, Belarus, Armenia and Kyrgyzstan, which are obliged to release certain goods from customs duties imported from third countries outside the EU, to impose duties at a single rate (thus regulating trade relations between member states of the union and third countries).

Conflict settings

Armenia, having become a full-fledged member of the EAEU since January 2, 2015, has been actively working within the framework of this structure for more than 2.5 years. Unfortunately, membership coincided with international economic processes (in particular, the imposition of economic sanctions on Russia), which had a negative impact on the country's economy, therefore, Armenia's accession to the EAEU was mixed by economists, political scientists and the general public. To date, some of them are categorically against cooperation with the EAEU and this issue is considered only from the negative side, while others ignore the negative consequences, and see great prospects. Initially, as a negative factor, was assumed the loss of Armenia's political independence, despite the fact that the structure has economic, not political character. The next negative factor is

related to the possible increase in the prices of imported goods from European countries in connection with the introduction of a new customs regime.

Nevertheless, in fact, membership in the EAEU provides Armenia with new opportunities, including expansion and modernization of production, import of fuel at prices cheaper than market prices, an increase in local production, as well as investments in member countries, the formation of new trade and economic relations with countries BRICS and the Shanghai Organization, the break of the economic blockade with the creation of the North-South corridor. Having joined the EAEU, Armenia has not only access to a capacious and protected market, but also provides the EAEU countries with environmentally friendly, exquisite, elite products and intellectual resources. After all, Armenia, like no other country of the union, has three main competitive advantages: the genetic predisposition to knowledge, ethnic, cultural values and network characteristics associated with the existence of the Armenian diaspora. The most vivid example of the above is the recently held Armenia-Diaspora forum in Armenia, an important achievement of which was readiness and commitment to the creation of an Co-Armenian council, as well as discussion of issues on increasing investment inflows to Armenia, political and economic support to Armenia from The Diaspora. According to the famous Russian economist, dean of the economic faculty of the Moscow State University Alexander Auzan, the Armenian economy can and should grow faster than the more complex and developed economies in the world, based on the historical role of the Armenian diaspora in the world economic development [1]. Of course, including the opportunities and potential of the Armenian diaspora in the positive process of integration of the EAEU will become a real new chance for the union.

The sixth Russian-Armenian forum held in Yerevan on October 6 this year also underlined to Armenia's important role in the EAEU, which, according to the director of the EAEU Institute Vladimir Lepekhin, underscored the need for further development and strengthening of Eurasian economic integration and Armenia's participation in it as one from its most active links [2], and now, as adviser to the Russian President Sergey Glazyev noted on the margins of the Sixth Russian-Armenian Interregional Forum of the Eurasian Partnership, Russia expects from Armenia to be actively promoted to the Eurasian integration [3].

Armenia can also become a link between the 180 millionth market of EAEU and Iran in the process of developing trade and economic relations, which can be facilitated by the activities of the free economic zone in the southern part of the Syunik region, which, being on the border of the two states, will serve Armenian and Iranian entrepreneurs and become an important component in strengthening international cooperation. Armenia can really become the shortest route for Iran, connecting the country through the Black Sea with the European Union, as well as a good corridor linking the Persian Gulf and the Black Sea. The strategic geographical position of Armenia can contribute to the creation of an effective regional and international transport and communication hub ensuring reliable trade and economic ties between the countries of the EAEU, the Persian Gulf, South and South-East Asia. Being the only country of the EAEU that has a land border with Iran, Armenia can become a bridge for these countries, as well as for the EU and the EAEU countries.

Armenia has been actively developing relations with the countries of the Persian Gulf over the past ten years, and especially with the United Arab Emirates, where they are well acquainted with Armenians and their business skills, which creates favorable conditions for the development of economic relations. The emirates highly appreciate the opportunities of Armenia as a member state of the Eurasian Economic Union. As the Extraordinary and Plenipotentiary Ambassador of Armenia to the United Arab Emirates Gegham Gharibjanyan said, the indicators of trade turnover for January-July of this year compared with the same period in 2016 are encouraging: this volume increased 2.5 times [4]. There are great opportunities for cooperation in the spheres of industry, jewelry and especially food production.

Armenia has every opportunity to enter major markets, and this is attractive not only for foreign investors, but also for representatives of these markets.

The country is historically at the crossroads of the Silk Road and important trade routes and has always been active in international trade. In this regard, Armenia must seriously apply the Chinese initiative "One Zone, One Way", create a professional team that will follow the developments and provide results to the government, organize a special program within which Chinese businessmen will be offered an Armenian cheap labor and, In case of production in Armenia, it will be possible to sell the results to the countries of the EAEU.

In fact, even now it is possible to say with a great degree of certainty that Armenia has its place in the global Chinese project "The Economic Belt of the Silk Road" in any scenario.

It turns out that the way that China will build from the Persian Gulf to the Black Sea ("Sea Silk Road of the XXI Century") passes through Armenia, which has no access to the sea, but has such a geopolitical location that is very attractive for the Chinese people in the case of the promotion of goods to the European market through the Middle East and South Caucasus, through Iran, as well as Armenia and Georgia [5].

Research results

Armenia, the only country in the region with a surplus in electricity generation, can actively join the creation of a unified grid of the EAEU, which, according to preliminary data, will be activated by the summer of 2019. Also, until 2018, the republic will be able to export gasoline at the zero customs rate, and to the unified tariff of the EAEU it will be transferred starting from 2020. Already by 2025 it is planned to form a single gas market, a single market for services, and a single financial market. As for the trade and economic relations of the member countries, by this year the countries of the EAEU can switch to mutual settlements in a single currency, especially in the trade in strategic goods, and abandon the peg to the dollar, which will allow intensifying mutual settlements in national currencies and reducing the dollarization of economies. Meanwhile, the desire to form a ruble zone does not correspond to the economic reality, since the ruble dominates only in bilateral transactions involving Russia, while in transactions between other states the dollar is prevailing, and the ruble does not fulfill the function of a universal measure of value and mutual settlements.

Armenia's foreign trade issues are of great importance for the development of the Armenian economy, especially given the fact that Armenia has adopted an export-oriented economic policy, and the export and import structures have suffered serious changes after organizing cooperation within the framework of the EAEU, since a year after joining the EAEU, a sharp decrease in export and import was recorded at 26.5% and 3.9%, respectively.

At first glance it seems that such a decline is related to membership in the EAEU, but in fact, the decline in export was mainly due to a decrease in domestic demand for domestic products, and a reduction in import - a decrease in domestic demand and export problems, as well as devaluation of the exchange rate [6].

According to the data of the last decade, Armenia's trade turnover amounted to 4,970.5 million US dollars. At the same time, in 2016, Armenia's trade turnover amounted to $ 5,075.3 million, an increase of 7% compared to the previous year, mainly due to export growth. Export increased by 20% compared to the previous year, which led to an improvement in the trade balance.

In 2016, the volume of exports from Armenia amounted to a record amount for the period of independence of 1,782 million dollars. If this trend persists following the results of 2017, this indicator may approach the level of 2 billion US dollars. According to the data of 2016, the share of the four main commodity groups of exports - mining, precious stones and metals, food and agricultural raw materials - was 69.9%, which is quite large.

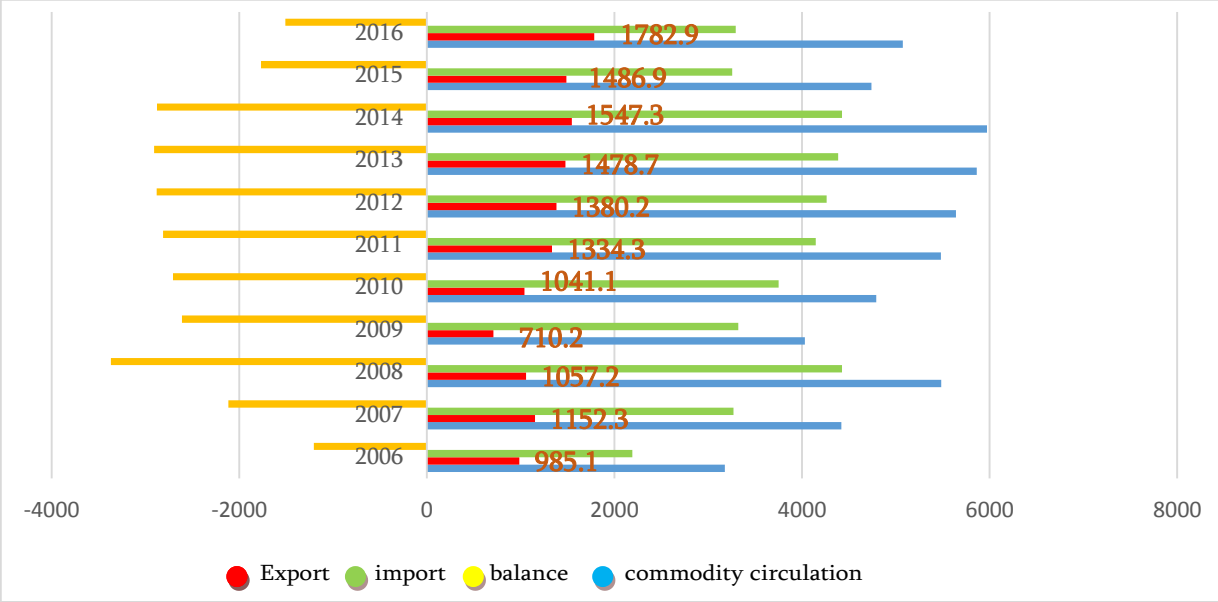

Figure 1. Foreign trade of Armenia (million dollars)[1]

From this we can conclude that the export of goods from Armenia should be diversified and cover more commodity groups, which will reduce the country's economic vulnerability due to sharp fluctuations in prices for certain goods in foreign markets, as well as structural changes in international markets. In 2015, the decline in prices for gold, molybdenum and copper in the world market had a big impact on Armenia's export status, as the share of these goods in Armenia's exports was quite high.

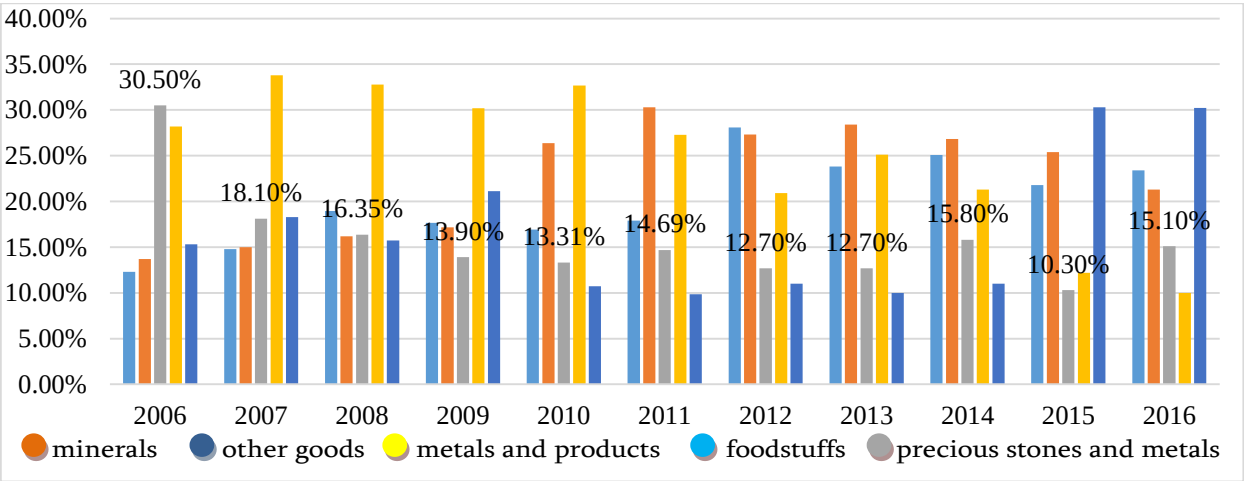

Figure 2. Commodity structure of Armenia's export in 2006-2016. (%[2])

`Despite the fact that the exclusion of exports of these goods was not exhausted, it left a stamp on Armenia's exports, moreover, the share of goods with a lower added value in the structure of Armenian exports is quite high.

According to the results of the first 5 months of 2017, Armenia's foreign trade turnover with the EAEU countries is $ 620 million, which is 21.3% more than in the same period in 2016. At the same time, the bulk of trade turnover - 97.6% or more than 605 million US dollars - is trade with Russia. With three other EAEU member states, the total trade turnover is only $ 14.8 million, as these countries are not among the main 20 trading partners of Armenia. Based on trade indicators, the potential of Armenia within the framework of the EAEU is limited by economic cooperation with

[1] http://armstat.am/file/article/sv_12_16a_411.pdf
[2] http://www.customs.am/Content.aspx?itn=csCIForeignTradeByProducts

Russia and at the initial stage of the formation of the union, the deepening of these relations continues. It is also important to note that Armenia imports more (2.4%) within the framework of the EAEU, rather than exports (0.9%).

At this stage, the EAEU exports to Armenia mineral and fuel-energy raw materials (60.6% of exports) and imports finished technological products (43.3%), which shows the low level and noncompetitiveness of the industrial potential of the countries of the commonwealth. For Armenia, the mutual trade turnover within the framework of the EAEU is only about 30% of the total foreign trade turnover of the country.

According to the results of the first 8 months of 2017, Armenia's foreign trade turnover amounted to 3 billion 880.6 million dollars, the growth rate - 24.4%, including the volume of exports from Armenia amounted to 1 billion 383.2 million dollars, growth rate - 21.7%. The main export commodities were mining products ($ 297 million), food industry ($ 240 million), precious metals and jewelry ($ 145 million), base metals ($ 132 million), light industry products ($ 51 million). Note that the main areas of Armenian exports are the Russian Federation, the EU, Iran, Iraq, Georgia and Switzerland.

In addition, the increase in mutual and foreign trade (with other countries, not members of the union) in the Eurasian Economic Union is observed throughout the first half of 2017, which indicates a steady economic growth in the countries of the Eurasian Economic Union.

Compared to the same period in 2016, the volume of foreign trade grew by 27.8% (by $ 63.5 billion). The volume of exports of goods increased by 29.6% ($ 41.6 billion), imports - by 24.9% ($ 21.9 billion). The positive balance of foreign trade in goods increased from $ 52.1 billion in January-June 2016 to $ 71.8 billion in January-June 2017.

The trade turnover of the EAEU states with third countries in the first half of 2017 reached $ 292.2 billion, including exports - $ 182 billion, imports - $ 110.2 billion. The volume of mutual trade of the countries of the Eurasian Economic Union in January-June 2017 grew compared with January-June 2016 by 27% ($ 5.3 billion) and amounted to $ 25.1 billion. Most significantly - in 1.6 times (by $ 1.2 billion) - increased mutual trade in metals and products from them. The mutual trade in machinery, equipment and transport increased by 36.5% ($ 1.1 billion), foodstuffs and agricultural raw materials by 22.7% ($ 730 million), mineral products - by 18.6% $ 1.1 billion).

Trade with the European Union continues to occupy a significant place in Armenia's foreign economic relations. Armenia's trade with the EU in January-May 2017 amounted to 531 million dollars, which is 15% more than in the same period last year [7]. This is due to the fact that Armenia is included in the list of countries using the general system of trade preferences of the EU (GSP +) which allows it to export more than 6,000 items of its own products to the EU countries for zeroed or significantly reduced customs duties[3]. It should be noted that the EU has provided the GSP + regime to 9 countries, none of which is a member of the CIS and the EAEU, except Armenia [8].

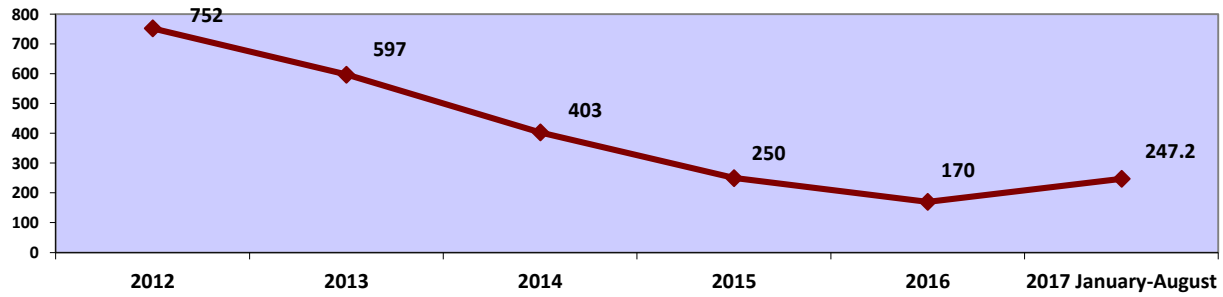

Figure 3. Foreign investments of Armenia, million dollars

[3] http://europa.eu/european-union/about-eu/figures/living_en

There is effective cooperation with the EU, including EU support for various instruments, Horizon 2020, Kosme and other applications, and this cooperation continues, as also evidenced by the preliminary signing of the agreement on a "Comprehensive and Expanded Partnership" between Armenia and the EU, which does not contradict Armenia's obligations within the framework of the Eurasian Economic Union and envisages cooperation in various sectors of the economy. The EU countries are the largest donors and investors in Armenia and deepening the partnership with the EAEU countries, Armenia does not stop cooperation with the EU, since it has no restrictions in the spheres of cooperation, investments, dialogues with European partners and sees itself as a country that brings these two markets closer. As for the level of attracting foreign investment, in the last two years the investment flow has sharply decreased, but increased in the first 8 months of 2017.

In recent years, the largest investments in Armenia were made by the Russian Federation. Moreover, if many countries investing in Armenia have a certain orientation of investments, the Russian Federation does not have such a position, since Russian capital is invested and operates in virtually all sectors of the Armenian economy, especially in the areas of electricity, gas and telecommunications. There are more than 1,400 joint ventures in Armenia with joint Armenian-Russian or all-Russian capital.

From the EAEU member countries Armenia and Belarus do not have investments. The last time Belarus invested in Armenia only in 2010 was 177.000 dollars, investments from Kazakhstan were made in 2010 and 2011 and amounted to 17.3 thousand US dollars and 5.5 thousand US dollars, and from Kyrgyzstan there was no investment implemented in general.

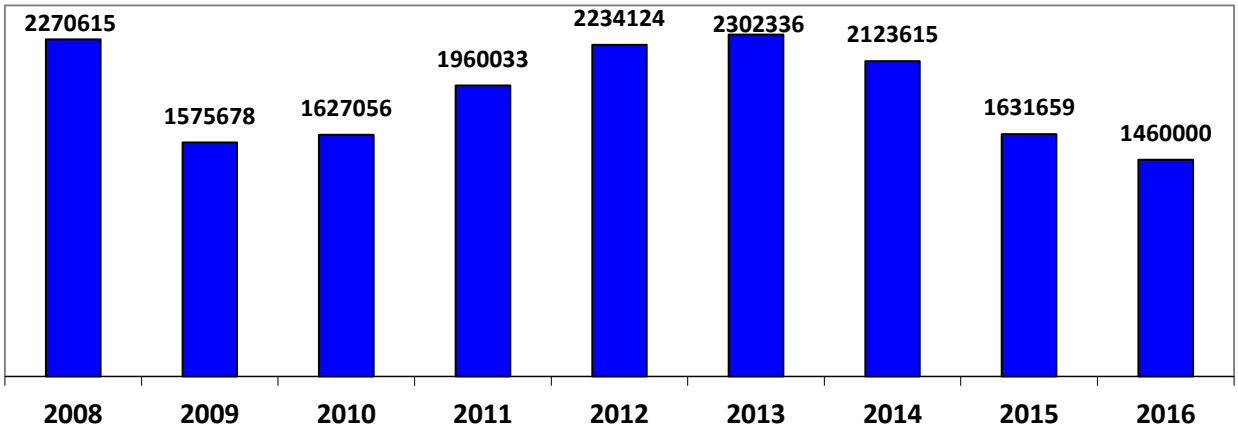

Figure 4. Total inflow of RA transfers in 2008-2016, million dollars

Armenian capital also actively participates in the territory of the EAEU, especially in recent years, investments from Armenia have grown in Russia and Belarus. Unfortunately, this year, in the percentage ratio, the amounts sent to Armenia from the EAEU member countries-Kazakhstan and Russia-have significantly decreased. Conversely, transfers in the opposite direction grew from Armenia to Russia and Kazakhstan. Over the past three years, the number of small and medium-sized enterprises, formed by citizens of Armenia, has more than doubled (to 145) in Kazakhstan [9]. It should be noted that remittances sent by Armenian citizens who work in Kazakhstan are three times higher than the entire trade turnover between the countries ($ 18.9 million in 2016) [10]. In addition, in 2016, in the real sector of Armenia's economy, foreign investments decreased by more than 70 percent. In this case again, the lion's share of the recession fell on Russian investment.

Let's consider another indicator of the Armenian economy before and after the membership of the EAEU - the index of openness of the economy, which is calculated as the ratio of the country's total trade (the amount of exports and imports) to the country's GDP (Openness Index = (exports + imports) / GDP * 100%).

Table 1.

Armenian economy openness index in 2012-2016, %

Year	Export (million,$)	Import (million,$)	GDP (million,$)	Openness index, %
2012	1380.2	4261.2	10619.4	53
2013	1478.7	4385.9	11121.3	53
2014	1547.3	4424.4	11609.5	51
2015	1485.3	3239.2	10529.1	45
2016	1782.9	3292.4	10547.3	48
2017г. January-June	993.9	1 821.2	4492.7	62.7

The interpretation of the index is that the higher this indicator, the greater the impact of trade on the domestic market and the stronger the economy of the country. This indicator in Armenia in 2016 reached 48.11%. This ratio is considered to be relatively high and means that every $ 100 in Armenia depends on the $48 of the world economy. This percentage would be considered acceptable if its largest share was for export. But in 2016, imports accounted for about 65% of total foreign trade. Deeper analysis of the time series of this coefficient over the last 5 years shows that it has declined - from 53% in 2012 to 48% in 2016, but in the first half of 2017, its increase was noted.

It should be noted that Armenia achieved progress in the sphere of economic competition in all three main areas - the indicator of the effectiveness of the antimonopoly policy (40th place), the index of influence of the dominant subjects on competition (28th) and the intensity of local competition (66th place) [11]. For all the above mentioned indicators, Armenia is the leader among the member countries of the EAEU. Progress was also made thanks to Armenia's accession to the EAEU, which led to significant activity and a decrease in market concentration.

In addition to trade and investment of goods and services, the EAEU member countries, including Armenia, also cooperate in other areas. In particular, Armenia, having joined the EAEU, has concluded agreements on consumer rights protection, agreed monetary policy, systematic transport policy, procurement regulation, protection of intellectual property rights, compilation and dissemination of official statistical information, etc. In connection with the accession to the EAEU, changes were made in the area of labor and social protection, the granting of licenses to business entities, in the medical and transport sectors.

It is especially important for Armenia to deepen cooperation in the field of information technologies. On December 26, 2016, the heads of the EAEU states signed a statement on the digital agenda, which is an effective mechanism for the formation and functioning of a single digital territory of the member states of the Union, which will create an opportunity for the development of digital economies and economic progress of the EAEU member countries. Armenia puts an emphasis on the digitalization of the economy and a small economy in this matter can become the main advantage of the republic. It should be noted that until the year 2019, digital transformation processes will be simulated, the first initiatives will be developed and launch projects launched, among which we can already single out such as the development of digital traceability of products, goods, services and digital assets, digital industrial cooperation, electronic commerce and government procurement, digital transport corridors, cross-border data turnover. In this context, it is especially important to reach agreement on the compatibility of digital economic standards with the members of the Eurasian Economic Union and China, for the transit of goods, services and capital on digital platforms.

Today, the sphere of information technologies in Armenia is considered to be a priority and the annual growth in this sphere is on average 20-25%. As a result of the first 8 months of 2017, 35% growth has already been achieved [12]. It is expected that during the next 5 years the Armenian IT sector will provide higher growth rates, therefore Armenia should demonstrate its decisive role in the

field of IT, becoming the center and donor of technologies for many countries. This is especially important if we take into account the great potential and comparative advantages in comparison with Belarus and Kazakhstan.

In this sense, Armenia can provide other countries of the EAEU with good and advanced programmers, and also have the financial resources coming from activities in the information technology industry.

Conclusion

Today, the Armenian government requires the implementation of an effective economic policy and concrete steps for the development of the Armenian economy. Armenia is an important bridge and should strengthen its position in the future as a connecting geopolitical link. Armenia's importance for the transport and energy corridor of the North-South, as well as its role in the development of trade and economic ties between Iran and Georgia can not be underestimated, and it's not just about using the territory of Armenia as a transit between them, but also about the possibility of trilateral cooperation and implementation of joint projects. This is facilitated by free trade between Armenia and Georgia, and additional benefits and favorable terms of trade provided to Armenia by the European Union after the re-establishment of integration ties with this regional alliance. In this sense, Armenia should be active and use its membership in the Eurasian Economic Union to attract both Georgian and Iranian investors and offer its own alternative.

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ՀԱՅԱՍՏԱՆԻ ԴԵՐՆ ՈՒ ՆՇԱՆԱԿՈՒԹՅՈՒՆԸ ԵՎՐԱՍԻԱԿԱՆ ԻՆՏԵԳՐԱՑՄԱՆ ՄԵՋ

Կ.Ա. Ներսիսյան, Ն.Վ. Բալայան

Շուշիի տեխնոլոգիական համալսարան

Հոդվածում քննարկվել և վեր են լուծվել ԵԱՏՄ-ին ավելի քան 2.5 տարվա անդամակցության ընթացքում ՀՀ մի շարք կարևոր տնտեսական ցուցանիշներ, մասնավորապես՝ արտաքին առևտրի շարժընթացը և ապրանքային կառուցվածքը, օտարերկրյա ներդրումների ծավալը, տրանսֆերտային հոսքերի շարժը, հաշվարկվել է ՀՀ տնտեսության բացության աստիճանը բնութագրող ինդեքսը, որոնց հիման վրա, ինչպես նաև բարենպաստ աշխարհագրական դիրքից ու նպաստավոր աշխարհաքաղաքական

պայմաններից ելնելով արդարացվել է տարածաշրջանում երկրի ունեցած դերն ու նշանակությունը, հատկապես ԵՄ և ԵԱՏՄ միջև հնարավոր համագործակցության համատեքստում:

Բանալի բառեր. ԵԱՏՄ, տարածաշրջանային համագործակցություն, մրցակցային առավելություններ, արտաքին առևտրաշրջանառություն, օտարերկրյա ներդրումներ, Հյուսիս-Հարավ տրանսպորտային և էներգետիկ միջանցք, միասնական թվային տարածք

РОЛЬ И ЗНАЧЕНИЕ АРМЕНИИ В ЕВРАЗИЙСКОЙ ИНТЕГРАЦИИ

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В статье рассматриваются и анализируются некоторые важные экономические показатели Республики Армения за более чем 2.5 года после вступления страны в ЕАЭС, в частности: динамика внешней торговли, его структура, объёмы иностранных инвестиций и трансфертных притоков в страну. Рассчитан показатель открытости экономики страны, на основе которого, а также с учетом выгодного географического расположения и благоприятных геополитических событий, обосновывается повышение роли и значения страны в регионе, особенно в контексте возможного сотрудничества между ЕС и ЕАЭС.

Ключевые слова: ЕАЭС, региональное сотрудничество, конкурентные преимущества, внешнеторговый оборот, иностранные инвестиции, транспортный и энергетический коридор Север-Юг, единая цифровая территория.

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THE STATE OF POWER INDUSTRY OF THE REPUBLIC OF ARMENIA AND THE MAIN DIRECTIONS OF REFORMS

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One of the key branches of the whole national economy of the Republic of Armenia is power energy generation. The constant increase in electricity generation is aimed at satisfaction of growing demands of both industry and consuming public in electricity. Therefore, in the program of the Government of the Republic of Armenia for the economic development for 2017 – 2022 a separate section is devoted to the main directions of power energy generation growth.

This paper studies data on total capacity of electric power stations of Armenia and their structure, sources and volumes of generated electrical power, energy balance of the country and its structure for the period of 2000 – 2015. The amount and value of exported from Armenia electrical power and that of imported to Armenia, electricity charges for 1000kW/h, as well as coefficients of foreign commodity turnover and comparative advantages of electrical power for 2000- 2016.

The authors highlighted the concepts of energy independence and energy security, giving them their own characteristics. Taking into consideration that the Republic of Armenia is a member of the EAEU, the principles of the union, the main problems and principles of the energy policy of the Member States, as well as the main directions of the energy policy have been presented. The authors also keep the latest developments in energy liberalization and legislation in Armenia at the centre of their attention.

Key words*: energy independence, energy security, electricity, export, import*

1. Current state of the Armenian power system development

In RA Government economic development program for 2017-2022 an important place is given to the energy and energy infrastructures. Particularly, as regards energy it was mentioned: "The energy policy of the Government of the Republic of Armenia is aimed at ensuring energy independence and rising security of the country, securing regional integration process, sustainable development of the energy sector, based on further development of nuclear energy, diversification of energy carriers supply and full, effective use of local primary (renewable) power resources, and on the implementation of current available measures and the introduction of new technologies. "[1, pp. 62-63].

In addition, it was stated in the foregoing program in the program that the activities of the Government of Armenia for the coming five years will be mainly aimed at

- ensuring energy independence of Armenia through active policy of regional search for new energy markets, active import and export policies,
- formation of legislative incentives for introduction of new and high technologies, pursuing a policy aimed at the development of the energy sector and the introduction of energy efficiency measures,
- to extend the design life of the second block of the Armenian Nuclear Power Plant, with the aim of increasing the efficiency and safety of the nuclear power plant operation, seting up a schedule for the supply of additional equipment and additional research of equipment and systems of the power block,
- implementation of Armenia-Iran and Armenia-Georgia 400 kV high-voltage electricity transmission lines construction programs, as a consecquence the Republic of Armenia will

become (after compltion of construction and putting into service of power transmission lines) a hub of the regional powerful power grids connecting power systems of Iran, Georgia and Russia.

- mplementation of solar energy systems construction projects, with the aim of implementation until the end of 2018 the construction of a peak-powered solar photovoltaic power plant of 55 MW at Masrik village,
- support the private wind power plant construction projects in the period of 2017-2022 by develop legislative incentives in that direction;
- construction of a geothermal power plant in a Karkar location involving a private investor in the project in case the final estimation of geothermal resources will enable economically sound generation of power [1, pp. 63-66].

Besides, RA Prime Minister Karen Karapetyan while presenting the economic development programm of the government at the National Assembly of the Republic of Armenia stated "We have great ambitions in the energy sector. Our object is not only the reequipment of the entire energy infrastructure, but also to become an active and key regional player. The government will implement energy market reform projects that will greatly contribute to the creation of renewable energy capacities, increase efficiency and security of the system, and dramatically increase cross-border electricity volumes.

As a result, we will have a modern, efficient, exporting and competitive energy system. At the same time, we planned to provide high quality energy services. One of the main goals of this sphere is liberalization of the energy market. "[2, p. 10].

Data on the output of power plants in Armenia and their structure for the period of 2000-2015 are given in Table 1.

Table 1

Power stations output in theRepublic of Armenia in the period of 2000-2015

	2000	**2003**	**2011**	**2012**	**2013**	**2014**	**2015**
All electrical power stations, including	3231.1	3351.7	3508.7	4054.6	4094.4	4099.5	4086.8
	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Thermal	1799.4	1774.4	1906.0	2394.0	2394.0	2390.0	2390.0
	55.7	52.9	54.3	59.0	58.5	58.3	58.5
hydroelectric	1024.2	1169.8	1191.2	1249.2	1289.0	1298.1	1286.7
	31.7	34.9	33.9	30.8	31.5	31.7	31.5
nuclear power	407.5	407.5	407.5	407.5	407.5	407.5	407.5
	12.6	12.2	11.6	10.1	10.0	9.9	10.0
other sources	-	-	4.0	3.9	3.9	3.9	2.6
	-	-	0.1	0.1	0.1	0.1	0.1

In numerator 1000 kW, in denominator with regard to output of all electrical power plants expressed in percenage.

The source was compiled and calculated [3, p. 283 and 4, p. 285].

It follows from the Table 1 that the total power output of all power plants was increased by 126.5% in the mentioned period. This growth was mainly achieved by growth of thermal power plants output (by 132.8%) and increase of hydroelectric power outputs (by 125.6%). The capacity of the nuclear power plant has remained unchanged over the years, and as for other sources (wind power plants) were insignificant. The power plant capacity structure of the Republic of Armenia proves that the thermal power stations have a dominant role (in 2000 - 55.7%, in 2015 - 58.5%, growth - by 2.8 percentage points), the share of hydroelectric power stations in 2000 was 31.7%, in 2015 - 31.5%, the decrease was 0.2%, the share of the Armenian nuclear power plant in 2000 was 12.6%, and in 2015 - 10.0%, the decrease was 2.6 percentage points.

Table 2 presents data on volumes and structure of electricity generation in Armenia.

Table 2

Volumes of electric power generation by source and structure in the Republic of Armenia

	2000	2003	2011	2012	2013	2014	2015
All electrical power stations, including	5958.6	5500.9	7432.7	8036.2	7710.0	7750.0	7798.2
	100.0	100.0	100.0	100.0	100.0	100.0	100.0
thermal	2692.1	1521.5	2390.3	3399.1	3173.1	3288.6	2801.2
	45.2	27.7	32.2	42.3	41.2	42.4	35.9
hydroelectric	1261.1	1981.9	2488.7	2311.0	2173.4	1992.6	2205.6
	21.2	36.0	33.5	28.8	28.2	25.7	28.3
nuclear power	2005.4	1997.5	2548.1	2322.0	2359.7	2464.8	2787.7
	33.7	36.3	34.3	28.9	30.6	31.8	35.7
other sources	-	-	5.6	4.1	3.8	4.0	3.7
	-	-	0.1	0.1	0.0	0.1	0.0

In numerator million kW/h, in denominator with regard to output of all electrical power plants expressed in percenage.

The source was compiled and calculated [3, p. 283 and 4, p. 284].

It follows from the Table 2 that during the period under discussion the volumes of total electrical power generation all power plants of Armeniawas increased by 130.8%. This growth was mainly achieved in hydropower plants (174.9%), in the nuclear power plant (139.0%) and in thermal power plants (104.1%) increase of hydroelectric power outputs (by 125.6%) at the expense of growth of power generation volumes.

The mentioned changes have made considerable shifts in the structure of electricity production volumes. If in 2000, the share of thermal power stations in Armenia amounted to 45.2%, then in 2015 - 35.9% (decrease was 9.3 percentage points), in hydropower stations 21.2% and 28.3%, respectively, (7.1% growth), in the nuclear power plant - 33.7% and 35.7%, respectively (increase was 2.0 percentage points). The resulting structural changes can be assessed as positive, for they have been achieved through the decrease of electricity generation in thermal power plants (which is particularly important from the ecological point of view), as well as due to development of such “clean” production of electric power generation facilities as hydroelectric power plants.

Table 3 shows the current energy balance of the Republic of Armenia and its structure for the period of 2000-2015.

Table 3

Electricity balance of the Republic of Armenia and its structure in the years of independence

	2000	2003	2011	2012	2013	2014	2015
Generated electrical power	5958.6	5500.9	7433.0	8036.0	7710.0	7750.0	7798.0
	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Imported electrical power	352.0	306.7	301.0	98.0	198.0	206.0	174.0
	5.9	5.6	4.0	1.2	2.6	2.7	2.2
Exported electrical power	814.8	583.1	1383.0	1696.0	1226.0	1314.0	1424.0
	13.7	10.6	18.6	21.1	15.9	17.0	18.3

In numerator million kW/h, in denominator with regard to output of all electrical power plants expressed in percenage.

The source was compiled and calculated [3, p. 283 and 4, p. 283].

Data in Table 3 show that in the mentioned period the structure of the electricity balance of the Republic of Armenia has considerably been improved, as the volume of electricity produced increased by 130.8%, the volume of imported electricity decreased by 3.7 percentage points, or from the physical point of view - twice), and the volume of exports increased by 174.8%, or by 4.6 percentage points. In essence, the electricity has become one of the main products exported from Armenia.

Electricity is mainly exported to the Islamic Republic of Iran and Georgia.

Table 4 shows the amount of electricity exported from Armenia and imported to Armenia as well as the value of 1,000 kW/h in 2000-2016.

Table 4

Quantity of electricity exported from Armenia and imported to Armenia, and value per 1000 kW/h for 2000-2016

Years	Export			Import		
	Amount, thousand kW/h	Value, US dollars	Value of 1000 kw/h, US dollars	Amount, thousand kW/h	Value, US dollars	Value of 1000 kw/h, US dollars
2000	814853.5	20551593	25.2	352012.4	10253051	29.1
2003	279460.6	4590867	16.4	54226	779495	14.4
2011	1533066.1	87514495	57.1	204528.2	9463950	46.3
2012	1696152.9	95223952	56.1	98115.2	3344560	34.1
2013	1312942.9	77962320	59.4	147674.6	4309484	29.2
2014	1313610.5	81292080	61.9	205750.3	9512630	46.2
2015	1423699.3	81211936	57.0	173603.1	7685247	44.3
2016	1228772.1	60991134	49.6	275071.4	13998956	50.9

The source has been compiled and calculated [5, p. 27, 6 p. 31, 7, p. 52, 8, p. 52, 9, p. 54, 10, p. 54, 11, p. 59, 12, p. 59].

According to the data presented in Table 4, in 2012 the amount of electricity exported from Armenia for the mentioned period was the highest (increment in electricity generetion was 208.2% as compared with that in 2000), after which a decrease in the export of electricity was observed (the export index in 2016 made up 72.4% of the 2012 export figure), and in general the volume of electricity exports from Armenia in 2016 was 150.8% as against that of 2000. The value of each exported 1000 kW/h was the highest in 2014 (61.9 USD), which in the following years had a downward trend (the index of 2016 was 80.2% in comparison with 2014). As regards the import of electricity into Armenia, in 2016 it was the largest one, and the import value was the (about 14 million US dollars) and the highest value paid for 1000 kW/h of electricity was 50.9 USD.

To make certain that electricity export from Armenia is a profitable trade, we have used use the theory of comparative advantages. For this purpose Table 5 presents coefficients of comparative advantages (CCA) of the RA foreign trade turnover as well as electricity exports in the period of 2000-2016.

Table 5

Coefficients of comparative advantages of RA foreign trade turnover and electrical power from 2000 to 2016

Years	Foreign turnover of Armenia			Electrical power		
	Export, in thousand US dollars	Import, in thousand US dollars	Coefficients of comparative advantage	Export, in thousand US dollars	Import, in thousand US dollars	Coefficient of comparative advantage
2000	300487.4	884733.2	-0.493	20551.6	10253.1	0.334
2003	685599.2	12779485.7	-0.898	4590.9	779.5	0.710
2011	1334338.8	4145332.0	-0.513	87514.5	9463.9	0.805
2012	1380199.2	4261232.7	-0.511	95223.9	3344.6	0.932
2013	1478748.6	4385865.9	-0.496	77962.3	4309.5	0.895
2014	1547286.6	4424424.5	-0.482	81292.1	9512.6	0.790
2015	1485331.9	3239238.7	-0.371	81211.9	7685.2	0.827
2016	1782924.7	3292425.3	-0.297	60991.1	13998.9	0.627

The source was compiled and calculated [3 p. 460, 4 p. 446, 13 p. 445, 14 p. 118].

As it is known, the state of both the whole trade turnover and import and export of some individual products are characterized by the Comparative Advantage Coefficient (PPP) calculated by the following formula:

$$CCA = (E - I)/(E+I),$$

where E is the export, I is import.

In other words, the numerator of the above formula presents the pure export, and the denominator - the foreign trade turnover. The value of the said coefficient is in the range [+1, -1], at that CCA UMC receives the +1 value when the country is only exported and the -1 value when the country only imports [15, p. 26]. That is, the closer the CCA is near to + 1, the higher is efficiency of the country's exports, and v.v. The negative CCA increases the negative value of the country's balance of payments, due to which the country faces external debt burden, exchange rate change for the worse, and other problems, while exporting of electricity from Armenia and being the principal player in the regional electricity market can dramatically improve the country's balance of payment. And this means that the economic policy implemented and maintained in the electricity market in Armenia can significantly widen possibilities of elecricity export and increase the state budget revenues.

2. The main directions of the RA Reforms in Power Industry

2.1. Concepts of energy independence and energy security

Many countries worldwide are striving for achieving "energy independence" and this idea is lays foundation for development of energy sector strategies or following up ongoing energy projects. Under conditions of geopolitical instability, unceasing fluctuations of energy carriers' prices, and in a situation when energy carriers (particularly oil) are becoming a source of political and economic power, and moreover, the cause of wars, energy independence can not be regarded as purely theoretical. On the contrary, it is necessary to make possible efforts to ensure energy independence of the country.

The former President of the United States Richard Nixon on November 7, 1973 anounced **Project Independence** initiative in reaction to the OPEC oil embargo and the resulting oil crisis. He stated that the goal of **Project Independence** was to achieve energy self-sufficiency for the United States by 1980, through national commitment to energy saving and development of alternative sources of energy. Nixon declared that American science, technology and industry could free America from its

dependence on imported oil, and establish its energy independence [16]. Depite these initiative, **Project Independence** failed to prevent to increase in American oil consumption after the 1973-74 embargo; its dependence on foreign suppliers rose essentially. Time has showed that it was much easier to send man to the Moon than to get energy independence.

We can state that there is no prospect of achieving energy independence through international isolation (that is attaining energetic self-sufficiency of the country). When prices of energy carriers will pass through all their phases, the situation will be disappointing because for achieving a secure energy future usually sides enter into long-term agreements. The isolation from global energy markets is neaningless and unrealistic.

A long-expected technological progress in the extraction, recycling of energy carriers and their production also is very important. The use of renewable energy sources and alternative fuels is a very attractive idea, and large-scale scientific research is being carried out in the above-mentioned directions. But today it is impossible to say when revolutionary changes will take place in this sphere and what will be the result.

There is a much more effective way. Its meaning is that the objectives of achieving energy independence should be interpreted differently: energy independence must be based on the reliability of supply of energy carriers and the opportunity to minimize the risks to the importing country. This notion of independence does not jeopardize international trade. At the same time, it emphasizes the main purpose of diversification - to encourage investments in alternative and traditional sources of energy and research funding. This creates incentives for rising energy saving and energy efficiency.

Such energy independence can be identified with energy security. In reality it requires not isolation, but interdependency from different countries, including energy consumers and manufacturers. The country's inner energy well-being is directly dependent on our relationships set up with other countries and regions.

Energy is the key driving force behind global economic progress and directly affects the well-being of billions of people worldwide. There are many factors of energy security, but unified and accepted worldwide, definition of this term has not been given yet. At the same time, differences between different countries around this issue are deepening, for energy-producing and energy-consuming countries approach energy security problems from different viewpoints.

Very often energy security is identified with the energy independence of a particular country. Such an approach has led to such a situation where the competition for natural resources in the world is getting worse and causes many conflicts. Though many threats are emerging in the field of energy security (which have long been common to all mankind) should have compelled countries to acquire resources so that they can embark on the development of a global energy security concept.

It is obvious that it has become imperative to create such a global energy system that will minimize all potential dangers. One of those policies is energy conservation and environmentally responsible use. Another direction should be offer increase of the supply of economically efficient energy resources. There are still enough fuel and energy resources in the world to ensure the demand for humanity in the foreseeable future. The main problem is not the physical deficit of energy carriers, but the necessity of applying joint efforts to realize that potential.

Striving for overall energy security, the international community should first aim at developing the infrastructure of the international energy market. The ultimate goal of the development of energy markets should become the formation of a unified energy area where uniform rules are used. Presently, much of the energy resources are supplied crossing the borders of countries, in the future this tendency will grow. It can be said that the world oil market already exists. At present, for the creation of a unified energy infrastructure, it is necessary to gradually establish interstate, continental and intercontinental energy associations that will work under common technological standards and management rules.

The role of the authorities is to provide constant assistance in the implementation of international energy trade and investment activities through the creation of favorable technical, ecological, political and legal conditions for supplying consumers from energy production areas.

Experts worried about energy security issues should be able to reach consensus on joint actions, balanced approaches and elaboration of a joint program. It is undoubtedly not an easy process and requires a dialogue between countries and a mutual openness. However, the general nature of energy security threats does not allow energy issues to be solved efficiently only by the efforts of individual countries.

In this context, energy independence is viewed as a procurement of local energy of countries, which takes into account the market demand and the possibility of using and/or building up stock of alternative fuel and energy sources.

Energy security is the protection of a country (countries) energy sector from external and internal conditions, factors and processes that endanger the sustainable development of the sector and the country's energy independence.

2.2. Energy Policy Foundations in Member States of the Eurasian Economic Community

In the member states of the Eurasian Economic Community, the principles of energy policy have been established on February 23, 2003 [17]. Thus, the energy policy of the Eurasian Economic Community states that the joint activities of these countries are aimed at the efficient use of energy resources, the formation of mutually supplementing fuel-energy systems of the partner countries, the development of transit potential of the countries, as well as creating favorable conditions for the increase of interstate supplies of energy resources. This policy is aimed at ensuring the energy independence of the Member States through restoration and development of mutually beneficial economic relations in the energy sector and the formation of a common energy market.

The main issues of Energy policy of the Eurasian Economic Community countries are the following:

- Development of mutually beneficial cooperation in the field of energy and undertaking of joint actions to form a common energy market;
- Domestic market’s saturation with energy resources and increase their export volumes to other countries;
- Formation of the wholesale market of electricity and energy potential,
- Efficient use of water and fuel-energy resources;
- Expansion of cooperation for the exploitation of new fields of hydrocarbon raw materials, its recycling and export,
- Development of transit potential of countries;
- Ensuring energy security and creating conditions for sustainable economic growth. The principles of energy policy of the Member States
- Mutual respect for sovereignty and national interests,
- Comprehensive co-operation in the formation of a common, complementary fuel-energy system;
- Joint responsibility for the application of measures to ensure national interests during the development of the energy sector, taking into account the interests of the countries' energy security,
- Adoption of the principle of preference for joint decision-making on energy security issues of the Member States.

The main directions of the energy policy are:

1. Ensuring energy security of the Partner Countries, which foresees the following:

- Unification of the legislation regulating the energy sphere and the creation of legal conditions for the formation of the energy market;

- Ensuring the demand for energy resources on the domestic market and the development of energy resources export potential of the Member States;
- Formation of coordinated principles of customs, tax and tariff policies related to the energy sector.

2. Formation of the common energy market of the cooperating Member States, which presumes:

- Expansion of cooperation between the Member States' energy systems and the provision of possibilities for intergovernmental transfers of electric power under the conditions of a common market of electricity and power;
- Providing electricity transmission systems to transit electricity to other countries, in accordance with non-discriminatory (the same) conditions against those of energy transfers in their own country, taking into account the mutual benefit of power systems' parallel work,
- Creating favorable conditions for efficient use of water energy resources and electricity;
- mutual assistance in the elimination of the effects of natural disasters and the consequences of accidents at energy facilities;
- Increasing the efficiency of existing energy capacities and creating new ones in order to meet energy security needs and cheap electricity demand,
- Establishment of joint ventures in the field of electric power generation, transmission and transition, and joint ventures for manufacturing of electric power equipment;

3. Establishment of the common oil and gas market of the Eurasian Economic Community, which envisages:

- Creation of conditions for increased efficiency of joint geological prospecting activities;
- Joint operation of new oil and gas fields,
- Implementation of coordinated measures for the reconstruction and upgrading of gas supply systems;
- Establishing of extractive joint ventures;
- Development of mutually beneficial cooperation for the creation of new transport systems and restructuring of existing ones aimed at optimization of the ways of oil and gas import in the partner countries and growth of capacities;
- Definition of unified rules for access to main oil and gas pipelines and the provision of transit of energy carriers through the territories of EAEU Member States;
- Development of optimal oil and gas pipelines routes;
- Creation of conditions for rational use of oil and gas;
- Conducting coordinated policies to expand markets of oil and gas resources;
- Establishment of joint ventures specializing in the production of oil and gas equipment.

To implement the above mentioned exposition of principal propositions of energy policy it is necessary to form a common fuel and energy market for the EAEU Member countries [17].

2.3. Energy system functions and state regulation

The main responsibility and key function of the state is to ensure the stability, self-preservation and development of the society, and repulse all possible threats to the country's security. For this reason it is necessary to clearly define the system of indicators or indices of economic safety. The latters, having received a numerical expression, send signals to the predetermined danger and allow to take measures to prevent them.

The three main functions of the energy system are:

- **social – infrastructural:**designed to meet the most important demand for the country - electricity, gas, heating, fuel and other energy products and services;
- **economic:** the energy system provides a significant part of the budgetary (mainly tax) receipts, as well as essential part of investments in differenr branches of industry;

- **geopolitical:** through activity of organizational-and-engineering structures provides regional contacts and relations, the possibility of creating a unified energy system, which can boost the joint energy security of the countries of the region.

The problem of establishing new relationships between the energy system and the state is the key issue of economic security of any country and new policy on energy, based on the raw material (or production) potentialities and the issues set forth for the "sustainable development". The energy system as a combination of energy, economy and ecology is considered as the main direction of Armenia's further development.

In the future, Armenia's economic security, both from the point of view of economic growth and expanded reproduction, will also depend on the country's fuel-and-energy balance in terms of overcoming severe vulnerability to external influences. Therefore, it is necessary to incorporate and calculate the following energy indicators referred to energy component:

- The ratio of energy (energy carriers) export and import,
- Share of the energy system product in GDP, which is directed to domestic consumption,
- Depreciation of fixed assets of industry, including of energy sector,
- Annual GDP power intensity decline,
- Tax burden on energy sector.

It should be noted that the state strategy for economic security made up on the basis of a national and its components elements should be based on the ideology of development that takes into account the strategic priorities and the national interests of Armenia. Should these factors be taken into consideration, security threats would be minimized. Without providing an ideology of development and industrial and scientific-technical progress, it is impossible to solve neither the problems of economic security, nor a living standard acceptable by population, as well as the social protection of the population.

It is also clear that the problem of energy security should be viewed at two levels - national and regional. The state regional policy should be a link between these two levels of security. Under current conditions of the regional development, it is important to highlight the most important energy component of Armenia's economic security components and consider it as a part of other components of economic security.

In recent years radical changes have been made in Armenia's energy system that have had an impact on both economic and social life. The energy system inceasently being the basis for the modernization of the economy, acquires characteristics of special public infrastructure in the process of formation of present time conditions of human society’s vital activity in the context of sustainable development in the future. Volumes and quality of energy production are largely predetermined by the security of the country, economic subjects and citizens, living standards and business activity.

Meanwhile, the issue of generation change and upgrading of production capacities has become imperative, as the character of RA power system’s technical capacities is the following:

- 38% of installed production capacities have been operated for more than 40 years;
- The duration of operation of the main equipment of the thermal power plants has reached the limit indicators and their technical-economic and environmental indicators do not meet requirements of international standards;
- In 70% of hydroelectric power stations (Dzorak HPS, Sevan-Hrazdan cascade, the system of Vorotan HPS) have been operated for more than 40 years, and 50% for more than 50 years.

The goal of the RA Energy Security Concept is to define the main ways to reach the specified level of energy security, compensating for the lack of commercially available local mineral fossil fuel, providing economically affordable, acceptable quality and uninterrupted power supply in daily conditions, in emergencies and warfare [18].

The following documents are the basis of the RA energy security protecion:

1. The **Rio Declaration on Environment and Development** was adopted at the United Nations Rio Conference known as the **Earth Summit** held on 3 – 4 June 1992 in Rio de Janeiro.
2. The **Johannesburg Declaration on Sustainable Development** was adopted at the World Summit on Sustainable Development, sometimes referred to as **Earth Summit 2002**, at which the **Plan of Implementation of the World Summit on Suautainable Development** was also agreed upon.
3. The **EU Energy Security Strategy** released by European Commission in May 2014 designed to secure Energy Supply Security, Competitiveness and Sustainability, reflected in the Green Paper of the European Commission;
4. The **Obligations** assumed by a number of other environmental conventions ratified by the Republic of Armenia.

Efficient use of renewable energy resources and energy conservation are crucial in ensuring energy security.

Promoting the use of own renewable energy sources (hydro, wind, biomass, solar, geothermal, etc.) is of great importance in ensuring energy independence of the country. The promotion of demanded investments for development of new renewable energy technologies, such as solar and bio technologies, geothermal and hydrogen energy, is of great concern not only for energy sector development and energy independence, but also enables to develop other related sectors of the economy. In particular, the development of various technologies for biofuels will contribute to the development of agriculture and the improvement of living standards of rural communities, development of processing and recycling industries in rural areas. Development of solar photovoltaic technology will create opportunities for the development of non-metallic mining and chemical industries, semiconductor technologies and semiconductor thermogenerators, which have wide range of applications.

One of the preconditions for the transition to knowledge-based economy is the large-scale introduction of energy conservation and energy-efficient technologies.

One of the most effective ways to promote energy supply with minimal costs is the reduction of energy waste, and, where possible, prevention by implementing energy efficiency measures, in particular, on the review of construction norms and introduction of energy saving standards, which will contribute to promoting the use in building industry non-metallic minerals that are a significant part of Armenia's national wealth.

The aim of the energy saving investment is to reduce energy dependence on imported energy resources, reduce greenhouse gas emissions through improvement of energy efficiency, increase public and private investment to provide energy saving in buildings, reduction of losses and raising energy efficiency and reliability level, as well as making the energy eficiency in other sectors of national economy an integral part of the government programs under implementation, and through the state support to ensure private capital involvement in energy eficiency sphere.

The concept outlines the measures necessary for energy efficiency:

- Follow the methodologies widely used in EU countries, develop a methodology for building up the energy balance of the Republic of Armenia and prepare annual energy balance of all types of energy - imported into the country, generated in the country and transferred to consumption sphere.
- Overcome the risky obstacles existing in the financial market that hamper the participation of commercial banks in the energy saving sector;
- Show that reasonable investments in increasing energy efficiency of buildings is profitable business,
- Promote energy saving demand in buildings, increase the awareness of commercial banks and skills of bank lending in energy saving,
- Carry out generation change of heat-and-power engineering capacities by introducing gas-turbine and combined thermal and electric power cogeneration systems that will operate in

competitive conditions without cross-subsidization and will be the best energy-saving solution.

2.4. The main directions of the reforms in energy sector undertaken by the Government of the Republic of Armenia:

The recent reforms in the energy sector undertaken by the RA government refer to the transition to a new, up-to-date power industry market in Armenia, the need of which is conditioned by the needs of the domestic market and is also important in terms of using cross-border trade opportunities [19].

The problem is that the current model of the Armenian energy market has been put into operation in 2004 and is based on the "single buyer (seller)" model, in which the electrical energy distribution license holder is entitled to buy electricity from the wholesale electricity market and sell it to consumers. In addition, the electricity market is fully regulated both in wholesale and retail sectors, electricity imports and exports are also regulated. In many developed and developing countries, energy markets have already been liberalized and have guidelines for a fully competitive market structure.

In order to liberalize the electricity market it is necessary to move to a new model of the market, which will increase the effectiveness of wholesale and retail markets and promote interstate trade will have some competitive elements in the domestic market.

The current electricity market is based solely on the annual electricity production and consumption forecasts and does not define responsibility for market participants in case of deviations from these volumes. As a result, the risks arising from the difference between the designed and actual volumes of electricity generation are balanced by electricity tariffs supplied to consumers, including the value of the balance risk of a person holding an electricity distribution license. Such a combination of legal relationships also does not enable to increase the efficiency of economic regulation of the power system. The new model of the market should be based on modern electricity trade rules, acting through demand and supply requests from business market participants and aim to incorporate accountability mechanisms for a market participant.

Tariff regulation is mostly implemented on the "profit rate regulation" principle, by annual complete recalculation of tariffs of system companies and service providers every year. This principle does not create enough incentives for regulators to increase the cost and effectiveness of investment. Electricity tariffs for consumers are differentiated by voltage levels, as well as overnight and daytime rates, insufficiently ensure the targeted distribution of electricity produced and system costs. For power generating stations have separate electricity and power rates are set, but they are not used in case of any consumer group and vice versa, night and day tariffs for consumers do not reflect the price of electricity production during that period. Such a tariff system can lead to an essential disbalance of financial flows in electricity production and consumption markets because of being different from the technological process. Therefore, there are addressed gaps in the tariff regulation system and application of new approaches is a necessity.

Conclusion

Taking into account the above, the transition from a fully regulated model of the electricity market to a new, liberal model, introduction of modern trade rules, further improvement of the tariff system and the promotion of interstate commerce are the main priorities of the RA electricity market liberalization (hereinafter - the Program) as priorities for domestic market consumer protection, including the distribution of responsibilities between market participants.

The main goals of the project are:

- Implementation of economic regulation in the electricity power system based on demand and supply requests from market participants.
- Introducing of individual responsibility for market participants and end-users in order to balancs risks resulting from the difference of predicted and actual consumption volumes.
- Establishing new opportunities for interstate commerce.

- Introduction of new mechanisms for the protection of domestic consumers.
- Improvement of investment environment and creation of attractive conditions for investors; The main steps to achieve these objectives are as follows.
- Introduction of new tools and regulations in line with the best international practices in the RA Law on Energy, to clarify the scope of competences of state bodies and persons involved in the field.
- Develop concepts of new model of electricity market for Armenia and of new mechanisms of electricity trade.
- To develop new market rules based on the above mentioned concepts and fully transition to a new market model and new trade mechanisms by 2020,
- Review the tariff regulation system.

On resoluteness of The RA Government to implementing the program speak already implemented in a number of laws changes the main objectives of which are:

- To define (separate) the functions of the Ministry of Electric Power Infrastructurs and Natural Resources of the Republic of Armenia, the Public Services Regulatory Commission and other state agencies.
- To make transition from the regulated model of the current single buyer-seller market to a new, liberal model, to introduce modern trade rules, to improve the tariff regulation system.
- To apply new tools to promote interstate trade having as a priority protection of consumers of the domestic market and the distribution of responsibilities among market participants.
- To separate distribution and supply functions as a result of which other suppliers may be able to act in the market, each as a licensed organization, which in turn will increase the collection of state dues. At the same time, the guaranteed supplier will operate in the market, which will provide services at regulated prices, enabling consumers to choose between both suppliers and buyers of electricity in the regulated and non-regulated market. At the same time, qualified consumers will have the right to buy electricity from electricity producers through direct contracts,
- To clarify functions of operators of the RA electrical power system and electrical power market.
- To define the concept of a new wholesale electricity trade license, under which the defined activities will not practically be regulated, which will promote interstate trade.
- To anticipate increase in the number of licensed persons engaged in business in a wholwsale power market who can fulfill the function of importing and exporting electricity, which in its turn will lead to the increase in state revenues.
- For the purpose of planning the development of the power system, it is envisaged to clarify the requirements and tools for the development of power generation plants, transmission and distribution systems.
- To define new provisions guaranteeing non-discriminatory right of the third-party access to electrical power markets, in terms of infrastructure availability and guarantees for new connections [20].

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ՀԱՅԱՍՏԱՆԻ ՀԱՆՐԱՊԵՏՈՒԹՅԱՆ ԷԼԵԿՏՐԱԷՆԵՐԳԵՏԻԿԱՅԻ ԱՐԴԻ ՎԻՃԱԿԸ ԵՎ ԲԱՐԵՓՈԽՈՒՄՆԵՐԻ ՀԻՄՆԱԿԱՆ ՈՒՂՂՈՒԹՅՈՒՆՆԵՐԸ

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Հայաստանի Հանրապետության տնտեսության առանցքային ոլորտներից է էներգետիկան, որի զարգացմամբ է պայմանավորված ինչպես տնտեսության, այնպես էլ բնակչության կարիքների բավարարումը էլեկտրաէներգիայի նկատմամբ: Այդ պատճառով էլ Հայաստանի Հանրապետության կառավարության ծրագրում (2017-2022թթ.) առանձին բաժին է հատկացված էներգետիկայի զարգացման հիմնական ուղղություններին:

Հոդվածում ուսումնասիրվել են ՀՀ էլեկտրակայանների հզորությունների և դրանց կառուցվածքի վերաբերյալ տվյալները 2000-2015թթ. ժամանակահատվածում, էլեկտրաէներգիայի արտադրության ծավալները ըստ ստացման աղբյուրների և կառուցվածքի, ՀՀ էլեկտրահաշվեկշիռը և դրա կառուցվածքը, ՀՀ-ից էլեկտրաէներգիայի արտահանման և ՀՀ էլեկտրաէներգիայի ներմուծման քանակը, արժեքը և 1000 կՎտ/ժ-ի արժեքը, ինչպես նաև ՀՀ արտաքին ապրանքաշրջանառության և էլեկտրաէներգիայի համեմատական առավելությունների գործակիցները 2000-2016 թվականներին:

Հեղինակները կարևորել են էներգետիկ անկախություն և էներգետիկ անվտանգություն հասկացությունները՝ տալով դրանց սեփական բնորոշումները: Նկատի ունենալով, որ Հայաստանի Հանրապետությունը ԵԱՏՄ անդամ պետություն է, ներկայացվել են այդ միության գործունեության սկզբունքները, անդամ երկրների էներգետիկ քաղաքականության հիմնական խնդիրները, սկզբունքները, ինչպես նաև էներգետիկ քաղաքականության հիմնական ուղղությունները: Հեղինակների ուշադրության կենտրոնում են նաև ՀՀ-ում էներգետիկայի ոլորտի ազատականացման և օրենսդրական վերջին փոփոխությունները:

Բանալի բառեր. էներգետիկ անկախություն, էներգետիկ անվտանգություն, էլեկտրաէներգիա, արտահանում, ներմուծում

СОСТОЯНИЕ ЭЛЕКТРОЭНЕРГЕТИЧЕСКОЙ ОТРАСЛИ РЕСПУБЛИКИ АРМЕНИЯ И ОСНОВНЫЕ НАПРАВЛЕНИЯ РЕФОРМ

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Одной из важнейших отраслей экономики Республики Армения считается энергетическая отрасль, развитие которой позволяет обеспечивать потребность экономики и населения в электроэнергии. Не случайно в Программе Правительства РА, разработанной на 2017-2022гг. отдельный раздел посвящен основным направлениям развития отрасли энергетики в республике.

В статье исследованы показатели мощностей электростанций, источники получения электроэнергии в РА и структура производства электроэнергии за 2000-2015гг., показатели электроэнергетического баланса РА и его структура, а также показатели экспорта и импорта электроэнергии, цены за 1000 кВт/ч электроэнергии, а также стоимости экспортируемой и импортируемой электроэнергии. Авторами рассчитаны коэффициенты сравнительных преимуществ во внешней торговле и торговле электроэнергией за 2000-2016гг.

Особое внимание уделяется понятиям энергетической независимости и энергетической безопасности, основываясь на богатой теоретической литературе авторы представили собственное видение энергетической безопасности. Поскольку Республика Армения является страной-членом ЕАЭС, авторы проанализировали основные задачи и принципы энергетической политики, утвержденные

Решением Межгоссовета ЕАЭС, а также основные направления осуществления энергетической политики в странах союза. Авторы статьи акцентируют внимание на последние реформы Правительства РА и изменения в законодательстве, суть которых заключается в либерализации энергетической отрасли.

Ключевые слова:. энергетическая независимость, энергетическая безопасность, электроэнергия, экспорт, импорт.

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CLASSIFICATION OF SOME LOGICAL TASKS AND THEIR SOLUTION BY TABLES OF TRUTHFULNESS

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Solving logical problems is a common way to train and develop the mental abilities of learners. There are no standard algorithms for solving logical problems, and attempts to find them continue. At the same time, there are differentiated, certain lessons on these problems, where they are solved by a certain principle. The most common ways of solving the logical tasks are the usage of the tables of correctness and the logical algebraic modes.

Key words: *logical problems, logical algebra, truthfulness chart, statement, resolution.*

Introduction

In mathematics logical problems form a unique lesson, the algorithms of the solutions are generally very unique and have been constantly tested to classify those issues and solve them according to a particular class.

To solve a classic logical problem, it is important to know the basic ways and approaches to its solution. To solve the same problem and to get the right answer, in many cases, it is possible to achieve it in different ways. Knowledge of different ways of solving problems will help to find out what method is more efficient and faster to solve the problem.

Textual tasks refer to “classical” logical tasks, the purpose of which depends on the conditions of the problem, the recognition or arrangement of certain objects in a particular order. The more complicated and attractive are the issues in which separate claims are true and the rest are untrue. Examples of non-standard wide-range logical problems include relocation, installation, weighing, and recovery issues.

The following methods of solving logical problems have been most common:

- the way of judgment;
- the way of using tables of truthfulness;
- logical algebra method.

The logical algebra is a powerful means of solving logical problems.

Statement of the question

The article presents a set of solving methods of some logical problems of certain class by using the tables of truthfulness. The essence of the method lies in the fact that the conditions of the problem are tailored to the corresponding tables of the problem and getting the results through judgments. Depending on whether true or not is the statement in the table, the corresponding box is filled in “1” or “0”.

Example 1.

Three sportsmen A,B and C are playing basketball. When the ball appears in the basket, A cries: “B has thrown the ball into the basket”.

B objects: “C has thrown the ball”, and C insists: “I have not done it”.

Who has thrown the ball into the basket if one of the three is lying?

Solution. We make a chart on the following principle: to the left we write all the claims that we have in the condition, above we write all the possible options of the facts.

Let’s regard the first possible option which says that A has thrown the ball into the basket. We discuss the statement from the left and fill in the first column.

According to our suggestion (A has thrown the ball into the basket) the claim of "B has thrown the ball into the basket" is not true. We insert 0 into the box. The claim of "C has thrown the ball into the basket" is not true too, so we insert 0 into that box. The claim of C is right, i.e. " I haven't thrown ball into the basket", consequently, we insert "1" into the box.

Let's regard the second possible option which is "C has thrown the ball into the basket" and fill in the second box.

The statement that "B has thrown the ball into the basket" is not true, so we insert 0 in the appropriate box.

The statement that "C has thrown the ball into the basket" is true, that's why we insert 1 into the box. The statement of C that "I haven't thrown the ball into the basket" is not true. We insert "0" into the box.

And at last, the third possible option is "B has thrown the ball" . In this case the statement that B has thrown the ball into the basket" is right, so we insert "1" into the box.

The statement that "C has thrown the ball into the basket" is not true, so we insert "0" into the box. Ant the statement "I haven't thrown the ball into the box" is true, consequently, we insert "1" into the box.

Table 1

Statements	Possible options of facts		
	A has thrown the ball into the basket	C has thrown the ball into the basket	B has thrown the ball into the basket
A: B has thrown ball into the basket	0	0	1
B: C has thrown ball into the basket	0	1	0
C: I haven't thrown ball into the basket	1	0	1

As, according to the condition, only one sportsman has lied, we choose that possible option of the answer from the filled table where the wrong statement is one. That is the third column, where we get the answer of the task which is "B has thrown the ball into the basket" option (from the three one has lied).

Example 2.

Three musicians Babken, Suren and Vrezh have got job in the symphonic orchestra , who are able to play violin, cello, viola, clarinet, hobo and trumpet.

It is known that

1. Suren is the tallest of all;
2. player of the violin is shorter than the player of the cello;
3. the players of the violin and cello and Babken like to eat pizza;
4. when the players of alt and trumpet argue, Suren tries to reconcile them;
5. Babken can not play the trumpet and hobo.

What instruments can play these musicians if each of them can play two musical instrument.

Table 2

Instruments / Musicians	violin	cello	alt	clarinet	hobo	trumpet
Babken	0	0	1	1	0	0
Suren	0	1	0	0	1	0
Vrezh	1	0	0	0	0	1

Solution. Build a table containing the terms of the problem, filling in the corresponding boxes by 0 or 1, depending on whether it is true or not.

As musicians are all three and the instruments 6 and each musician can play on both instruments, so every musician plays on the instruments on which others can not play. It follows from the 4th that Suren does not play on the hobo and clarinet, and in terms of conditions 3 and 5 it follows that Babken plays on the viola and clarinet. The first line is complemented with no difficulty. It follows from conditions 1,2,4 that Suren does not play violin and trumpet, where follows that Vrezh plays violin and trumpet. The rest is very clear, Vrezh can not play on the hobo and cello, and it remains that Suren is able to play on those instruments.

Example 3.

In response to the question of which of the three students studied mathematical logic, the following answers were received:

"If the subject was examined by the 1st student, and it was also examined by the 2nd student", but the statement of "if the subject was examined by a third student then the second student also examined it" is not true.

Who has studied the subject of mathematical logic?

Solution. Make appointments with P1, P2, P3 assuming I, II, III. Students have studied the subject of mathematical logic respectively.

From the conditions of the problem we get (P1 → P2) & (P3 → P2). The truth of the statement is in the chart.

Table 3

$P1$	$P2$	$P3$	$(P1 \to P2)$	$(P3 \to P2)$	$(P1 \to P2)\&(P3 \to P2)$
0	0	0	1	0	0
0	0	1	1	1	1
0	1	0	1	0	0
0	1	1	1	0	0
1	0	0	0	0	0
1	0	1	0	1	0
1	1	0	1	0	0
1	1	1	1	0	0

We conclude from the table that the third student has studied mathematical logic.

Results of the study

By presenting the logical problem with the claims, presenting the problem in the form of the final claim and using the rules of filing the table of truthfulness of logical algebra, we get the solution of the tasks.

Conclusion

With a logical algebra, the logical problem solving algorithm can be presented as follows:

1. it is necessary to study carefully the conditions of the problem;
2. separate simple words and designate them in Latin lowercase;
3. write the terms of the problem in the language of logical algebra;
4. to make the final formula for which you need to combine all the formulas and equate to one by logical multiplication and summarizing;
5. simplify the formula by examining the received result or making a verification table. Find the values in the table for which the final statement is true, F = 1.

Taking advantage of the logical algebra with the rules of action and the terms of the problem, getting the final statement of the problem, we get the answer to the problem by completing the table of truthfulness.

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ՏՐԱՄԱԲԱՆԱԿԱՆ ՄԻ ՔԱՆԻ ԽՆԴԻՐՆԵՐԻ ԴԱՍԱԿԱՐԳՈՒՄՆ ՈՒ ԼՈՒԾՈՒՄԸ ՃՇՄԱՐՏԱՑԻՈՒԹՅԱՆ ԱՂՅՈՒՍԱԿՆԵՐԻ ՄԻՋՈՑՈՎ

Ռ.Մ. Հարությունյան, Ռ.Հ. Զախարյան
Շուշիի տեխնոլոգիական համալսարան

Տրամաբանական խնդիրների լուծումը ընդունված միջոց է մարզելու և զարգացնելու սովորողների մտավոր կարողությունները: Տրամաբանական խնդիրները լուծելու համար գոյություն չունեն ստանդարտ ալգորիթմներ և դրանց գտնելու փորձերը շարունակվում են: Միևնույն ժամանակ արդեն տարբերակվել են, առկա են այդ խնդիրների որոշակի դասեր, որտեղ խնդիրների լուծումները կատարվում են որոշակի սկզբունքով: Առավել տարածում են ստացել տրամաբանական խնդիրների լուծումների դատողությունների, ճշմարտացիության աղյուսակների օգտագործման և տրամաբանական հանրահաշվի եղանակները:

Բանալի բառեր. տրամաբանական խնդիրներ, տրամաբանական հանրահաշիվ, ճշմարտացիության աղյուսակ, ասույթ, բանաձև

КЛАССИФИКАЦИЯ НЕСКОЛЬКО ЛОГИЧЕСКИХ ЗАДАЧ И ИХ РЕШЕНИЯ С ПОМОЩЬЮ ТАБЛИЦ ИСТИННОСТИ

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Решение логических задач - общепринятый метод обучения и развития логических способностей учащихся. Не существуют стандартные алгоритмы для решения логических задач, и их поиски продолжаются. В то же время наличествует дифференциация определенных классов, где задачи решаются по определенному принципу. Для решения логических задач наиболее распространенными являются методы: использование суждений, таблиц истинности и алгебры логики.

Ключевые слова: логические задачи, алгебра логики, таблица истинности, высказывание, формула.

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MODERN STATE AND PREDICTIONS OF ENSURING ECONOMIC SECURITY OF THE NKR

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In the article the methods of analysis of the modern economy of the NKR are presented on the basis of econometric models. This work aims at the development and identification of econometric models of modern economy of NKR for the assessment, prediction and security, on the basis of information published in the public domain. The necessity of development and creation of econometric models of economic security of the NKR dictated an important aspect of the viability of the unrecognized Republic.

Key words: *modern economy, prediction, economic security, econometric modeling, time series.*

Introduction

In addition to the political resources and social factors an important aspect of the viability of the Nagorno Karabakh Republic are economic resources. Despite all the economic difficulties associated with the unrecognized status of NKR, the Republic's economy is developing rapidly, improve social indicators. For two decades, the NKR has overcome the devastating consequences of war in almost all spheres of economic and social life. The agricultural sector has been restored as a traditional for Nagorno-Karabakh industry, as new – were established mining, energy, tourism and so on. Today rapid growths of the NKR economy are observed. The statistical indicators are the proofs of economic growth.

A fundamental transformation in the socio-economic sphere has brought to the fore of the problem of economic security. The severity of the problem in the Republic is present due to several reasons, in particular: the influence of such negative factors as the lack of recognition of the NKR status, the economic and political blockade by Azerbaijan, as well as the factors related to the formation of new business structures; the complexity of regulation of various forms of ownership in connection with a high degree of monopolization of the economy, low level of GDP per capita, the presence of unemployment, poverty and low levels of investment, low competitiveness of enterprises; weak development of market infrastructures; lack of experience of regulation of the market economy, lack of knowledge etc.

The concept of “economic security” used to justify certain positions related to economic risks that threaten the security of the country. This makes it necessary to establish the causes of threats to the economic security and aim for a scientific definition of this concept.

National economic security cannot be described with one definition, as it has several aspects: the Republic forces and means to counter the threat to the economic interests of the state and society; the ability of the economy to neutralize the effect of internal and external factors that have a negative impact on its preservation and further development; the ability of the country to ensure the compliance of the economic mechanism for changing circumstances and development; the ability to perform the necessary actions to achieve the goals over a given period of time; the ability to securely protect and efficiently use human, material, natural and financial resources of the country.

In accordance with the principle of efficiency of national resources must be used so that growth was observed in the non-production of the final product value, meet the demand of the consumer with the best structure. At the same time we need to ensure fairness of income distribution, and stability of the state. Collectively, national economic security refers to the state of the country, which in certain vital economic sectors, ensures compliance with national interests by purposeful and continuous development of individuals, state and society, or excludes the possibility of threat to the national economy reducing their scope to a minimum.

The problem of economic security in countries with economies in transition (which is the Republic of Nagorno-Karabakh) is quite specific: there is a danger of transformation of economy as a “relative economy”, the collapse of industries based on the latest technologies brain drain and a general decline of intellectual potential, incomplete use of available human capital and the plundering of natural resources, excessive increase in external debt relative to GDP, deterioration of scientific and educational systems. The definition of economic security involves: evaluating the internal and external threats, conditions and factors that lead to the emergence of threats to the Republic, society and the vital economic interests of the individual, based on the criteria characterizing the state of the economy, the vital interests of the Republic and a mechanism to ensure the vital interests, focusing on the development of cooperation of all public authorities. Special attention is required to develop the system of indicators of estimation of economic safety, definition of the thresholds of safety indicators, analysis of the factors influencing this assessment, a comparative analysis of the economic security of several countries with the aim of establishing indicators that are already in threat range and threaten their relationship.

Statement of the problem

The problem of economic security of the NKR can be solved by using econometric models of the main economic indicators of living standards of population and social sphere, which allows to evaluate the possibility of adoption to ensure the economic safety of the Republic.

First, it is necessary to consider such economic indicators as gross domestic product (GDP), which is a universal measurement tool of economic activity in the country. As it is known, the calculation of the GDP only considers the final product, besides, the products that were produced in the Republic and exported, are considered, but imported goods are not taken into account.

The main groups of indicators of economic security include: the overall economic potential of the Republic; the economic security of its defense capacity; the degree of possible independent development of the economy, the standard of living of the population, the level of safety of the financial system, the degree of economic independence, state system of economic security management.

Let's refer to the GDP of NKR directly during the last 15 years. In 1999 GDP was only $ 59 million, which is 80% less than the figure that was in Soviet times. The growth rate has not kept itself waiting. By 2005, the GDP doubled and reached a figure of $ 114 million and an economic growth of 14%. In 2009 GDP was $ 260 million, and by 2012 accounted for approximately $ 380 million. In the current year the NKR's GDP is projected at $ 420-425 million. Based on the above statistics, we can understand that the economy of the unrecognized Republic is developing very dynamically. Despite the fact that GDP is not a measure of overall quality of life of the country, changes in the volume of production of goods and services per person (GDP per capita) is often used as a measure of greater or lesser prosperity of the average citizen of the country. Considering the fact that the population of the NKR in the last 15 years increased slightly (1999 – 139,4 thousand people, 2011 – 144.7 thousand people), we can conclude that GDP per capita grows every year, and with it the general welfare of the population.

Another important economic indicator is the budget of the NKR. The budget is a Central part of financial system of any state. Its main purpose is using financial resources to create conditions for effective development of Economics and solving national social problems, such as providing the population with public goods and services, redistribution of income, stabilization of the economy. Without these tasks, the authorities are almost powerless to achieve the legitimacy of the regime and to enlist public support. All these tasks cannot be resolved without the financial support. Therefore, the state accumulates a certain amount of funds (state budget revenues), and then distributes them on purpose (the expenditure of the state budget). The state budget is a financial plan that matches

expected revenues and expenses. Thus, the sum of the annual budget and source of revenue can adequately assess the economic resources of de facto state.

The agricultural sector has always been the backbone of the economy of Nagorno Karabakh. In Soviet times the growth rate of agriculture was quite large, the peak was in the decade from 1981 to 1990, when there were powerful material and technical bases with a large number of advanced agricultural equipment. However, after the war, the powerful system, created during decades, had been destroyed. And for the past two decades the process of agricultural recovery has been going on, but the pre-war figures are not yet achieved.

The government of the Nagorno Karabakh Republic elaborates the concept of food security, according to which it is expected to ensure the level of development of the economy, allowing conditions to provide the population with appropriate and affordable food, scientifically based standards of consumption independent of international market constructions, to prevent food crises. According to experts, the agricultural potential of the Nagorno-Karabakh Republic is so great that it is able to provide food not only for NKR, but also for a part of Armenia.

Overall, the NKR authorities will continue to transform the agricultural sector into a locomotive of Karabakh's economy as the main link ensuring economic safety of the Republic. Agriculture is a strategic sector and food security of de facto state is a priority. At the moment the main goal is the achievement of the pre-war figures in agriculture, for this purpose, every year investments in industry increase. In addition to budget funds, attempts are made to attract foreign investments.

In addition to agriculture we have rapidly developing industry in the last ten years. Mostly small and medium-sized enterprises are in private ownership. The largest enterprise for production of construction materials remains Stepanakert factory of construction materials, to which several quarries of building stone and facing materials of granite, felsite, marble, tuff, etc. belong on the territory of the Republic. The presence in NCR's rich resources of valuable tree species promises a great future for the forestry and wood industry. Almost half of the total industrial production comes from mining. Drmbon GOK, launched in 2003, is the largest enterprise of the mining industry of NKR. The plant employs 1,200 people and the company contributes to solving the problems of jobs in the country. "Basemetals" (enters into group of companies "VallexGroup"), the company owning the plant and Drmbon mine is the largest taxpayer of the de facto state. In 2011 the company has paid to the budget of the NKR about 3.9 billion drams of taxes ($ 9.7 million). Nowadays, taxes and other payments from "Basemetals" account for 17% of the revenues of the entire budget. The field itself contains about 5-10% of the total reserves of gold and copper in the country. Other promising deposits are copper and molybdenum deposits of Tsakhkashen in Martakert region, NKR. The field promises to be much more promising, Vallex Group plans to invest about $80 million in the development of this project. Good stocks are also in Kashatagh, Martuni and other regions. Taking into account the fact that the ore reserves on Drmbon field run out in 3 years, new field explorations are very important for the further development of the mining industry of NKR.

Other priority direction of the economy is energy. The rise in energy actualizes energy projects and plans to ensure economic self-sufficiency of the NKR. Over the past few years several small hydro power plants were commissioned — "Trghe-1", "Trghe-2", "Syunik-1" and "Syunik-2", "Madaghis-1", "Madaghis-2", and in the near future it is expected to launch "Trghe-3" and "Syunik-3". In addition to the Sarsang HPP, a new hydro power station will produce about 330 million kWh/h of electricity, the total potential of the republic allows to produce up to 700 million kWh/h, which is twice the NKR needs, potentially making the Republic the electricity supplier to neighboring countries. In this area the first step is also made, enabling citizens to become co-owners of state property – everyone can become a shareholder of Open Joint Stock Company "Artsakh HPP", the number of shareholders has reached 1,200 people there.

Thus, based on the above mentioned, we can confidently assert that the economy of NKR, despite the dependence on Armenia is developing very dynamically. GDP and budget of the de facto States grow each year, respectively, and increase the level of tax revenues in the budget, and it gives the opportunity to existing NKR a regime to solve the basic socio-economic problems. In addition, the opening of new businesses contributes to solving the most important problem in the Republic - unemployment.

Research results

Table 1 groups the main indicators: economic, living standards of population and social sphere.

Table 1

Dynamics of the main economic indicators of NKR

Years	Gross Domestic Product, total, mln. drams	GDP per capita, thsd. drams	Population size, thsd. persons	Natural growth of population, persons	Average monthly wages, drams	The lowest wages, drums	Money incomes of population per capita, thsd. drams
2000	23148,6	172,2	134,4	1037	27222	10000	23670,4
2001	23880,7	176	135,7	1231	28178	10000	26692
2002	26477,8	193,8	136,6	948	29673	10000	29380,2
2003	33883,7	247,3	137	826	33661	10000	34408,7
2004	42830	312,2	137,2	789	41170	10000	43061
2005	51379,4	373,1	137,7	744	51127	15000	51826,8
2006	61885,9	449,4	137,7	867	56700	15000	57901,8
2007	70791	510	138,8	918	68610	20000	69103,3
2008	87148,1	623,1	139,9	1101	80480	25000	80764,6
2009	102338,7	723,7	141,4	1555	88768	30000	88366,8
2010	118187,2	823,2	143,6	1353	92736	30000	96898,6
2011	135498,5	936,1	144,7	1289	98453	32500	112936,4
2012	150015,7	1023,3	146,6	1268	101346	35000	120425,5
2013	168563.6	1137.9	148.1	1027	1286211	45000	136500,4
2014	188840.3	1268.1	148.9	1119	141193	50000	150907,5
2015	209345.7	1414.3	148.1	1292	151058	50000	155940, 4

Let's make the following designations:

Gross Domestic Product, total, mln. Drams - $x_{1;}$

GDP per capita, thsd. Drams - $x_{2;}$

Population size, thsd. Persons - $x_{3;}$

Natural growth of population, persons – x_4;

Average monthly wages, drams – x_5;

The lowest wages, dram – x_6;

Money incomes of population per capita, thsd. drams – x_7.

To analyze the dynamics of economic indicators we used the following statistical procedures: correlation analysis, stepwise regression analysis (based on Fisher criterion) and the procedure of analysis and prediction of time series. The statistical analysis was applied SP Minitab 18. and SP Statistica 10.0.

When stepwise regression analysis was taken into account only those models at which the adjusted coefficient of determination more than 50%.

The result was obtained with the following model: income and the minimum wage depend on GDP per capita, while the adjusted coefficient of determination in both cases is above 95%. In the first case : the minimum wage from GDP per capita adjusted R^2=96,55. In the second case: incomes of GDP per capita adjusted coefficient of determination R^2=99,51.

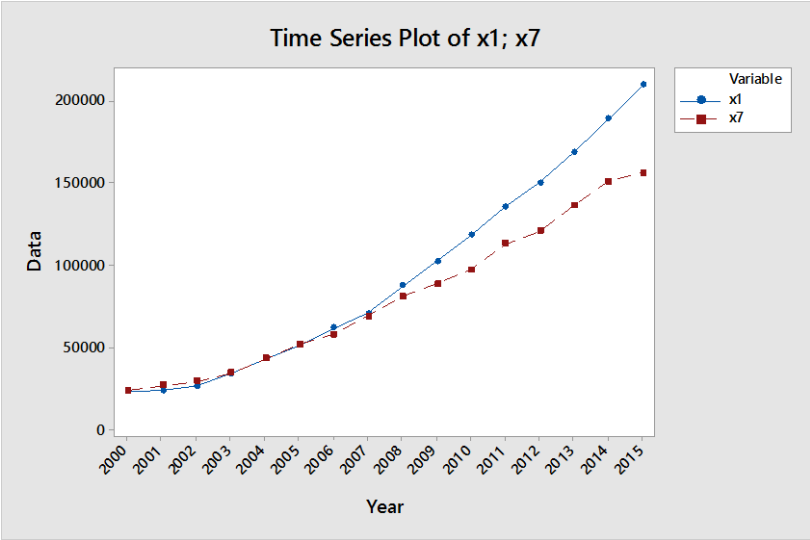

Figure 1. Time series GDP and Money incomes of population per capita

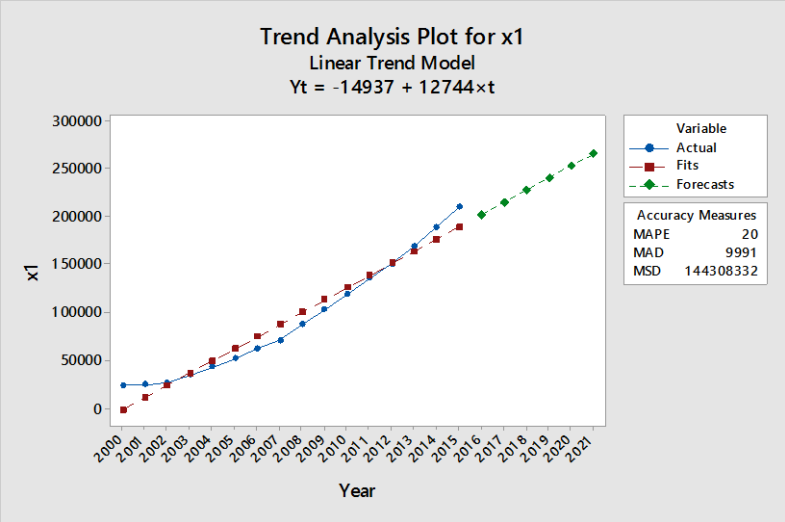

Figure 2. Trend analysis plot for x_1

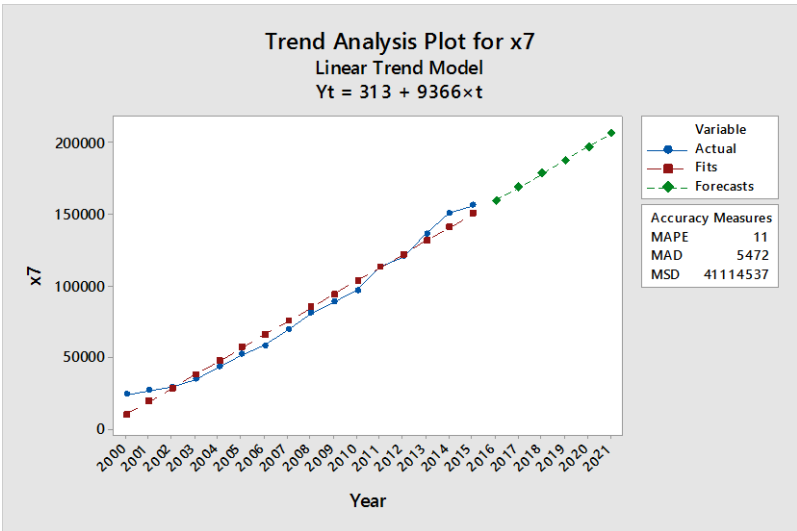

Figure 3. Trend Analysis plot for x_7

Conclusion

Thus, to ensure the economic security of the NKR we need to pay special attention to indicators such as GDP and GDP per capita.

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ԼՂՀ ՏՆՏԵՍԱԿԱՆ ԱՆՎՏԱՆԳՈՒԹՅԱՆ ԱՊԱՀՈՎՄԱՆ ԱՐԴԻ ՎԻՃԱԿԸ ԵՎ ԿԱՆԽԱՏԵՍՈՒՄՆԵՐԸ

Ի.Վ. Հարությունյան, Լ.Է. Դանիելյան

Շուշիի տեխնոլոգիական համալսարան

Հոդվածում առաջարկվում է մեթոդիկա ԼՂՀ ժամանակակից տնտեսության վերլուծության հիման վրա էկոնոմետրիկ մոդելներ. Տվյալ աշխատանքը նպատակ ունի մշակել և նույնականացնել ԼՂՀ ժամանակակից տնտեսության համար էկոնոմետրիկ մոդելը, ԼՂՀ ժամանակակից տնտեսության գնահատման, կանխատեսման և անվտանգության ապահովման, այն տեղեկատվության հիման վրա, որը հրապարակվել է հանրային տիրույթում.

Էկոնոմետրիկ մոդելների մշակման եւ ստեղծման անհրաժեշտությունը թելադրված է ԼՂՀ տնտեսական անվտանգության չճանաչված հանրապետության կենսունակության
կարեւոր առումով:

Բանալի բառեր: ժամանակակից տնտեսություն, ժամանակային շարքերի կանխատեսում, տնտեսական անվտանգություն, էկոնոմետրիկ մոդելավորում, ժամանակային շարքեր:

СОВРЕМЕННОЕ СОСТОЯНИЕ И ПРОГНОЗЫ ОБЕСПЕЧЕНИЯ ЭКОНОМИЧЕСКОЙ БЕЗОПАСНОСТИ НКР

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В статье предлагается методика анализа современной экономики НКР на основе эконометрических моделей. Данная работа ставит целью разработки и идентификации эконометрической модели современной экономики НКР для ее оценки, прогноза и обеспечения безопасности, на основании информации, опубликованной в открытом доступе.

Необходимость разработки и создания эконометрических моделей экономической безопасности НКР продиктовано важным аспектом жизнеспособности непризнанной республики.

Ключевые слова: современная экономика; прогноз; экономическая безопасность; эконометрическое моделирование; временные ряды.

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THE MAIN PROBLEMS OF THE DEVELOPMENT OF AGRICULTURE IN NKR

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The article highlights the strategic importance of agriculture in terms of addressing the country's food security problem, which is one of the components of the country's economic security. Favorable conditions for the development of the agriculture of the NKR have been singled out. In the conditions of risky agriculture, the directions of forecasting, prevention and overcoming the consequences of risks were noted. The need to introduce an agricultural insurance system is emphasized.

Key words: *gross output, plant growing, animal husbandry, investments, agrarian policy, risks, insurance*

Introduction

Agriculture in the Republic of Nagorno Karabakh has an important strategic importance, first of all, in the context of the country's food security problem, which is one of the components of the country's economic security.

State regulation of agriculture is carried out through legislative, tax, credit and subsidizing forms. It is worth mentioning that at the present moment, those engaged in agriculture in Nagorno-Karabakh are in dire need of material and financial resources, the most efficient and perspective way of crediting is the state subsidies. This is explained by the fact that legislative regulation does not directly affect the agricultural resource capacity, the impact of the tax form is not significant with respect to existing privileges and mandatory payments.

The credit form should be provided here in the form of preferential lending of agricultural producers, as the commercial lending of agriculture today is a heavy burden on the risk. Thus, there is a need for a new system of state institutions for economic relations and agricultural support. This system should be flexible, respond to current agricultural requirements, to rapidly changing economic situations. The problem is to develop an optimal mechanism of economic relations between the state, agricultural producers and commercial structures.

By supporting the investment in agriculture, the state should first of all emphasize the need to allocate funds on the basis of repatriation that will lead to more efficient use of resources and investment activity.

The government implements agriculture crediting through the NKR Agriculture and Agricultural Support Fund, which provides preferential loans to economic entities. Unlike bank loans, interest rates on these loans are lower. Long-term loans are provided by the Fund. However, these loans are provided on a mandatory basis under a pledge that limits the borrower's access to these credit resources as they are pledged as collateral, in particular for real estate.

Conflict settings

It is necessary to elaborate a detailed leasing mechanism with the participation of commercial banks.

The NKR Village and Agricultural Support Fund provides leasing companies with equipment. In particular, the cost of one German combine harvester, including the cost of delivering to Nagorno-Karabakh, is 60.0 million drams. The soil cultivators are provided with leasing at 2/3 of the equipment, i.e. 40.0 million drams, with a 10% prepayment period of up to 5 years. Up to 5.0 million

drams worth of equipment are provided annually by 12 percent, 6 percent of which is subsidized by the state. Techniques with a value greater than 5.0 million are provided annually by 12 percent, of which 12 percent is subsidized by the state.

The situation in the Nagorno-Karabakh Republic has led to a sharp drop in the economy as well as the agro-industrial production. There are a number of problems that require urgent solution.

Gross agricultural output in 1995 has decreased for six times compared to the previous times in 1985. In 2012 it has reached and exceeded 1985 level, and in 2016 gross product grew only 1.4 times.

Gross agricultural output in 2016 made 68467.6 mln. drams, which, compared to the same period of the previous year, increased by 7.4%. The dominant share in its structure belongs to grain production - 29.8%, meat - 26.4%, milk - 15.0% [1].

Table1

Gross agricultural output [2]

Mln AMD

Years	In all branches of economics		
	Total gross product	Including	
		Plant breeding	Livestock
1985	47859,0	31108,0	16751,0
1995	7854.1	4278.4	3575.7
2012	50313.0	33262.9	17050.1
2013	55172.2	34901.0	20271.1
2014	57646.8	27949.3	29697.5
2015	64309.6	33293.4	31016.2
2016	68467.6	36024.2	32443.4

The steps towards agricultural reform related to the reorganization of the collective farms and the soviet farms, the privatization of the land and the development of land lease basics have allowed to lay the foundations for the development of the branch, the implementation of land reform.

Crisis phenomena in agriculture have arisen in the economy of the country and especially in the agrarian sector. The production potential has diminished, land fertility has declined, the state of pedigree cattle breeding and seed farming, agricultural machinery and equipment outdated, no land use rules and technological production proportions have been preserved.

The sharp reduction in the use of organic and mineral fertilizers has resulted in a deficit of nutritional substances, which, in turn, causes land degradation and fertility decline. Humus content in the soil continues to decline.

The former livestock complexes are not functioning and dismantled. Livestock production has been shifted to small farms. Production here is based on obsolete technology and mainly handmade.

The income level of most agricultural producers does not allow organizing the economy on the basis of reproduction, maintaining and updating the material base, timely repayment of debts to suppliers, bank loans and so on.

Rural roads rehabilitation is of great importance in the development of agriculture, which contributes to the social development of the village and the increase of agricultural productivity.

Problems arose in the scientific-educational system of the agrarian sector. An agrarian education, science and production co-operated system has not yet been formed. The material-technical base of scientific-educational institutions is weak. It is necessary to create prerequisites for effective agrarian scientific-educational system.

Many economists guarantee the use of this or that country's experience in justifying agrarian policy proposals. However, it is difficult to isolate the patterns and peculiarities of its implementation in the context of a market economy, depending on the political structure, national traditions, economic

development stages, nature conditions and so on. There is a need to generalize the whole international experience and choose the experience that will contribute to the implementation of the most effective agrarian policy.

Any state, based on the climatic conditions and the economic policy pursued, can implement an export-oriented agrarian policy or self-sufficiency policy.

In a number of western countries, they are aiming to fight with over-production, mainly for keeping the prices high, and in the NKR, in the village foodstuffs and imports should be reduced.

When defining support measures, it is important to take into account the existence of a state budget deficit, as a result of which many methods that are actively used by other countries are generally unacceptable.

The NKR agriculture is a low-productive and half-productive one. At the same time, conditions for the development of agriculture are favorable. NKR can completely satisfy its population with basic food products. It can also be exporting to other countries, not only in crop production, but also in livestock sector. Moreover, NKR can become a major food exporter.

As favorable conditions for development of NKR's agriculture can be distinguished.

• the land of agricultural significance per inhabitant, which is inaccessible to most other countries,

• soil fertility and climatic conditions, in case of proper agro-technical measures, are favorable for high yields, including fodder crops,

• construction of reservoirs and the existence of rivers will allow expanding irrigated lands where fruits and vegetables, technical crops will be grown, as well as to develop fishery in artificial reservoirs to ensure the demand for their own country,

• existence of exclusive conditions for multiple development of cattle breeding, huge massive pastures, the opportunity to receive all the crop cultivation at the expense of growing grain,

• more than half of the country's population lives in the surplus labor force. In the past, the population of Nagorno-Karabakh differed in its special diligence and love for its own land,

• the demand for food self-sufficiency in the Republic of Armenia is to allow the state to import as little as possible. In comparison with the NKR, the conditions for the development of agriculture in Armenia are not favorable and the Republic of Armenia will be able to solve its food problem through Nagorno-Karabakh. At the moment, the Republic of Armenia ensures more than half of the demand for the crop and livestock products of Nagorno Karabakh and grants an interstate loan of 2/3 of the NKR state budget to its scarce funds,

• the financial and professional potential of the Karabakhi people abroad can be used for mutual benefit both for the owner and for the Nagorno Karabakh Republic in agro-industrial complex.

Presently, the resolution proposed by P. Struewo at the beginning of the twentieth century: "If the state wants to consolidate ... land, then it can achieve that not only because it does not pursue the economic equality between peasants, but only by supporting its viable elements ... "[3, 527].

The review of the issues of state support for agriculture should be carried out using the deductive method by moving from macroeconomic level to microeconomic level step by step through partial claims of common ideas.

The need for the formation and use of certain cash-generating funds arises from the unwanted, unpredictable phenomena, the risk of reinsurance and active involvement of the insurance system in the agricultural sector. The role of insurance is significantly increasing, and its qualities and capabilities are particularly evident in the market economy. Insurance is a means of ensuring the continuity of people's welfare. However, mainly due to climatic conditions insurance companies avoid insurance of agriculture. The state should do the same, that is, to ensure that correct agro-technical measures are provided through consultation, and the anti-hail stations should also be studied and ensured by the reliable and efficient use of those plants. All this will be an impetus for insurance companies to actively participate in the insurance of agricultural risks.

Installation of anti-hail stations requires financial investment. Especially, the cost of procurement and installation of one anti-hail station is 5.0 million drams, and annual exploitation costs - 400.0 thousand AMD [4].

Conclusion

The following issues need to be addressed for the development of the plant cultivation of the Nagorno Karabakh Republic:

- gradual engagement of agricultural land plots that have been excluded,
- improvement of soil condition and fertility,
- solution of problems of cereal, vegetable, fodder crops and potato seeds and fertilization;
- stabilization and development of viticulture;
- establishment of pomegranate gardens;
- solution of sales and processing of agricultural products.

Activation of the recycling system and the increase in export volumes will contribute to the solution of the problems in the sale of agricultural products and increase the level of economic productivity. Positive shifts will be more significant if the problems of agriculture crediting and risk insurance have been completely resolved.

The functions of state regulation of agriculture are:

- assistance to melioration, irrigation, road construction and development of social infrastructure in the village;
- creation of legislative bases, ensuring free competition,
- monitoring and conservation of agricultural land;
- prevention of epidemic and quarantine diseases of livestock and plants;
- scientific and technical support of the sector, support for information and consulting services,
- food security,
- adoption of development programs and provision of conditions for their implementation;
- development of international cooperation and expansion of marketing opportunities [4].

Under the conditions of risky agriculture in NKR it is necessary to forecast, prevent and overcome the risks in the following directions:

- expansion of the anti-hail system;
- regulation of irrigation water use under drought and scarcity;
- investment of water saving technologies;
- investment of the agricultural insurance system.

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ԳՅՈՒՂԱՏՆՏԵՍՈՒԹՅԱՆ ԶԱՐԳԱՑՄԱՆ ՀԻՄՆԱԽՆԴԻՐՆԵՐԸ ԼՂՀ-ՈՒՄ

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Հոդվածում կարևորվում է գյուղատնտեսության ռազմավարական նշանակությունը երկրի պարենային ապահովության հիմնախնդրի լուծման տեսանկյունից, որը հանդիսանում է երկրի տնտեսական անվտանգության բաղադրիչներից մեկը: Առանձնացվում են ԼՂՀ գյուղատնտեսության զարգացման բարենպաստ պայմանները: Նշվում են ԼՂՀ ռիսկային գյուղատնտեսության պայմաններում ռիսկերի կանխատեսման, կանխարգելման և հետևանքների հաղթահարման ուղղությունները: Հատկապես կարևորվում է գյուղատնտեսության ապահովագրական համակարգի ներդրման անհրաժեշտությունը:

Բանալի բառեր. Համախառն արտադրանք, բուսաբուծություն, անասնաբուծություն, ներդրումներ, ագրարային քաղաքականություն, ռիսկեր, ապահովագրություն

ОСНОВНЫЕ ПРОБЛЕМЫ РАЗВИТИЯ СЕЛЬСКОГО ХОЗЯЙСТВА В НКР

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*В статье подчеркивается стратегическое значение сельского хозяйства с точки зрения решения проблемы продовольственного обеспечения страны, которая является одним из компонентов экономической безопасности страны. Выделены благоприятные условия для развития сельского хозяйства НКР. В условиях рисково*го сельского хозяйства отмечены направления прогнозирования, предотвращения и преодоления последствий рисков. Особо подчеркивается необходимость внедрения системы сельскохозяйственного страхования.*

Ключевые слова: валовая продукция, растениеводство, животноводство, инвестиции, аграрная политика, риски, страхование

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Sheet format A4, margins up , down 15mm, left 30 mm, right 20 mm.
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1. The title of the article is given in the article's submitted language, in capital letters, in Armenian 11, Russian and English 12 bold font size at the right bottom of the page.
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9. The formulas are presented in separated lines, in the middle and are numbered on the right, in brackets. The formula , as well as math's symbols and expressions are given in the text in Microsoft Equation, Italic 10 font size.
10. There can be found pictures, diagrams , graphs and tables in texts. The pictures and diagrams are numbered by transit numbering by sign "Figure". The description of pictures, diagrams , the names of pictures , diagrams graphs and the signs of description are given below. They can be placed vertical or horizontal in Armenian 9,Russian and English 10 bold font. Tables are numbered by "Table" transit numbering. The names of tables , sign description are given above. They could be placed vertical or horizontal. If the table can't be placed on a single page, it must be transferred to the other page and mentioned as condonation. In table column must not be left free lines, there must be put dash or write " not" ("determined").
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Հոդվածների հեղինակային օրինակների ձևակերպման համար ներկայացվող պահանջներ

Հոդվածները կարելի է ներկայացնել հայերենով, ռուսերենով և անգլերենով՝ մինչև 14 էջի ("Էկոնոմիկա" խորագրով՝ մինչև 24 էջի) սահմաններում. էջի ֆորմատը՝ A4, լուսանցքները՝ վերևից, ներքևից՝ 15մմ, աջից՝ 30մմ իսկ ձախից՝ 20 մմ. Տառատեսակը հայերեն՝ Unicode /GHEA Grapalat/, ռուսերեն և անգլերեն՝ Times New Roman. Միջտողային հեռավորությունը՝ 1,15:

1. Էջի վերին աջ անկյունում, հոդվածի ներկայացման լեզվով, գլխատառերով՝, հայերեն՝ 11, ռուսերեն և անգլերեն՝ 12 **bold** տառաչափով տրվում է հոդվածի խորագիրը:
2. Հաջորդ տողի էջի ձախ անկյունում տրվում է ՀՏԴ-ն՝ առնվազն վեցանիշ թվով:
3. Դրանից մեկ տող ներքև, մեջտեղում, հոդվածի ներկայացման լեզվով գլխատառերով դրվում է վերնագիրը՝ հայերեն՝ 12 **bold**, ռուսերեն և անգլերեն՝ 14 **bold** տառաչափով:
4. Երկու տող ներքև, ձախից, հոդվածի ներկայացման լեզվով, հեղինակի (հեղինակների, որոնց թիվը, որպես կանոն, չի կարող գերազանցել 4-ը) Անվան, Հայրանվան սկզբնատառերը և Ազգանունը՝ հայերեն՝ 11, ռուսերեն և անգլերեն՝ 12 **bold** տառաչափով:
5. Մեկ տող ներքև, ձախից, հոդվածի ներկայացման լեզվով, շեղատառերով (*Italic*) տրվում է կազմակերպության (կազմակերպությունների) անվանումը՝ հայերեն՝ 9, ռուսերեն և անգլերեն՝ 10 տառաչափով:
6. Անջատելով տեքստը հորիզոնական հոծ գծով՝ էջի ձախ անկյունից, հոդվածի ներկայացման լեզվով, տրվում են Բանալի բառերը (5-8 բառ)՝ հայերեն՝ 10, ռուսերեն և անգլերեն՝ 11 տառաչափով:
7. Երկու տող ներքև, հոդվածի ներկայացման լեզվով, մեջտեղում, շեղատառերով (*Italic*), գրվում է հոդվածի համառոտագիրը՝ 10-20 տող՝ հայերեն՝ 9, ռուսերեն և անգլերեն՝ 10 տառաչափով:
8. Երկու տող ներքև ներկայացվում է հոդվածի հիմնական տեքստը՝ հայերեն՝ 10, ռուսերեն և անգլերեն՝ 11 տառաչափով: Պարբերությունները սկսվում են նոր տողից՝ 10 մմ խորքից: Երաշխավորվում է նյութի շարադրման հետևյալ սխեմա. «***Ներածություն***», «***Խնդրի դրվածքը***», «***Հետազոտության արդյունքները***», «***Եզրակացություն***»: Անհրաժեշտության դեպքում կարող են լինել նաև այլ բաժիններ՝ համապատասխան վերնագրերով:
9. Բանաձևերը ներկայացվում են առանձին տողով, մեջտեղում և համարակալվում են աջ մասում, փակագծերի մեջ: Բանաձևերը, ինչպես նաև տեքստում տեղադրվող մաթեմատիկական սիմվոլներն ու արտահայտությունները տրվում են Microsoft Equation-ով, Italic՝ 10 տառաչափով:
10. Տեքստում կարող են լինել նկարներ, գծապատկերներ, գծագրեր և աղյուսակներ: Նկարները և գծապատկերները համարակալվում են միջանցիկ համարակալմամբ՝ «**Նկ.**» նմուշառմամբ: Նկարների, գծապատկերների, գծագրերի անվանումները, նշանակումների բացատրությունները տրվում են ներքևում: Դրանք կարելի է տեղադրել ուղղաձիգ կամ հորիզոնական դիրքով՝ հայերեն՝ 9, ռուսերեն և անգլերեն՝ 10 **bold** տառաչափով: Աղյուսակները համարակալվում են միջանցիկ համարակալմամբ՝ «**Աղ.**» նմուշառմամբ: Աղյուսակների անվանումները, նշանակումների բացատրությունները տրվում են վերևում: Դրանք կարելի է տեղադրել ուղղաձիգ կամ հորիզոնական դիրքով: Եթե մեկ թերթի վրա աղյուսակը չի տեղավորվում, պետք է շարունակել մյուս թերթի վրա՝ նշելով, որ շարունակությունն է: Աղյուսակի սյունյակներում ազատ տեղեր չպետք է մնան. պետք է դնել գծիկ կամ գրել «չկա» («չի որոշված»):
11. Նկարները, գծապատկերները, գծագրերը էլեկտրոնային տարբերակով, որպես օրենք, տրվում են գունավոր տարբերակով:
12. Հոդվածի վերջում, երկու տող ներքև, ձախից՝ 10 մմ խորքից տպագրվում է «**Գրականություն**»՝ հայերեն՝ 11, ռուսերեն և անգլերեն՝ 12 **bold** տառաչափով: Մեկ տող ներքև ներկայացվում է գրականության ցանկը՝ համարակալված ըստ հղումների հերթականության: Ցանկում աղբյուրները պետք է նշվեն [...] տեսքով և ընդգրկեն՝ հեղինակի/ների/ ազգանունը և անվան /Հայրանունի/ առաջին տառը /երը/, նյութերի լրիվ անվանումը, հրատարակության տվյալները /տեղը, հրատարակչությունը, քաղաքը, տարեթիվը, հատորը, էջերը/: Տեղեկատվական պաշտոնական, այդ թվում՝ էլեկտրոնային աղբյուրների, համակարգչային ծրագրերի, հաշվետվությունների, հրահանգների, հեղինակային իրավունքի արտոնագրերի, պատենտների դեպքում ներկայացվում են լրիվ տվյալները: Աղբյուրները բերվում են բնօրինակի լեզվով: Միևնույն ժամանակ, հայերեն և ռուսերեն աղբյուրները ներկայացվում են նաև լատինատառ շարվածքով:
13. Առանձին էջերի վրա տրվում է հոդվածի գլխամասի և համառոտագրի թարգմանությունը (բացի հոդվածի ներկայացման լեզվի)՝ հայերեն, ռուսերեն (Резюме) և անգլերեն լեզուներով (Summary):
14. Հոդվածները պետք է ուղարկել info@bulletin.am էլ. հասցեով:
15. Տեքստի խմբագրված և սրբագրված տարբերակը համաձայնեցվում է հեղինակ(ներ)ի հետ:
16. Առանձին թղթի վրա տրվում է հեղինակների մասին տվյալները (Ազգանուն, Անուն, Հայրանուն (ամբողջական), լուսանկարը, գիտական աստիճանը, գիտական կոչումը, հասցեն, հեռախոսը, կազմակերպությունը, զբաղեցրած պաշտոնը, էլեկտրոնային հասցեն):

Требования, предъявляемые к оформлению авторских образцов статей

Статьи можно представить на армянском, русском и английском языках объемом до 14 страниц (статьи под рубрикой "Экономика" до 24 страниц)
Формат страницы: А4, поля сверху, снизу 15 мм, справа 30мм и слева 20мм
Шрифт армянский - Unicode/GHEAGrapalat/, русский и английский - TimesNewRoman. Междустрочное расстояние - 1,15

1. В верхнем правом углу страницы заглавными буквами (на языке статьи) записывается название рубруки по шрифту: армянский – 11 **bold**, русский и английский - 12 **bold**.
2. На следующей строке в верхнем левом углу страницы записывается УДК (минимум шестизначное число).
3. На следующей строке набирается заголовок статьи заглавными буквами по центру по шрифту: армянский – 12 **bold**, русский и английский - 14 **bold**.
4. Две строки ниже, слева, на языке статьи набирается фамилия и инициалы автора (соавторов, как правило, не более 4 человек) по шрифту: армянский – 11 **bold**, русский и английский - 12 **bold**.
5. На следующей строке, слева, на языке статьи курсивом (*Italic*) дается название организации (организаций) по шрифту: армянский - 9, русский и английский - 10.
6. Отделив текст горизонтальной выделенной линией, слева даются ключевые слова (5-8 слов) по шрифту: армянский - 10, русский и английский - 11.
7. Две строки ниже, на языке статьи, по центру курсивом (*Italic*) дается аннотация (10-20 строк) по шрифту: армянский - 9, русский и английский - 10.
8. Две строки ниже, дается основной текст статьи по шрифту: армянский - 10, русский и английский - 11. Абзацы начинаются с новой строки с отступом 10 мм. Рекомендуется следующая схема изложения материала: "Введение", "Постановка задачи", "Результаты исследования", "Заключение". В случае необходимости могут быть также другие разделы с соответствующими названиями.
9. Формулы располагаются отдельной строкой по центру и нумеруются в правой части в скобках. Формулы, а также математические символы и выражения приводятся по “MicrosoftEquation”, курсивом (*Italic*) по шрифту - 10.
10. В тексте могут быть рисунки, графики, чертежи и таблицы. Рисунки и графики нумеруются по порядку - "Рис.". Названия рисунков, графиков, чертежей, объяснения обозначений приводятся снизу. Их можно расположить в вертикальном или горизонтальном положении по шрифту: армянский - 9 **bold**, русский и английский - 10 **bold**. Таблицы нумеруются по порядку - "Таб.". Названия таблиц, объяснения обозначений приводятся сверху. Их можно расположить в вертикальном или горизонтальном положении. Если таблица не помещается на одной странице, нужно продолжить ее на следующей странице, отметив, что это продолжение данной таблицы. В таблице не должно быть свободных столбцов, в этом случае нужно поставить черточку или написать "нет" ("не определено").
11. Рисунки, графики и чертежи в электронной версии, как правило, приводятся в цветном варианте.
12. В конце статьи, через две строки, с отступом слева 10 мм печатается "Литература" по шрифту: армянский - 11 **bold**, русский и английский - 12 **bold**. На следующей строке приводится список использованной литературы, пронумерованный по последовательности ссылок. В списке источники должны указываться в виде [...] и включать фамилию и инициалы автора (авторов), полное название статьи (материала), данные публикации (место, издательство, город, год, том, страницы). В случае официальной информации, в том числе электронных источников, компьютерных программ, отчетов, инструкций, сертификатов об авторских правах, патентов, приводятся полные данные. Источники приводятся на языке оригинала. В то же время армянские и русские источники печатаются также латинскими буквами.
13. На отдельных листках дается перевод названия статьи, фамилии и инициалов автора (авторов), названия организации (организаций), ключевых слов и аннотации (кроме языка статьи) на армянский язык (Ամփոփում), русский язык (Резюме) и английский язык (Summary).
14. Статьи нужно отправить на почту info@bulletin.am.
15. Отредактированная версия текста согласовывается с автором (авторами).
16. На отдельном листе приводятся сведения об авторах (Фамилия, Имя, Отчество (полностью), фотография, ученая степень, ученое звание, адрес, номер телефона, организация, занимаемая должность, адрес электронной почты).

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