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OBSERVATIONS OF THE STAGES OF CUTTING THE STEM WITH A KNIFE OF A DISK CHOPPING APPARATUS

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Abstract. In this scientific article, it is analyzed that the results of the analysis of the process of cutting the stem with a disk-shaped knife, taking into account the physical and mechanical properties of stalk feed. The shell of corn stalks grown in the hot climate of our country is thicker and harder, and its coefficient of friction is somewhat lower. The smaller the angle of friction, the more difficult it is to clamp such a rigid piece of rod between the active and fixed blades. To avoid this condition, the stem must be pinched and sheared between the active blade and the passive blade. On the basis of kinematic studies, the conditions for ensuring the sliding of the rod along the blade of the grinding knife are determined in the work. Based on the physical and mechanical properties of corn stalks, the conditions for ensuring the sliding movement of the stalk along the chopper knife blade are considered.

Key words: stalk, corn, solid body, warm climate, apparatus, blade, active, passive, friction, cutting

Introduction. It is known that the characteristics of crop products grown in the hot climate of Uzbekistan differ from the characteristics of products grown in European conditions. The shell of corn stalks grown for grain in our republic is thicker and harder, and in our experiments it was found that its coefficient of friction with metal is somewhat lower [1]. As a result of initial observations, a part of the corn stalk from the root side (12-15 cm) has a hard shell, which makes it somewhat difficult for the knife blade to penetrate. Due to the fact that the friction angle is less by 3-4°, such a part of the stem does not suddenly stop being pinched between the active and fixed knives, and sliding towards the edge of the fixed knife increases, which makes it difficult to grind such a hard part. To prevent such a situation, we adopted the idea (hypothesis) that it would be better to slightly curve the rectilinear shape of the actual knife blade forward. A number of scientists from foreign countries and in our country conducted research on the theoretical study of the process of grinding stems [2,3,4]. We will carry out a kinematic study of a disk multi-knife grinding apparatus according to the method of prof. S. Melnikova [5].

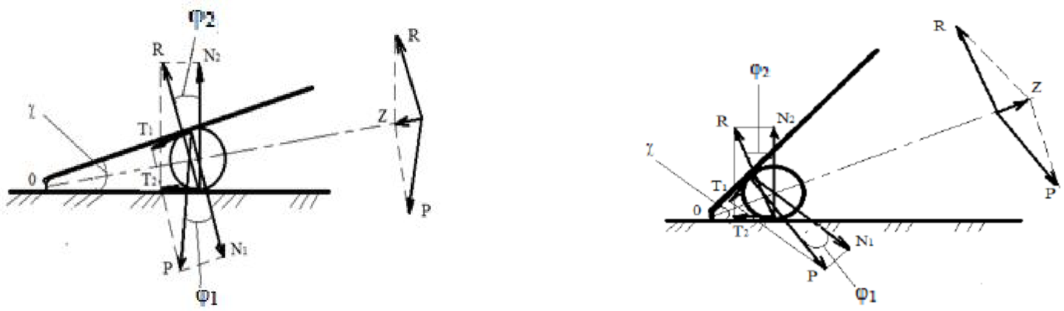
Object and methods of research. The process of grinding a rough stem is associated with cutting the stem. To grind the stem, it is necessary to ensure that the knife blade slides relative to the stem until we reach its clamping between the active knife blade and the passive knife blade. This can be explained by the diagram in Figure 1.

The pinched blades exert pressure on the body to be ground by normal forces N_1 and N_2. If the angle between the blades χ is less than the sum of the angles of friction between the body and the blades φ_1 and φ_2, i.e.

$$\chi \leq \varphi_1 + \varphi_2 \quad (1)$$

To reduce the deformation of the elastic wedges, the belt needs to make the roller run over the initial section of the belt with a minimum angular velocity, i.e. with a minimum moment of inertia of the compressed body stops there (Figure 1, a), since the friction forces between the blades and the body oppose the outward movement of the body: $T_1 = N_1 f_1$ and $T_2 = N_2 f_2$ are directed towards point 0, due to which the stem cannot withstand the pressure of the blades N_1 and N_2, break the fibers in the bark of the stem and cut off the body.

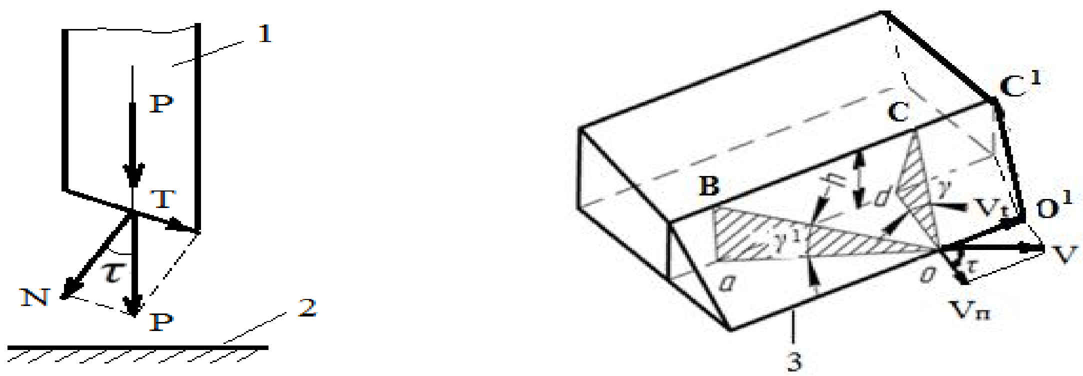
If $\chi > \varphi_1 + \varphi_2$, (Figure 1, c) the force Z acts in the opposite direction and forces the body to come out between the blades. Therefore, the angle χ is called the pinch angle. We will take this rule into account later when determining the dimensions of the knife.



a) *b)*

Figure 1. Schemes for determining the pinching of the stem between a pair of knives (*a*) and the resulting force Z to push it out of there (*b*)

It is determined that $\chi = 40 - 50°$ for stems grown in European conditions.



a) *b)*

Figure 2. *a*-the occurrence of a tangential force T to ensure sliding; *b*-position as if a knife is sharpened a lot; 1-knife; 2-cut body; 3-blade

Let us investigate the second condition necessary for a sliding cutting body. Based on the kinematic study, we determine the conditions for ensuring the sliding cutting of the stem along the blade of the chopper knife.

With sliding cutting, firstly, it seems that the geometric parameters of the knife cross section have changed (Figure 2, *b*). In sliding cutting (Figure 2, *a*), if the cut body receives pressure P from the knife and divide it into forces T along the blade and N along the normal to the blade, then it follows that the angle τ is necessarily less than the angle of friction φ.

With sliding cutting, the knife blade acts on the body not in the *CO* direction, but in the *BO* direction (Figure 2, *b*). As a result, the knife blade seems to be sharpened at an angle γ_1, which is smaller than the angle γ. This ensures that the knife is more easily embedded in the body. In addition, during sliding cutting, the burrs constantly present on the blade, like the teeth of a saw, alternately cut the stem fibers, reducing energy costs. Like an ax, chopping a body uses more energy to cut through all the fibers at once.

The scheme of the improved apparatus is shown in Figure 3. The screw is installed on the disk in the continuation of the shaft. The rectilinear blade of the knives is 20 degrees bent backwards relative to the radial direction. This position provides a sliding cut. The active knife moves along the gap between a pair of fixed knives. A gap of 0.5-1.0 mm is left between active and inactive knives. As a result, the stalk that falls on the fixed knives is cut with a two-support method (Figure 3).

The scheme of two reference cutting and deformations arising in the stem, the acting forces are taken from the works of S.V. Melnikov [5]. The diagram shows the work process as a wedge on both sides of a sharpened knife. In the choppers IKV-F-5A or Volgar-5A studied by us, the blade of the knives is not sharpened (Figure 3, *a*), the thickness of the blade is 5 mm, they form an angle of 90 ° to the sides. This position of the needle causes the stem to be cut to slide along the fixed blades. Such execution of a knife gives the chance on the cut material the sliding movement. As a result, sliding cutting is performed, according to the scheme of Fig. 3*b*, the active knife cuts like a punch [6-9].

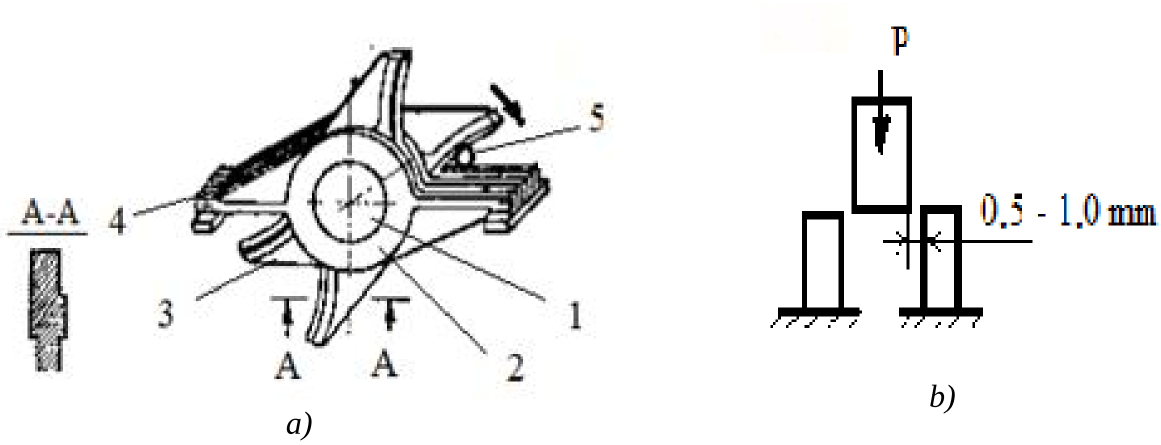


Figure 3. Cutting apparatus of the chopper IKV-F-5A

a-general view; c-scheme of the introduction of an active knife into the gap between passive knives: 1-shaft of the driven pulley; 2-disk; 3-knives installed on the disk; 4-fixed knives and slots created by them; 5-stem pinched between active and passive blades

In our case, we believe that the main factors in cutting the stem are the sliding cutting mode, with the pressure of the blade on the stem. Because our main goal is to grind the rough, tough stalk into small sizes for comfortable eating by animals. To study the process carried out by the disk-shaped multi-knife apparatus under study, we will conduct a kinematic and dynamic study of this apparatus (figure 4).

Research results and discussion. On the pinched stem C between the knife blade, rotating around the axis *O* with a constant angular velocity ω and a stationary passive blade, it acts with normal pressure *N*. If the coefficient of friction between the knife and the stem f is known, then the tangential force $T = Nf$ acts on *C*. Due to the sliding of the knife blade along the stem, the opposite total resistance force *R* will arise, the resultant force *P* acting on *N* and *T*.

Due to the sliding of the knife blade, the resultant force *R* changes its place of action, i.e., the stem *C* changes its position as it slides along the blade from a to b. The minimum radius vector rmin increases with respect to *O* and reaches r max. Thus, even if the magnitude of the resistance forces does not change, due to a change in the force arm r, the moment of resistance on the shaft *M=Rr* increases. The power consumption increases.

Taking this situation into account, we accepted our hypothesis outlined above. In fact, if a very hard and rough stem reaches the end of the blade without breaking, the amount of force N required to break it increases. As a result, *R* also increases and increases the moment *M*. Thus, a sliding cut must be ensured, but the stalk must be cut short of sliding towards the center of the passive knife.

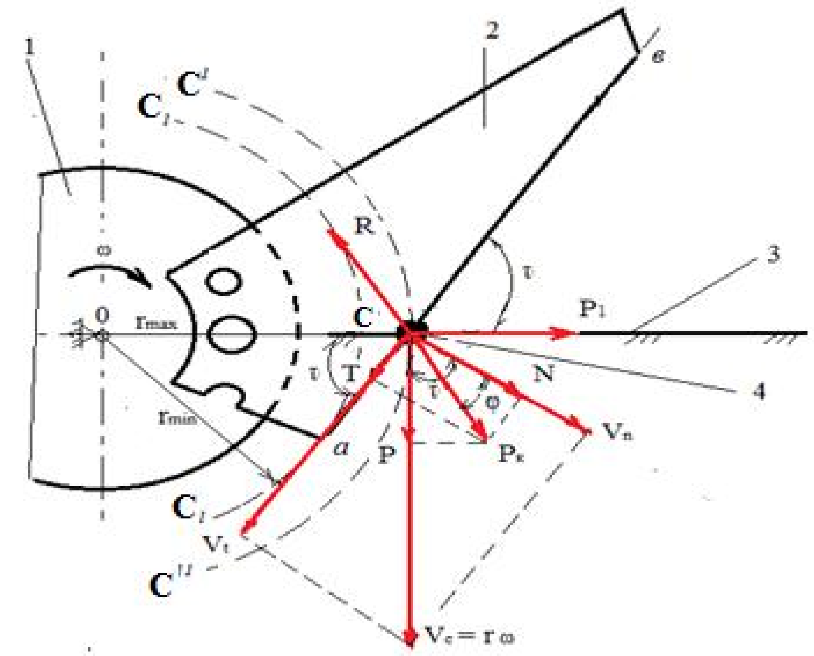


Figure 4. Scheme of the action of the forces of the knife of the grinding apparatus on the stem. 1-knife fixed disc; 2-knife; 3-fixed passive knife; 4-place of the initial meeting of the stem with the knife blade; C_1- at the end of cutting

The sum of the resistance forces arising at point *C* is equal to R, but the knife must act in the opposite direction with the force *Pк*. The rotational force P, component *P к*, is directed perpendicular to the radius vector r. A force P_1 appears, acting in the direction of the radius vector.

Under the action of the rotational force *P*, point C will be shifted along its trajectory C_1-C^{11} , then the force P $_1$ will press the stem against the passive knife. The angle between the radius vector rmax and the active blade a-b is called the slip angle.

The rotation speed *Vc =rω* of point *C* indicates the cutting direction. We find the direction *Vt* along the blade by dividing *Vc* by the normal *Vn* and the tangential velocity *Vt*. If the blade is curved (in our hypothesis it should be a piece of the Archimedean spiral), then the curve Vt will be tangent to the curved blade. The angle between the vectors *Vn* and *Vc* is equal to the glide angle *τ*. That *tg τ* - denotes the ratio of *Vt* to *Vn*, that is, the slip coefficient $\mathcal{E}$:

$$\mathcal{E} = tg\tau = V_t \,/\, V_n \quad (2)$$

The force P_k relative to the force of normal pressure N will be rotated by the angle of friction φ. If we divide the force R by the normal force N and by the tangential force T directed along the blade, then the angle between N and P_k will be equal to φ. Then,

$$T/N = f_1 = \text{tg}\ \varphi. \quad (3)$$

Based on the results of the study, the following conclusions can be drawn.

Conclusions. To reduce energy consumption, the blade of the knife should slide over the stem to be cut.

The section on which the resistance force *Rq* acts, acting on the blade as a result of sliding, shifts towards the end of the blade, its shoulder increases relative to the center of the disk, and the torque increases. The resistance acting on the shaft increases.

The knife, working as a punch, not only cuts the bark of the stem, but also grinds the material inside the bark, i.e., does positive work.

The rhizomes of corn stalks grown in hot weather are very hard. The active blade cannot cut it right away. The stem glides over the blade with a long glide. The moment of resistance increases. Therefore, in order to reduce the sliding process when cutting such a stem, it is preferable that the blade be made in the form of an Archimedean spiral directed towards the stem, rather than a straight line.

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RESEARCH THE PARAMETERS OF THE DISC CHOPPING APPARATUS OF THE FEED CHOPPER

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Abstract. In this article it is described that the results of a study in the kinematics and dynamics of a multi-blade disc cutting device. In the advanced hardware scheme, the clipping process is performed as punches. We have a straight blade edge rotated 20^0 degrees back from the radial direction. As a result, the sliding motion process is reduced and the trunk is easily cut. For this reason, it is advisable to reduce the sliding process when cutting a hard stem, and it is preferable that the blade be made in the form of a hyperbolic spiral, and not an Archimedes spiral, the curvature of which is directed towards the stem, and not in a straight line. Kinematic and dynamic studies performed on a multi-knife disk shearing device accelerate the technological process of the device, increase the pressure of the blade on the trunk, and make it possible to cut it intensively.

Key words: apparatus, blade, stalk, corn, disk, straight, curved, kinematics, dynamics, pinching, knife length.

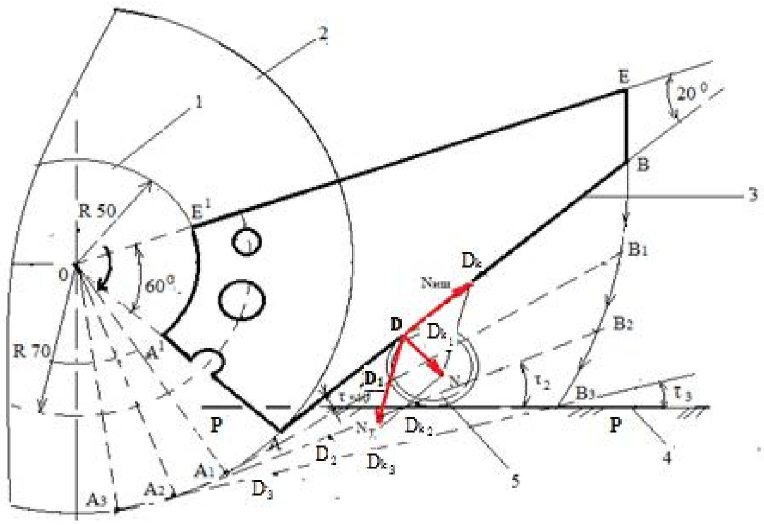
Introduction. At present and in the near future, the main method of processing feed raw materials for animal husbandry will be mechanical. At the same time, the effectiveness of various methods of feed processing (grinding, cutting, crushing, etc.) depends on the most convenient use of the physical and mechanical properties of the crushed raw materials when choosing operating modes and parameters of the corresponding working bodies of machines and mechanisms. Studies of the physical and mechanical properties of fodder crops and the process of their grinding can be the basis of the works of a number of scientists [1, 2, 3, 4, 5, 6, 7, 8, 9, 10].

Object and methods of research. On figure. 1 shows a diagram of the active knife 3 installed on the disk 2 of the grinding apparatus. This shows the position of the insertion of the active blade

A-B into the gap of the fixed knife blade *P-P*.

The angle between the blades is $t=40^0$, and the conditions being cut to the stem 5 are clamped in it, since the angle τ is less than the sum of the angle of friction φ_1 between the stem and the active blade and the angle of friction φ_2 between the fixed blade and the stem, that is, $t<\varphi_1+\varphi_2$.

Due to the rotation of the active blade *A-B* around the center O, it sequentially assumes the position A_1-B_1; A_2-B_2; A_3-B_3. As a result, the stem slides along the blade *A-B*, cuts the bark of the stem and grinds the internal soft substances. After position A_3-B_3, the knife continues to rotate at idle and again returns to position *A-B*, the cycle repeats.



1-drive shaft; 2-disk; 3-blade of the active knife mounted on the disk; 4-blade fixed knife; 5-initial position of the stem pinched between the blades

Figure 1. Scheme cutting a pinched stem between a fixed knife and an active knife *A-B-E-E¹-A¹* of the chopping apparatus

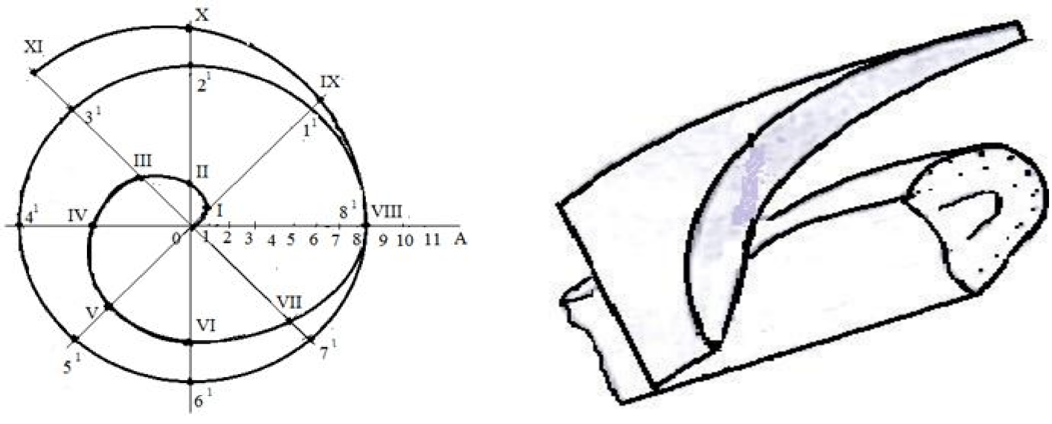
Above it was determined that the coefficient of friction on steel is lower by $\Delta\varphi=3\text{-}4^0$ due to the fact that the shell of the lower root part of the corn stalk grown in the hot weather conditions of our republic is more solid compared to the stalk ripened in European conditions.

If such a part of the stem is not immediately cut off when meeting point *D* of the knife, the knife blade slides along the surface of the stem and cuts the bark fibers one by one, like a conventional saw, creating conditions for plunging the blade into the stem and crushing it until it reaches position A_3-B_3, The stem is cut off part D-D_k of the knife blade will reach the position D_3-D_{k3}. At the point *D* of the stem, the forces N_{work} and $N\tau$ act, resulting in the offset of the action of the pressure force *N*.

The reason for the change in the shape of the knife blade is that the angle of friction of corn stalks grown in hot and dry climates is 4° less than that accepted in the literature. A stem like in Figure. 1, is pinched at $\tau_1=36^O$ instead of $\tau=40^O$, that is, instead of the blade part D- D_κ, another part located far from the center of rotation 0 works. The lever of force *N* will be greater relative to 0, the required moment $M\ ^1b$ will be greater than in the first case, it will be consume more power. Therefore, we came to the conclusion that it is better to change the shape of the *D-B* section of the knife blade: the section *DB* of the knife blade after point *D* should be slightly bent towards the rod, and not be straight. Then pinching the stem is not tightened, the length of the blade will be used effectively.

In literary sources, scientists such as Melnikov S.V., Reznik N.E. [3, 4] recommended that the shape of the blade be made the optimal part of the Archimedean spiral. A. A. Vertiy [6] made a knife in the shape of an Archimedes spiral and tested it (Figure 2). The curvature of the blade is based on a full Archimedean helix, which suddenly reduces the sliding cut of the blade.

We believe that it is better to make the part of the knife blade *AD* (Figure. 1) effectively proven by many years of practice straight and keeping the inclined part by 20° in the radial direction *O-E*, only the *D-B* part to be made curvilinear. We believe that a hyperbolic spiral, rather than an Archimedes spiral, is effective for such a solution.



a *b*

a-standard Archimedean spiral; b-examined knife

Figure 2. Spiral of Archimedes and view on the base of his made knife

In figure 3, the hyperbolic spiral is drawn using a circle whose radius is equal to the radius of the disk on which the knife is mounted. The goal is to select a specific part of this curve as the shape of the knife blade. We chose its part *A-C-B*, and we believe that in this form it will be effective to use the chopper knife blade, since the straight line *A-C*, tending to the asymptote of a hyperbolic spiral, overlaps the part of the blade *A-D* in Fig. 1 that after the point *D*, the part *D-B* will be replaced by the curvilinear part of the spiral *C-B*. Most importantly, the degree of curvature of S-V does not change sharply relative to the straight line *A-C*, the tangent drawn through the point V is inclined by 4° relative to the asymptote. This is consistent with our goal of reducing the blade slip angle to 4° [6].

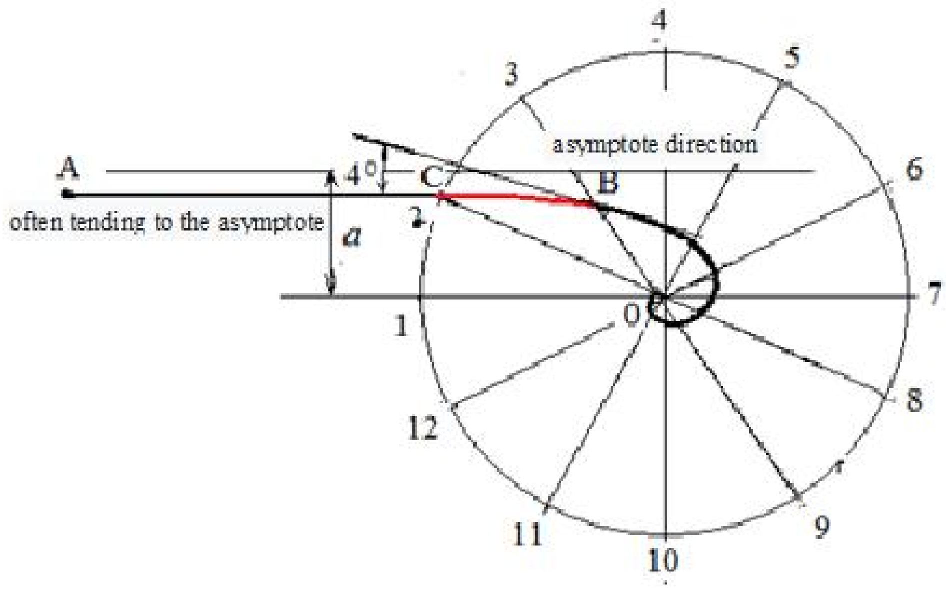


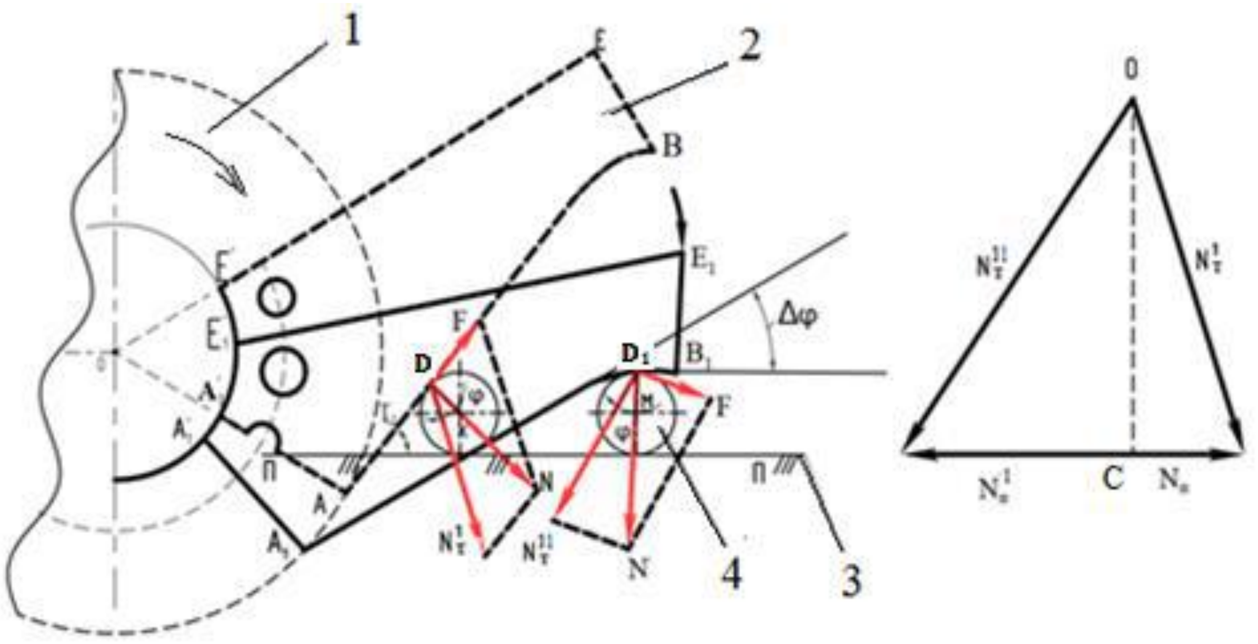
Figure 3. Scheme for constructing a curved line *A-C-B* of a hypervolic spiral

The hyperbolic spiral shape occurs when a point moves in a straight line in a circular motion, and its distance from the center of rotation varies inversely with the angle of rotation. The angle of rotation is defined relative to the starting radial line. The spiral equation is taken as $r\varphi=\alpha$. Here α is the distance of the spiral asymptote line from the center of rotation; φ-angle of rotation; r - radial arm of the point position.

For the initial case $\varphi=0$, naturally $r=0$. The asymptote line B-C is drawn from the center at a distance a parallel to r_1 (Figure 4). Point 0 is the asymptotic point of the spiral where the curved line can never reach. A circle is drawn around 0 plus the pole, which is divided into several equal parts and denoted by 1,2,3 ... and radial lines are drawn from the pole. In radial lines, the radii r_1, r_2, r_1... are calculated using the formula $r_i=\frac{an}{2\pi(i-1)}$. In this case, n is the number of parts divided around the circle; i-number of the next radius. For example, $r_1=\infty$; $r_2=\frac{an}{2\pi}$; $r_3=\frac{an}{4\pi}$ etc. With the help of radii, points I, II, III, IV and ... X of the spiral are indicated and they are connected by a curved line.

If the part E-B of the improved knife is replaced by the improved blade with the E_1-B_1 curve, the technological process performed by the knife will practically not change (Figure 4).

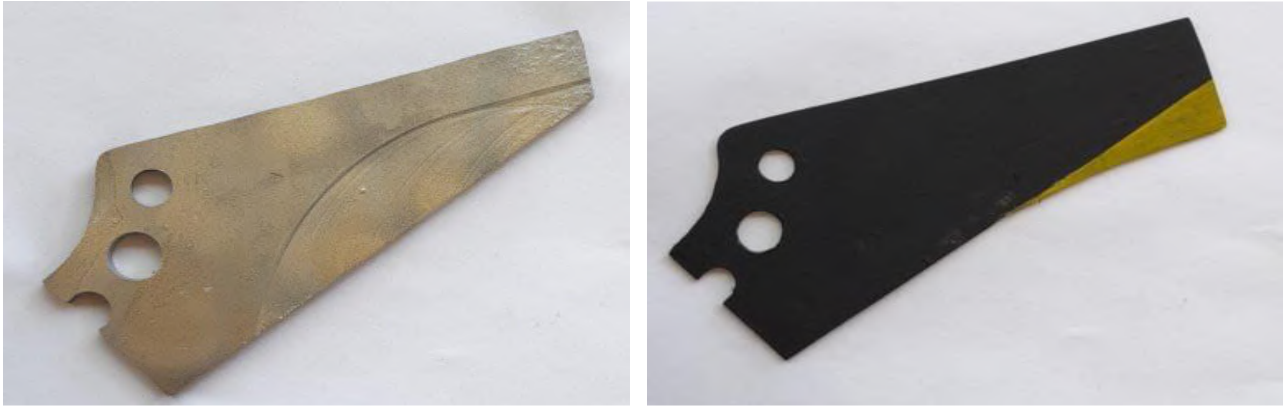
Research results and discussion. On figure 4 schematically shows the forces on the blade AB of the improved knife acting on the stem being cut. Normal pressure N (represented by dotted lines) that compresses the stem at point D on the straight part of the blade. It depends on the friction force F and the sum of the forces N and F, i.e. forces Nt, which are directed against the movement of the blade along the barrel. We assume that the stem should be pinched on the blade to point B. If we find the projections of the force vectors N_T^1 and N_T^{11} on the straight line connecting their ends, then it can be seen that the projection $N_п^1$ is longer than the projection $N_п$.



1-disk; 2-active knife; 3-fixed knife; 4-stalk sandwiched between blades

Figure 4. Scheme of forces acting on the blade of an improved knife

On figure 5 shows a drawing showing the difference between an improved knife made according to the results of research and between a real knife of the IKV-F-5A machine.



a) *b)*

a-blade of an existing knife; *b*-blade of an advanced knife

Figure 5. Drawing indicating the difference between the improved knife made according to the results of research and between the real knife of the IKV-F-5A machine

Therefore, it can be concluded that the stalk will pinch, stopping before the end of the blade B_2. Therefore, more slippery stems will not come off the fixed knife without being crushed, which has a positive effect.

Conclusions. The shell of the lower part of the corn stalks grown in the hot and dry climate of our republic is hard, and the friction angle with steel is 3-4^0 less than that accepted in the literature. In order to make the sliding cutting process more efficient with less energy consumption, it is recommended to change the blade shape of the moving knives.

Kinematic and dynamic studies performed on a multi-knife disc grinder made it possible to determine the parameters that must be taken into account to improve the grinder technological process.

Improving the shape of the chopper knife of the machine in the form of a hyperbolic spiral accelerates the process of sliding cutting, increases the pressure of the blade on the stalk, makes it possible to intensively chop it.

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CREATING AND INTRODUCING OF A CULTIVATOR FOR SOIL TREATMENT ROWS AND ROWS OF VINEYARD

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Abstract. In this article it is described that the results of theoretical and experimental reserch on finding the optimal scheme of a cultivator for tillage in vineyards, providing high-quality tillage with minimal energy consumption. The basic parameters of the machine and working bodies are substantiated. Analyzing and comparing the average indicators of traction resistance depending on the speed when cultivating inter-bush strips and row spacing, as well as cultivating only row spacing when working on heavy soils, we will determine with sufficient accuracy their difference for the actual values of the lateral universal working bodies of the UK-3 machine. The values of traction resistance for two working bodies operating in adjacent rows of inter-bush strips of vineyards, at the corresponding speeds of 1.45; 1.55; 1.75 and 1.95 m/s will be 0.25; 0.50; 0.65 and 1.20 kN. Thus, the results of the energy assessment of the traction resistance of the side rotary working bodies in contact with the root stem of the vineyard bushes give reason to consider the optimal speed of movement in the range of 1.48-1.60 m/s in order to avoid damage to the root system of the vineyards.

Key words: tillage, energy consumption, vineyard, speed of movement, land pots, soil, weed free, cultivator

Introduction. Large-scale measures are being taken in the republic to reduce labor and energy costs, save resources using advanced technologies and develop high-performance agricultural machines in the production of grapes. The Action Strategy for the Further Development of the Republic of Uzbekistan in 2017-2021, in particular, outlines the tasks of "...increasing the gross domestic product by more than two times by 2030, ... further strengthening food security, expanding production of environmentally clean production, rational use of land and water resources, the introduction of modern intensive agricultural technologies, the increase in orchards and vineyards by optimizing the sown area by reducing land plots for cotton and wheat in 2017-2020" [1,2].

In the program to increase the production of grapes, one of the decisive factors is the introduction of advanced technology and comprehensive mechanization in the vineyards.

The types and designs of machines, their working bodies and adaptations to machines for tillage in vineyards depend on the row spacing, the method of bush management, the cultivation zone (uncovered or covering), soil and climatic conditions, etc.

The studies of scientific research institutes and the production experience of advanced farms have established that in the shelter zone of viticulture, especially during irrigation, the row spacing is 2.5-3.0 mclearly insufficient, tk. at the same time, the potential of the grape plant in terms of a significant increase in yield is not used, it is difficult to achieve a reduction in manual labor costs, an increase in productivity, an improvement in the working conditions of machines and modern energy-saturated general-purpose tractors when cultivating the soil and caring for vineyards. Care of vineyards, in particular, the implementation of the most labor-intensive and energy-intensive operations for tillage on them (cultivation or loosening,cultivation between bushes, autumn plowing between rows, renewal of planting, etc.), can only be carried out on the base of mechanization. But, machines designed for tillage in vineyards are not yet produced. One of the reasons for this situation is the lack of sufficient theoretical and experimental data necessary for the development and production of a cultivator for tillage in rows and rows of vineyards.

Materials and methods. The task of tillage in vineyards is to create favorable conditions for the growth and fruiting of plants. By tillage, accumulation and conservation of moisture, its economical use, improvement of aeration, destruction of weeds and pests, incorporation of fertilizers, protection of the vineyard from winter frosts are achieved.

The soil in the vineyard is kept loose and weed-free. This is achieved by systematic (three to four times per summer) cultivation of row spacing to a depth of 10-12 cm with PRVM-3 and MPV-3 plows or chisels. Cultivation between rows is carried out after every watering, and in rainfed vineyards - after heavy rain.

In summer treatment destroy weeds, a loose layer is formed on the soil surface, which helps to preserve moisture, improve the water-air and nutrient regime of the soil in the area where the main mass of roots is located.

Tillage in a row the middle the bushes is a very fundamental technique, but doing it manually requires a lot of labor. On the other hand, now this work is successfully carried out by the mechanisms of inter-bush processing.

During the summer days, the soil and the bushes is loosened one to three times to remove weeds. During the last loosening, it is advisable to leave a small depression between the bushes up to 10 cm in the form of a strip, where, during autumn laying, part of the vines closed for the winter will be placed.

A cultivator for soil cultivation in the aisles and rows of vineyards must provide high technological and agrotechnical performance, be versatile, able to work under various soil conditions.

Research work on the mechanization of tillage in vineyards began in the 50s of the last century at a width of 3.0; 3.5 m [3, 4, 5, 6, 7].

As a result of the research conducted in different years were developed and introduced into productionvineyard cultivators, cultivators MPV-1A, PRVN-2.5A, PRVM-3, KV-3, etc. The use of the above technical means made it possible to increase the level of mechanization of work on the cultivation of vineyard soils and the general culture of the industry.

Compared to domestic plows for inter-row cultivation of vineyards, foreign plows of the same purpose are less versatile in design, since they can perform one, two or three operations and are designed for relatively shallow plowing (12-16 cm).

Their structural advantages include the following:

Possibility of individual adjustment of the angle of inclination of the hulls (which affects directly the plowing depth).

The presence of chisels on the bodies, providing more reliable and trouble-free operation of the shares when they are used in soils containing stony inclusions.

Simplicity of design, originality of fastening and dismantling of working bodies for work in row-spacings with different planting widths.

Experimental cultivator for tillage between rows and rows of vineyards(conditional brand UK-3) (Figure 1) is a tool and consists of a frame of a universal rectangular shape, designed to mount on it all the units of the machine, two universal beds, two leashes, one central ripper, three fertilizer spreaders with a drive, racks for attaching working bodies, a set of working bodies, two covering and four arable bodies, as well as two support wheels with a mechanism for adjusting the depth of the stroke of the working bodies.

As a result of the search, development and research carried out in previous years (2010-2019), by 2019 there was a very definite trend and directions regarding the scheme and design of the machine for tillage in vineyards, namely: the machine must have reinforced frame with regulation of its capture [8, 9, 10].

Figure 1. Vineyard cultivator-cultivator UK-3 at the operation of row-spacing cultivation with processing of inter-bush strips

However, to date, none of the machines proposed and described above has been a prototype for industrial production, which, another reasons, can apparently be elucidated by the lack of sufficiently scientifically based data, in particular, on the quality of work, the energy intensity of the process in vineyards under specific conditions. . Of considerable interest in this regard are the studies of the mechanization laboratory of the NIISViV named after academician M.M. Mirzaev (2010-2019) of the wide-cut cultivator UK-3 developed here.

Studies of cultivation UK-3 were carried out at the farm “Negmatov Rakhsiboy agrofayz” of the Zangiata district of the Tashkent province (July-August 2019) on the traction of the TL-100 tractor on plantations with a row spacing of 3 m (the distance between plants in a row is 1.5-2 m , boles height - 110-120 cm, Taifi pink) on row-spacing cultivation with inter-bush tillage with the developed device. Soil moisture was low and in the layer of five to ten and ten to thrity cm, respectively, averaged 15.5% and 19.6%. At the same time, soil hardness was very high and uneven across the row spacing: outside the track, in a layer of 0-10 cm, it was 0.56-1.01 MPa, in a layer of 10-30 cm - 2.21-2.80 MPa , and along the track from the previous passages of aggregates, the soil was strongly compacted over the entire horizon and in a layer of 0-30 cm its firmness reached 2.8-2.96 MPa (Figure 2).

Despite the unfavorable soil conditions for the operation of the UK-3 machine, the arithmetic mean value of the cultivation depth in the area of the passage of wide-cut cultivator paws was 12.1

cm with an experimental accuracy of ± 2.6%. Damage to the ground part of bushes, boles and vines, trellises and racks was not observed.

The traction resistance of the wide-cut cultivator UK-3, determined by strain measurement, was 16-22 kN, the speed of the unit was 1.4-2.0 m/s, the productivity was 12-16 ha per shift, which is almost 2 times higher compared to the MPV machine -1A for cultivation with inter-bush cultivation of vineyards with row spacing of 3-3.5 m.

The use of a cultivator for soil cultivation in the aisles and rows of vineyards with replaceable working bodies and devices, improved or unified with serial production for vineyard machines with a working width of 2.5 and 3.0 m, will allow mechanizing the main soil cultivation operations in the aisles of vineyards in one pass of the units on the traction of powerful energy-saturated general purpose tractors class. thrust of 20-30 kN, more fully use the power of their engines, reduce the number of passes of the units along the aisles, increase their productivity by 1.5-2 times compared to the MPV-1A machine, which will give a significant agrotechnical and economic effect.

Figure 2. Vineyard cultivator-cultivator UK-3 at the operation of cultivating row-spacings with the processing of inter-bush strips in a unit with a tractor TL-100 “NEW Holland”

At the same time, it is necessary to provide, as noted above, the achievements of advanced agricultural technology and promising technology for tillage in vineyards, which will make it possible to obtain high quality performance indicators, reduce energy costs and increase machine productivity.

Results and discussions of the study. In a double rowwith an increase in the working width of the tool, the number of working bodies operating in a continuous medium does not increase, clogging of the working bodies with soil and plant residues is excluded; all working bodies, except for the middle one, work in an unblocked environment, the weight of the implement is much less and its center of pressure is located closer to the tractor. Traction resistance is significantly reduced, wear of working bodies is reduced, the formation of large lumps is eliminated and the leveling of the soil surface is improved, free and convenient access to working bodies for maintenance, etc. is provided.

Based on the above, in order to exclude clogging of the working bodies with soil and plant residues, the placement of the working bodies on the frame is taken according to a two-row scheme.

Cultivation of row-spacings and inter-bush strips is carried out by flat-cutting working bodies and a rotary flat-cutting share in a row.

The technological process of row-spacing cultivation is in principle similar to the process of continuous loosening and differs from it only in that weed cutting and soil loosening is carried out throughout the row-spacing by working bodies equipped with elongated shares, and. to a shallower depth - 10-12 cm.

Due to the shallow depth of loosening during cultivation, the question arises whether it is necessary to install bits on the side racks of the working bodies of the chisel in order to better deepen the flat-cut shares.

The results of comparative studies of the quality indicators of the design of the working bodies of the UK-3 cultivator are given in Table 1, confirm the usefulness of installing the chisel on the side loosening racks of the working bodies, which provide the required stability of the stroke depth during surface cultivation.

Table 1. Dependence of the quality indicators of the cultivator working bodies of the UK-3 machine on the angle of the bit at a translational speed of 1.45-1.95 m/s

No.	Indicators	The angle of elevation of the bit of the working bodies, hail.			
			26	30	32
1	Depth of processing, cm: installation	12.0	12.0	12.0	12.0
	average	12.73	11.15	12.29	11.60
	standard deviation	1.42	1.11	1.24	1.23
	the coefficient of variation,%	11.15	9.96	10.09	10.60
2	Soil crumbling by fractions, %				
	less than 10 mm	68.61	67.05	62.08	53.64
	10-20	11.08	13.29	12.35	9.08
	20-50	12.95	9.61	14.37	10.92
	50-100	7.58	10.05	11.18	8.47
	over 100 mm	-	-	-	17.89
3	Combing, see:				
	average	4.21	5.05	5.79	6.58
	standard deviation	1.96	2.19	2.57	2.60
	the coefficient of variation, %	46.56	43.37	44.39	39.51
4	Protective zone, see:				
	average	26.27	27.15	27.49	29.05
	standard deviation.	5.39	5.83	5.88	6.02
	variation coefficient, %	20.52	21.47	21.39	20.72

As can be seen from Table 1, with an increase in the angle of elevation of the bit from 26 to 34 °, the deepening ability of the working bodies noticeably increases, varying within 11.60-12.73 cm at a set stroke depth of 12.0 cm. standard deviations of 1.11-1.42 cm with coefficients of variation of 9.96-11.15%. Similar results were obtained in terms of depth uniformity along the stroke length with a corresponding penetration from 11.18 to 12.02 cm with satisfactory values of the standard deviation of 1.00-1.49 cm, coefficient of variation 9.68-13.94% and experimental error 0.04-0.06 cm.

It should be noted, however, that with the complete destruction of weeds by flat-cutting plowshares, the following is observed: a slight decrease in the degree of crumbling of the soil into optimal fractions: less. 10 mm - from 68.61% to 53.64%; from 10 to 20 mm - from 11.08% to 9.08%; reduction of the working width from 2.953 to 2.940 m; an increase in the bedding from 4.21 to 6.58 cm and an increase in the protective zone from 26.27 to 29.05 cm. At the same time, the deterioration of these indicators is insignificant with an increase in the angle of elevation of the bit to 32° and is clearly noticeable at a value of 32°.

Analysis of the results of experimental studies allows us to conclude that for surface cultivation of the soil to a depth of 10-12 cm, the angle of elevation of the bit of cultivator working bodies with elongated flat-cut shares should be within 24-32°.

When cultivating inter-bush strips, short flat-cut shares are installed on the central ripper, and long ones are installed on the side universal working bodies of the device.

Conclusion. Analyzing and comparing the average indicators of traction resistance depending on the speed when cultivating inter-bush strips and row spacing, as well as cultivating only row spacing when working on heavy soils, we will determine with sufficient accuracy their difference for the actual values of the lateral universal working bodies of the UK-3 machine. The values of traction resistance for two working bodies operating in adjacent rows of inter-bush strips of vineyards, at the corresponding speeds of 1.45; 1.55; 1.75 and 1.95 m/s will be 0.25; 0.50; 0.65 and 1.20 kN.

Thus, the results of the energy assessment of the traction resistance of the side rotary working bodies in contact with the root stem of the vineyard bushes give reason to consider the optimal speed of movement in the range of 1.48-1.60 m/s in order to avoid damage to the root system of the vineyards.

After mathematical processing of the results of strain measurement, the data obtained are summarized in Table 1.

As can be seen from Table 3.7 and graphs (Figure 3), with an increase in travel speed from 1.45 to 1.95 m/s, the effective and traction power increase, and the nature of the increase in all operations has a parabolic dependence.

An analysis of the required power confirms the feasibility of operating cultivator units at speeds within the range of 1.45-1.75 m/s. The required traction power in these modes differs little and is small for row-spacing cultivation and cultivation of inter-bush strips and row-spacings (respectively 21.20-24.27 kW and 21.53-24.78 kW).

Cultivator for tillage between rows and rows of vineyardsUK-3passed laboratory and field tests inAccredited Testing Agrotechnical Center at JSC "BMKB - Agromash"(Protocol No. 1-2016).

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RESEARCHING THE PARAMETERS OF THE WORKING BODY OF AN ENVIRONMENTALLY COMFORTABLE SPRAYING UNIT

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Abstract. In this article, it is described that the general structure and operation process of the vibro-hydromachine, which is agrotechnically and ecologically convenient for the agro-industrial complex, does not cause chemical damage to other types of crops in the environment, and ensures that the spraying unit is energy-efficient. The theoretical aspects of determining the main parameters and operating modes of the vibrohydroelectric machine are given (velocity pressure of a hydraulic or pneumatic mixer and the potential energy of settling particles (or kinetic energy at the moment of settling), to ensure the circulation of mixing flows, the required flow rate of jets from the hydraulic mixer nozzles is, fluid pressure force at point A, pressure at point 2 at depth h, measured from the level of point 1, absolute pressure (P_a) at an arbitrary point in the liquid, excessive pressure P_i, flow of working fluid through the sawing device of the unit, insignificance h_e). Also, field experiments have shown the performance of the modernized proposed working bodies.

Key words: working fluid, energy-saving, hydro-meshalka, theory, drops, flow rate, pressure, spraying unit

Introduction. The agricultural sector uses agrotechnical, mechanical, biological, chemical and physical methods of plant protection [1-3]. According to many scientists and specialists [4-6], the chemical method of plant protection in the near future still remains one of the main methods of protecting plants from various pests and diseases.

At the same time, the transition to a low-volume or ultra-low-volume spraying method is both economically and environmentally beneficial.

Therefore, improving the design of modern spraying equipment is of great interest.

Existing technical means have a high energy intensity of the spraying technological process and low technical efficiency of the working fluid used [2, 3]. A large volume of supplied working fluid requires significant kinetic energy to crush it and transport the formed droplets to the surface of the object being processed.

Materials and methods. Hence the need arose to increase the technical efficiency of the formed droplets and reduce the energy intensity of the dispersion process by expanding the technological capabilities of the spraying unit.

To achieve this task, the authors have developed a new multifunctional spraying unit containing a vibro-hydro or pneumatic mixer 4, a rotary-roller dispenser 19, a reservoir 2, a control unit 16 with a distributor 14 and hydraulic communications 7 and 21 (Fig.1) [4].

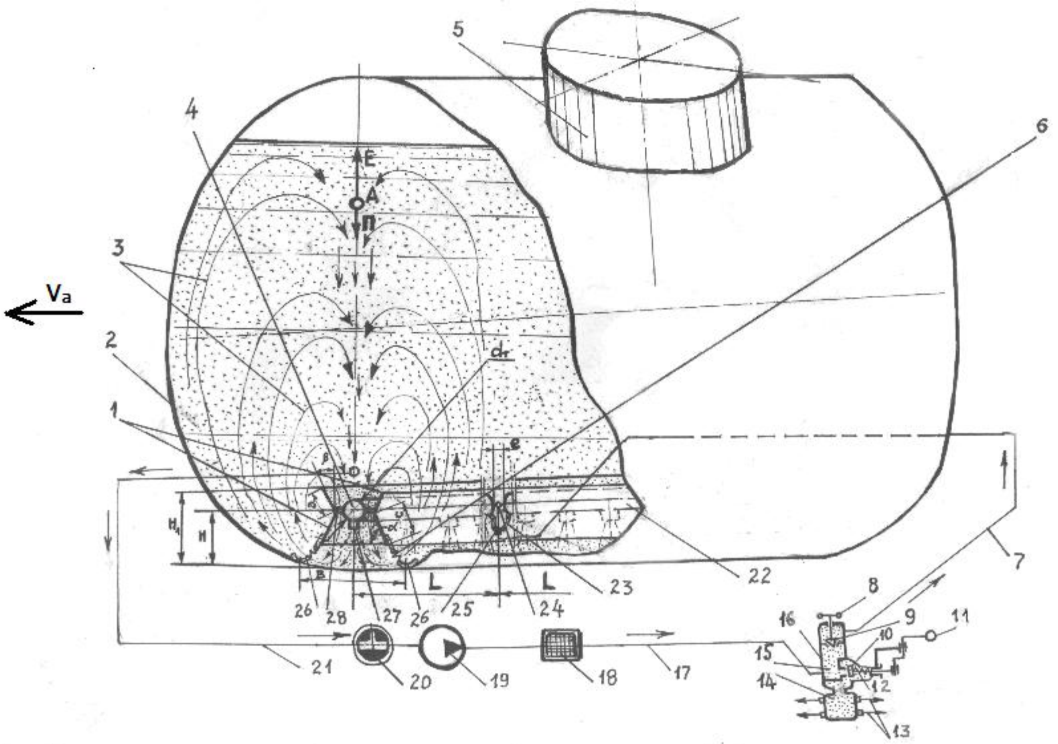

Fig.1. Scheme of the technological process of operation of the proposed vibrating hydraulic mixer: 1- fairings; 2-reservoir; 3 currents of working fluid; 4-vibrohydro-or pneumatic mixer; 5- neck; 6- spring-vibrator; 7,17,21,22,23,13- tubes; 8-valve; 9-bypass valve; 10-stop valve; 11-handle; 12-return spring; 14-distributor; 15-working cavity; 16- block regulator; 18-main filter; 19- rotary roller pump; 20-way valve; 24-hinge; 25-adapter; 26-foot; 27-spray; 28-perforated bracket; H, H_l, d, e, L, B, c, α, β - the main parameters of a vibrohydro or pneumatic mixer; V_a – unit speed.

The tank is equipped with a float dispenser. The dispenser is made in the form of two float elements 2, placed inside the tank with the possibility of free movement up or down along the rod 9 vertically lowered into the tank through its lid (Fig.2).

Unlike the well-known one [5], the proposed vibrohydro or pneumatic mixer consists of two folding parts. The hinged mount 24 greatly facilitates service work to eliminate sudden failures in a vibrohydro or pneumatic mixer. If necessary, the outlet pipe 21 can be directly connected to the aero-vortex caviator of the spraying unit. The hydraulic mixer can also operate in pneumatic mode.

Due to the constant circulation of the working fluid around the vibrating hydraulic mixer, conditions are created to ensure a constant concentration of the sprayed working fluid.

Results and Discussion. In the proposed vibro-hydro or pneumatic mixer, settling particles of the drug can be lifted upward under conditions if:

$$E \geq P, \quad (1)$$

where E, P – are the velocity pressure of the hydraulic or pneumatic mixer and the potential energy of the settling particles (or kinetic energy at the moment of settling), kgm^2/sec^2.

To ensure the circulation of mixing flows, the required flow rate of jets from the nozzles of the hydraulic mixer is equal to:

$$\upsilon_j = K_c \sqrt{\frac{M}{nd_n^2}} C, \quad (2)$$

where K_c – circulation coefficient, K_c=4.5; M – is the mass of the filling dose of the drug, kg; n – is the number of hydraulic mixer attachments; d_n – diameter of the nozzle hole, m; C – value is assumed to be constant for the operating conditions of the hydraulic mixer, $m^6/kgsec^4$.

Springs - vibrator 6 imparting oscillatory movement on the body of the mixer 4 creates conditions for increasing the intensity of mixing the liquid in the tank.

The reservoir of the unit is equipped with a float dispenser 2 (Fig.2), which ensures the supply of a small portion of the working fluid by the air-vortex caviator.

So, for example, in a tank, on the surfaces of the float elements 2 there is a compression stress equal to:

$$\underset{\lim \to \Delta S}{P_A} = \frac{\Delta P}{\Delta S}, \tag{3}$$

where P_A – is the fluid pressure force at point A; ΔS – is the value of the elementary area containing point A; ΔP – compressive force acting on the area ΔS.

The pressure of the working fluid increases with depth h according to the law:

$$P_2 = P_1 + \gamma h, \tag{4}$$

where P_1 – is the pressure at an arbitrary point 1 of the liquid in the tank; P_2 – is the pressure at point 2 at depth h, measured from the level of point 1; γ – specific gravity of liquid (γ=1000kg/m^3).

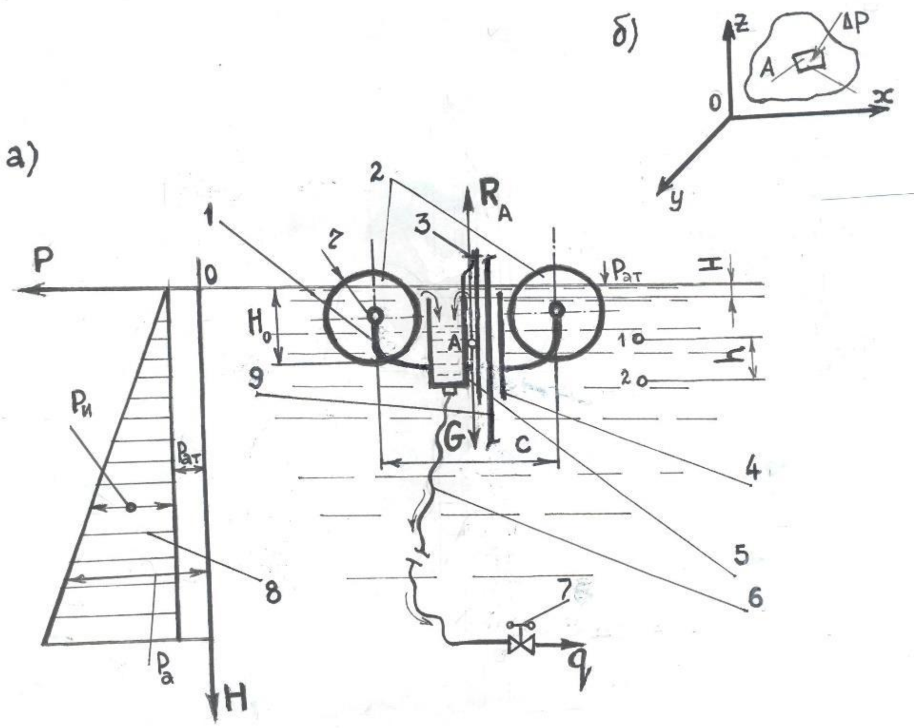

Fig.2. Scheme for calculating a float dispenser: 1- bracket; 2 - floats; 3-adjusting element; 4- bushing; 5- siphon; 6- tube; 7- valve; 8-fluid pressure diagram; 9- rod, b- coordinate axes of point A.

The absolute pressure (P_a) at an arbitrary point in the liquid is equal to:

$$P_a = R_{at} + \gamma H, \tag{5}$$

where H – is the depth of the point above the free surface; R_{at} – atmospheric pressure.

The excess pressure created in this case only by the volumetric weight of the liquid is equal to:

$$P_e = \gamma H . \tag{6}$$

As can be seen, by maintaining a constant depth h of sinking siphon 5 into the working fluid. Applying the theorem of momentum on the jet axis, we find the flow rate of the working fluid through the sawing device of the unit:

$$H\gamma F_c = q\rho\upsilon = f_j\upsilon^2\rho = \upsilon^2\frac{\gamma}{g}; \quad (7)$$

$$q = \mu_c f_c\sqrt{2gP_e}, \quad (8)$$

where f_j – jet cross section ($f_j = \frac{\pi d_c^2}{4}$); P_e – excessive pressure in the central tube at the level of the capillary channel of the caviator, ($H = \frac{P_e}{\gamma} = \frac{P_a - P_{at}}{\gamma}$); υ- the speed of the supplied jet, м/c; d_c^2 – diameter of the capillary channel; μ – capillary channel flow coefficient, (μ≈1,0); d_c – diameter of the capillary channel.

When using a pneumatic mixer, the tank of the apparatus transforms into a closed vessel with some excess pressure on the free surface ($P_o > P_{at}$) and the piezometric plane can be located above the free surface of the working fluid by the following amount:

$$h_e = \frac{P_o - P_{at}}{\gamma} = \frac{P_e}{\gamma}. \quad (9)$$

where P_e – excessive pressure on the free surface of the liquid.

However, due to the insignificance of h_{on} compared to h, it can be neglected in calculations.

The coaxially streamlined air flow created by the OVX-600M fan of the unit transports highly dispersed droplets formed by the sprayer to the object being processed.

Conducted field experiments showed the performance of the modernized proposed working bodies. The average median diameter of droplets formed is 99.79...104.05 microns at a working fluid flow rate of up to 75 l/ha (200 l/ha with the existing one), and the average level of leaf fall during cotton defoliation was 97.5% (80-90% with existing spraying method), which indicates the high efficiency of the modernized spraying unit.

Conclusion. Traditional spraying methods do not provide a low-volume supply of working fluid to the sawing tips.

The use of a vibrating hydraulic mixer ensures the stability of the concentration of the working fluid in the tank.

Equipping the unit with a vibrating hydraulic mixer and a float dispenser increases the technical efficiency of the sprayed liquid and makes the unit multifunctional.

The average median diameter of the formed drops was 99.79...104.05 microns at a working fluid flow rate of up to 75 l/ha (200 l/ha with the existing one), and the average level of leaf fall during the defoliation of cotton was 97.5% (80-90% with the known spraying method).

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OBSERVATION OF THE OPTIMIZATION OF LABOR PROTECTION MEASURES IN ENGINEERING WORK IN MINING

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Abstract: In this article, it is described that studies injury rates by age categories of personnel at coal mines, research work of employees under 20 years - 20%, from 20 to 59 years - 55.4%. 60 years and older-24.6% and above. As a result, measures were taken to protect workers by types of production activities at the Coal mines, aimed at improving working conditions at the workplace and achieved a certain reduction in the level of injuries of workers, the incidence of occupational diseases. The management system of occupational safety measures aimed at reducing morbidity should contain blocks of statistical processing of information, modeling of quantitative levels of morbidity associated with production, classification and optimization of preventive measures.

Key words: coal mining, safety measurement, injures of workers, mathematical methods

Intraduction. Occupational safety measures should be planned on the basis of management theory, which uses a systematic approach for goals, criteria, methods and management tools. The methodology of the system approach allows us to reveal the internal connections of the process under study, to determine the main management functions. For optimal planning of labor protection measures in order to effectively use available resources, it is necessary to create a management system that provides mathematical methods and information analysis, adoption and implementation of management decisions.[1]

Materials and methods. If we take into account the statistics of our Republic when planning labor protection measures, it shows that at the beginning of 2023, there were 18.13 million men out of the total population, and 17.89 million women. The urban population was 18.33 million people, the rural population was 17.69 million. People younger than working age make up 31.7%, able-bodied - 56.8% and older than working age - 11.5%. The number of live births in 2022 amounted to 932.2 thousand people, including 482.4 thousand boys and 449.8 thousand girls. 473.4 thousand people were born in cities, 458.8 thousand in rural areas.

The share of births of one child was 97.8%, two children - 2.1%, three or more children - 0.1%.

38.9% of women under the age of 25 were in labor, 60.1% were 25-39 years old, and 1% were 40 years old and older. [2]

Fathers under the age of 25 were 10.7%, 25-39 years - 83.4%, 40 years and older - 5.9%. From the above statistics , it can be analyzed that the number of employed people consists of: (Diagram-1)

Occupational health and safety management systems at the level of an enterprise, association, and industry allow increasing the effectiveness of combating occupational injuries, general and occupational diseases will ensure the achievement of the most favorable working conditions. [3]

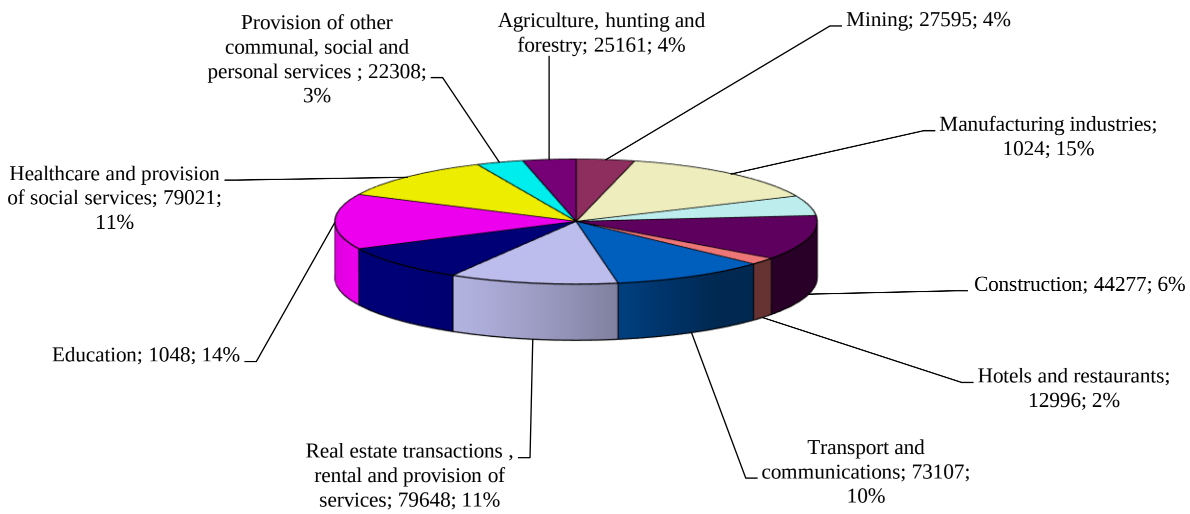

Figure 1. Structure of the employed population

In general, the management system consists of a management object, a management body, information processing tools and means of implementing management decisions [4].

The purpose of the operation of the control system is to change the output parameters of the object in accordance with the specified criteria or control program. At the same time, input and output parameters are recorded, which are used to identify the object, that is, to build a sufficiently adequate mathematical model that allows predicting the values of output variables and developing the necessary control actions [5].

The control object is considered as a converter of the vector of input random functions of time x (t) vector of output random functions y (t):

$$y\ (t) = A_t x\ (t), \tag{1}$$

where A_t is the object description operator. [6]

Each output variable y(t) (i=1, m) is defined by a set of input variables x1 (t), xn(t), however, their full accounting is practically impossible. Therefore, we have to limit ourselves to a part of the defining variables, and attribute the rest to uncontrolled noise [7].

We will define some elements of the management system of occupational safety measures aimed at reducing morbidity.

The object of management in this system is the state of health of the studied contingent of workers.

This contingent is characterized by a certain length of service, age sex and professional structure, and is united according to the principle of qualitative homogeneity of the factors of working conditions affecting it [8].

Results and Discussion. The purpose of the system is to achieve harmless and safe working conditions that allow for these climatic and socio–economic conditions, taking into account the characteristics of the contingent of workers, to ensure the lowest possible levels of morbidity.

Input variables are environmental and industrial environment parameters and professional and demographic characteristics of employees. Output variables are indicators of morbidity that characterize the health status of workers.[8]

The criterion of effectiveness in the system under consideration should be to ensure the background level of morbidity, which is not related to the influence of production, but is determined by climatic, social and other factors uncontrolled in this system.

The controlling influences are labor protection measures aimed at achieving the lowest possible levels of morbidity of workers. These measures can improve working conditions, compensate for the damage caused by adverse impacts, contribute to the protection of workers, regulate their work and rest regime.

The management bodies in this system are the labor protection (safety and industrial sanitation) services working together with the administration of the enterprise. They analyze the current information about working conditions and the health of workers, consider possible options for management decisions, make action plans and monitor their implementation.

Information about the state of the management object contains data on compliance with labor protection rules and regulations, on the implementation of planned measures, current values of factors of working conditions, indicators of the health of workers and economic data.

Information processing tools are organized, technical and software that allows you to generate and accumulate indicators, perform their comprehensive analysis and develop optimal recommendations for management bodies.[7]

The means of implementing control actions are research, design and technical solutions, measures of moral and material incentives, means of individual and collective protection, medicines and equipment, etc., necessary for indicators of the health status of workers [4].

✓ To implement the main functions of managing occupational safety measures, an automated data processing system should be created, where the following tasks should be solved:

✓ registration, control and accumulation of information;

✓ calculation of statistical indicators and printing of information tables;

✓ identification of the management object in order to determine the relationship between the parameters of working conditions and morbidity indicators;

✓ determination of the minimum possible levels of morbidity and their corresponding optimal, but lying within the realistically achievable limits of the values of production factors;

✓ compilation of various options for preventive actions and selection of the optimal option;

✓ assessment of predicted morbidity levels;

✓ determination of the socio-economic effect of the system of optimal planning of preventive measures [5].

With the help of a functional calculation and a scheme, we will consider the sequence of stages of optimizing morbidity. Such optimization involves the use of an automated data processing system.

The control object is characterized by input variables-parameters of working conditions, and output variables- indicators of morbidity of workers. This information is accumulated in the corresponding data archives. Such archives are formed and used during the operation of the automated system in the information management mode.

In the first case, the archives of data on working conditions and morbidity data are replenished and adjusted with a given frequency. If it is necessary to compile reports or obtain operational summaries for a given sample, the values of production factors are estimated and morbidity rates are calculated. At the same time, it becomes possible not only to promptly obtain the necessary information, but also to compare working conditions and morbidity of individual groups of workers with the help of common signs, identify the most disadvantaged areas of production and thereby facilitate the planning of targeted preventive measures.

When the system is operating in the control mode, it is supplemented with blocks of identification and prediction optimization. The parameters of working conditions and morbidity indicators after their statistical processing and grouping, which allows for comparative analysis, serve as the initial basis for the identification model. Here, using the methods of factor and regression analysis, quantitative dependencies are determined [7]:

Where is the intensive indicator of the form of the disease;

- vector of working conditions parameters;

- the number of forms of diseases registered in the studied contingent of workers.

Each of the morbidity indicators [5] characterizes the particular properties of the control object, therefore, for a complete description of the object, models should be built according to the indicators.

Morbidity rates [4] were functions of the parameters of working conditions [2] with an appropriate optimum of independent variables, they can take minimal values. These values [6] can be defined as the minimum possible levels of morbidity, provided that at these points they are continuous, differentiable and have global positive minima, and the corresponding optimal values of the arguments [4] are in a realistically achievable area determined by technical and economic constraints [8].

In cases where the minima of the function do not satisfy the specified conditions or the values of the corresponding arguments lie outside the really achievable area, the minimum possible incidence levels are determined by the boundary values of the real area in the direction of the optimum.

Thus, to determine the minimum level of morbidity in the form, it is necessary to solve the following problem.

Where is the lower edge (the exact smallest value) of the morbidity indicator function - the vector of working conditions parameters;

X is the set of really achievable values on which the minimization problem is solved. The vector minimizes the function.

Each of the obtained in solving the minimization problem of the partial optimal vectors of the parameters of working conditions minimizes the indicators of the form of the disease [7]. To minimize the total morbidity index equal to the sum of intensive indicators for individual nosological forms, it is necessary to determine the overall optimal vector of parameters of working conditions, all components of which belong to particular vectors [8].

Thus, the general optimal vector of working conditions for the studied contingent of workers can be as a combination of partial optimal vectors minimizing individual forms of diseases.

The parameters that make up the overall optimal vector should be used when planning preventive measures. For the automated compilation of individual variants of the plan, classifiers developed for specific production facilities (workshops, sites, professions, etc.) are indispensable. In these classifiers, not only the harmful factors of working conditions that they counteract, but also the proportion of specific weakening of these factors, as well as the cost of measures, must be matched to each preventive measure [2]. To achieve the calculated optimal values of the parameters of working conditions, with the help of classifiers, variants of prevention plans are compiled, differing in the composition of measures, the total cost and the resulting health effect [3].

In order to determine the most rational variant of the action plan, the optimization problem is solved with a given efficiency criterion, taking into account technical and economic constraints. In the present task, these conditions are the criterion of the minimum possible level of the total morbidity index with limited costs for prevention.

Assuming that after carrying out a set of optimal measures, the minimum possible levels of morbidity will be reached after some time, we take this time for the forecasting period. Having estimated by expert means the values that the parameters of working conditions will have over time (without carrying out optimal measures), using the identification model [1] we will determine the real forecast of morbidity indicators:

-the prognostic value of the morbidity index according to the nosological form after the time of non-implementation of measures; -prognostic values of factors of working conditions through without carrying out activities.(Diagram-2)

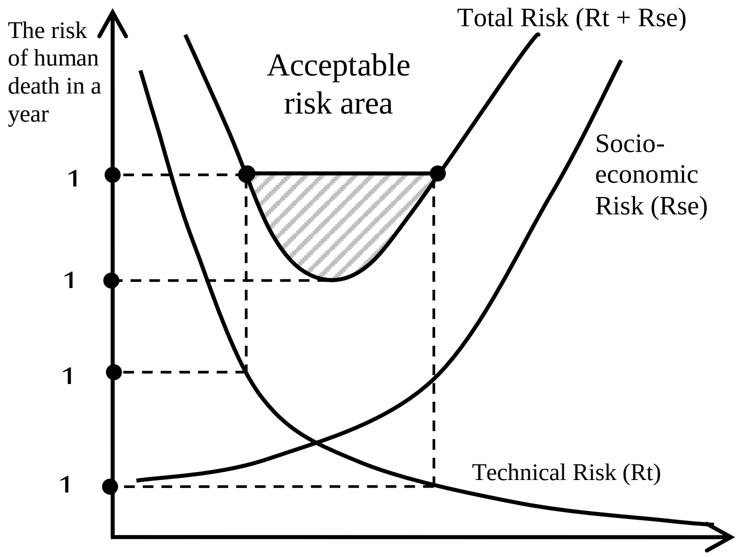

Figure 1. Acceptable risk

The calculation of prognostic values of morbidity indicators makes it possible to determine the socio-economic effect that can be achieved as a result of optimizing preventive measures. Assuming that as a result of optimal measures, the incidence rates will decrease to the lowest possible values, we will determine the magnitude of this decrease for individual nosological forms.

Summing up this decrease in all the forms of diseases identified for the object under study, we obtain a general decrease in morbidity as a result of optimizing preventive measures.

The social effect of health-improving measures should be determined by the number of workers removed from the influence of harmful and harsh working conditions, which directly affects the reduction of morbidity rates. Thus, the calculated decrease in the number of sick people, the number of cases of diseases can be considered the equivalent of one of the types of social effect obtained by optimization. The reduction in the number of working days lost as a result of diseases will be considered an indicator of the socio-economic effect, since, indicating a reduction in the severity of diseases, it means a reduction in the loss of working time, and hence a decrease in under-production. Knowing the cost of one working day, according to this indicator, it is possible to calculate the economic efficiency of optimal planning of measures aimed at reducing the morbidity of workers.

The first stage of the automated system of accounting and analysis of information on working conditions and morbidity of workers has been introduced into industrial operation in the main workshops of the production association. This system implements the following stages of the above-described approach to optimizing labor protection measures: statistical processing of data on working conditions of workers and on morbidity with temporary disability; printing of information tabulograms; modeling of quantitative dependencies between factors of working conditions and morbidity indicators. The approbation of the subsequent stages of the described approach to the optimization of labor protection measures is assumed during the implementation.

Conclusions. Optimal planning of preventive measures aimed at reducing the morbidity of workers should be based on the functioning of an automated control system.

The management system of occupational safety measures aimed at reducing morbidity should contain blocks of statistical processing of information, modeling of quantitative levels of morbidity associated with production, classification and optimization of preventive measures.

Optimization of measures aimed at reducing the morbidity of workers should be based on the criteria of maximum health effect and be carried out taking into account technical and economic constraints.

Automated control system, including the stages of statistical processing and modeling.

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