REPUBLIC OF AZERBAIJAN

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ABSTRACT

of the dissertation for the degree of Doctor of Philosophy

OPTIMIZATION OF THE PROCESS OF CLEANING RAW COTTON GROWN IN AZERBAIJAN FROM FOREIGN IMPURITIES

Specialty: **3326.01- Technology of materials and products of the textile and light industry**

Field of science: **Technical sciences**

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Ganja-2021

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GENERAL DESCRIPTION OF THE RESEARCH

Relevance and degree of completion of the topic. The important achievements made in recent years in the direction of economic diversification and improving the well-being of the population in the Republic of Azerbaijan are perceived as a success of socio-economic development.

The resolutions “Main directions of the national economy and the strategic roadmap for the main sectors of the economy” of december 06, as well as the “State Program for the development of cotton production in the Republic of Azerbaijan for 2017-2022” of July 13, 2017, signed by the President of the Republic of Azerbaijan Ilham Aliyev, are of particular importance for the sustainable development of the national economy, including the agricultural sector.

In the strategic roadmap, the development of the textile industry for the outstripping growth of the population's demand for consumer goods is set as an important task. To achieve this goal, economic reforms in the textile industry should ensure the introduction of innovative technologies and the creation of high-performance technological equipment.

At the existing cotton gins in our country, the cleaning of raw cotton from foreign impurities is carried out mainly on cleaning machines that have been in operation for many years. In recent years, YHC combined cleaners with sections of large and small mixed cleaners have also been used.

According to the statistics of 2021, the cotton harvest in the country reached 332 thousand tons, and this is far from the final goal. The expansion of the processing of cotton produced in our country, the construction of modern processing plants and the use of modern machines and equipment for cleaning cotton have become a necessity.

In the process of cleaning raw cotton from the action of numerous forces, a defect of the “fibrous shell" occurs with mechanical damage to the fiber and needles, which reduces the spinning ability of the fiber. Therefore, when cleaning raw cotton, much attention is paid to improving the cleaning process. It is necessary to improve the cotton

processing equipment that ensures the preservation of high quality fiber, new methods of cleaning raw cotton and fiber from foreign impurities, the creation of working bodies that ensure the efficient operation of technological machines.

Thus, the topic of the dissertation is relevant and has scientific and technical significance due to the fact that it is devoted to the development of new designs of grate mesh-the main working body of clea-ners, which provides an increase in the cleaning effect of raw cotton from foreign impurities.

Purpose and objectives of the study. The aim of the study is to increase the cleaning effect of raw cotton by processing a three-sided prism, a round segment and combined profiled grates for the cleaning working body of equipment that cleans raw cotton from large impurities.

The objectives of the study include:

- improvement of the method of cleaning cotton from large impurities and the development of new working bodies in order to increase the cleaning effect of cleaning agents;
- development of mathematical models expressing various variants of the connection of edge mixtures with cotton, and their imitation with physical models;
- study of the law of action of raw cotton at different values of parameters and random technological stability in the grate network;
- determination of the grate load by selecting the optimal parameters of the grate mesh and resistance modes in the technological process of raw cotton cleaning;
- study of the interaction of parameters and working bodies on the design and operation of the mathematical model of the developed combined grate network;
- study of the technological parameters of the cotton gin for cleaning large impurities with the proposed cleaning modes and new grate networks;
- determination of the optimal mode of the raw cotton cleaning process on large combined cleaners of the new grate network by the method of mathematical planning of the experiment.

Research methods. As an object of research, the system “sawn

drum-grate network" of the raw cotton cleaner from large impurities was adopted.

This goal was achieved with the help of theoretical and experimental studies. Theoretical studies were solved on the basis of theoretical and applied fundamentals of mechanics, theoretical and technological foundations of textile machines and processes. Kinematic and dynamic analysis was carried out on the basis of the provisions of the theory of machines, mechanisms and machine science. The equations of motion of cotton jets were solved numerically in the MSExcel program.

Experimental studies were carried out on a special bench installation, test samples, as well as directly on raw cotton cleaners СЧ-02, 1ХК, РХ-1, 1ХП . The estimates obtained from the experiment were performed using mathematical statistics using new computer programs Statistica 10, Mathematica 10, and Microsoft Excel 13.

Main provisions to be submitted for defense:

- valuation of the interaction between the layers of the feed rollers and the transferred layer of cotton;
- determination of the shape and calculation of the adhesion forces based on the elastic properties of raw cotton;
-theoretical model of the impact of grates on foreign impurities in the cleaning process;
- mathematical expressions of the movement of cotton elements in the area of the saw drum-grate mesh;
- evaluation of the processes of depreciation and unloading of raw cotton;
- design and technological features of experimental grates developed at the level of the utility model;
- results of production tests and economic efficiency of the experimental installation;

Scientific novelty of the research. The power system of large mixed cleaners is theoretically studied, the influence of functional elements of the power system on the primary cleaning of cotton is studied. A new profiled grate network has been developed, which makes it possible to intensify the cleaning of raw cotton from foreign impurities.

The regularities of the movement of new profiled grates on the surface under the impact of shock loads on raw cotton wool are established, and differential equations of the movement of planes on the surface of the grates are derived. Modes of movement of wheelers with elements of circular, triple and circular segments were carried out using the theory of impact. The optimal mode of the process of cleaning cotton from large impurities by introducing a newly treated grate mesh into the cleaner is justified.

The novelty of the experimental grates was confirmed by the State Committee for Standardization, Metrology and Patents of the Republic of Azerbaijan, the Central Public Legal Entity for Patents and Trademarks (Patent Az) as a utility model **(F 2020 0023)**.

Theoretical and practical significance of the study. Based on the results of the conducted research, a new design of the grate mesh on the raw cotton cleaner was developed. The increase in the cleaning capacity of the proposed design of the grate mesh of cotton gins with circular segment profiled grates is confirmed by production tests.

The new grate mesh with the proposed parameters has been successfully tested and implemented at the Terter and Barda's cotton gins. The economic effect of using the proposed PX-1 grate cleaner in the production of the Terter's cotton gin plant was 1,850 manats per year.

Approbation and application of works. Research results of the scientific and practical conference of the faculty of ATU (Ganja 2016-2021);Scientific and methodological seminars of the department "Engineering and design of light industry" (Ganja 2016-2021); Internauka "Young guard". Challenges and prospects". XI International Scientific and Practical Conference, No. 9 (11), Moscow-2016; AzTU, International Scientific and technical conference "Intelligent technologies in mechanical engineering". Volume 5, No. 1, Baku-2016; AzTU, Materials of the 2nd International scientific and technical conference "Problems of metallurgy and materials science", Baku-2017; At the Scientific and Technical Council of the Azerbaijan Technological University (2018); at the International scientific and technical conference "De-

sign, technologies and innovations in the textile and light industry", Moscow, 2018; at the scientific and practical conference at the Azerbaijan State University of Economics (2018), as well as at national and international scientific conferences.

The new profiled grates were proposed for use in large mixing crushers and passed production tests at the Terter and Barda's cotton processing plants. The annual effect of the proposal was 18,836 manats.

The name of the organization where the dissertation work is performed. The dissertation work was carried out at the Azerbaijan Technological University.

The total volume of the dissertation with an indication of the volume of the structural sections of the dissertation separately. The dissertation work consists of an introduction, five chapters, a conclusion, a list of references in the number of 128 and appendices. There are 41 figures, 20 tables, and 16 appendices. The content of the dissertation contains an introduction of 5 pages and 9593 characters, the first chapter 17 pages and 34222 characters, the second chapter 21 pages and 22814 characters, the third chapter 51 pages and 58157 characters, the fourth chapter 35 pages and 52844 characters, the fifth chapter 7 pages and 8312 characters, conclusions 2 pages and 2676 characters, recommendations for production 1 page and 747 characters and the list of references 128 pages consists of 25423 characters. The volume of the dissertation is 174 pages of computer text, the total volume is 238715 characters (197327 characters excluding the list of references and appendices).

CONTENT OF THE WORK

In the introduction, the relevance of the topic, the problem statement and the general characteristics of the dissertation are given.

First chapter. This chapter is entitled it is devoted to a review of the literature and production information on the state of cleaning raw cotton from foreign impurities.

At the cotton processing plants of our republic, the design and principle of operation of cleaners used for cleaning raw cotton from

foreign impurities, as well as the best practices of foreign countries in this field were studied, scientific and experimental studies conducted in the field of cleaning raw cotton from foreign impurities were analyzed, the influence of grates-the main working body of large cleaners – on the cleaning effect of cotton and fiber quality was studied.

It is proved that increasing the efficiency of cotton cleaning, improving the technical indicators in the cleaning process is impossible without studying the mutual functional relationships between the geometric, kinematic, dynamic and technological parameters of cleaning machines.

As a result of the review of the literature and production, the expe-diency of improving the design of such grates as an element that has a decisive influence on the cleaning effect of large mixing cleaners is justified.

Thus, the cleaning of raw cotton from foreign impurities is on the agenda as an urgent scientific and technical problem. Solving this problem will improve the quality of cotton fiber produced in our country, and ultimately increase the efficiency of production in the textile sector.

Second chapter is it is devoted to the results of theoretical studies of the system of primary cleaning and nutrition of raw cotton in large combined cleaners.

It is established that the feed system must ensure the uninterrupted supply of raw cotton to the machine without damaging the cotton fiber and the shoulder, while the direct impact of the working bodies on the cotton and the forced penetration of the mixtures into the depth of the fiber mass should not be allowed. Under these initial conditions, the interaction of the feed rollers with the cotton layer was studied and the deformation of the cotton layer under the influence of the rollers was studied.

The estimates of the expansion forces that affect the feed rollers and are the most important factors in accordance with the energy intensity of the process, the symmetric and asymmetric states of the rollers in terms of the strength condition and, most importantly, the safety of the processed material are analyzed.

It is established that in the symmetric case, the displacement of the layer surface under the action of the forces P_1, P_2, P_3 and P_1', P_2', P_3' is caused only by local deformations, and in the asymmetric case, the overall displacement of the layer occurs (fig.1, a). It is generally assumed that the feed roller is deformed when a thick layer of raw cotton S consists of curtains (n) evenly distributed around the circumference of the roller and a central angle $\varphi_n = \frac{2\pi}{n}$ between these curtains (fig. 1, b).

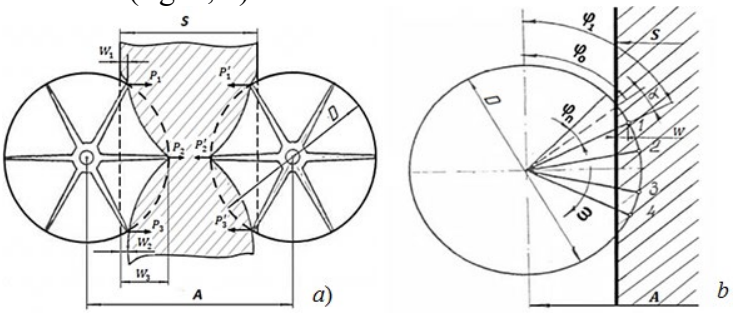

Figure 1. Mutual arrangement and scheme of action of roller curtains fed by a layer of raw cotton wool.

The complete cycle of deformation of the layer of raw cotton with a uniform arrangement of curtains on the feed roller is completed when the transition from the state of 1 $\varphi_1 = \varphi_0$ to the state of. 1 $\varphi_1 = \varphi_0 + \frac{2\pi}{\text{n}}$ the deformation of the layer in the direction perpendicular to its axis for any intermediate state of the surface can be expressed as:

$$\text{W}_1 = \frac{\text{D}}{2}\sin\varphi_1 - \frac{\text{A - S}}{2} = D\cos\frac{\varphi_1 + \varphi_0}{2}\sin\frac{\varphi_1 + \varphi_0}{2}, \qquad (1)$$

$\text{W}_1 - \text{W}_0 = \alpha$ let's specify and simplify the expression (1), that is

$$\text{W}_1 = \text{D}\cos(\varphi_0 + \frac{\alpha}{2})\sin\frac{\alpha}{2}, \qquad (2)$$

for the *i-th* fan $(1 \le i \le r_{\max})$ provided that, in the general case, the following expression is obtained:

$$\text{W}_\text{i} = \text{D}\cos\left[\varphi_0 + \frac{\pi}{\text{n}}(i-1) + \frac{\alpha}{2}\right]\sin\left[\frac{\pi}{\text{n}}(i-1) + \frac{\alpha}{2}\right]. \qquad (3)$$

Thus, according to the last formula, the mechanics of interaction of the web of feeding rollers with the transported layer of raw cotton are disclosed. Based on the geometric parameters of the blade rollers and the cotton layer, the extremum of the total deformation is analytically determined. The calculation of variable forces by the matrix method shows that the shape of the deformable layer is based on the properties of elasticity of raw cotton.

When the parameters of the feed rollers were not symmetrical, the energy consumed by the feed cylinders was estimated on the basis of a comprehensive analysis of the feed system, and stable and unstable cylinder equilibrium positions were determined.

Third chapter the theoretical aspects of the influence of the profile of the grate mounted on sawn drums on the intensity of cleaning raw cotton wool from foreign impurities are investigated. The interaction of a cotton jet fixed on the teeth of a saw drum with the existing circular grate bars with a triangular cross-section is considered.

It is established that cotton jets must travel a certain distance depending on their own elastic force and the coefficient of recovery from impact on the grate, but since the jets in the fibrous mass with a length S are closely related to the sawn-off headset, this does not happen, while the sawn-off drum rotates at a constant angular velocity (fig.2). At this time, the air resistance of the plane A $\delta = K \cdot V_b^2$ the friction force T=f· N and the gravity of the plane P affect

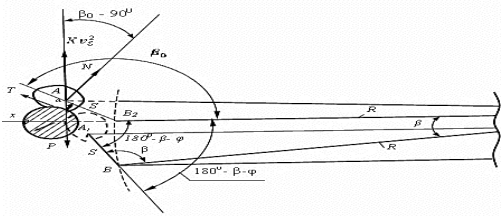

Figure 2. Scheme of interaction of a cotton jet with circular grates.

If we take a fixed system at point B and take the first derivative of the coordinate in time to determine the absolute velocity of the plane a (Fig. 3), then they will be equal to the projection of the velocity of the plane on the coordinate axes *x* and *y*, i.e

$$x = -\left[S\cos(180^0 - \beta - \varphi) + R\cos\varphi\right],$$
$$y = -\left[S\sin\varphi - S\sin(180^0 - \beta - \varphi)\right]. \quad (4)$$

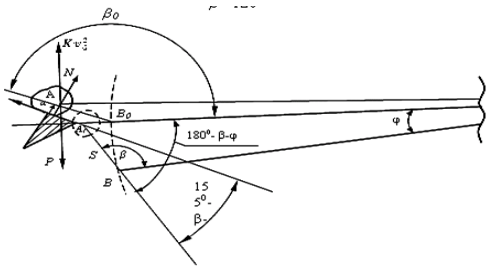

Figure 3. Scheme of interaction of a cotton fly with three-sided grates.

From the time coordinates, we obtain a first-order derivative and, after simplification, we obtain the formula (5) for determining the absolute velocity of the plane A:

$$v_A = \sqrt{S^2(\dot{\beta} + \dot{\varphi})^2 + R^2 \cdot \dot{\varphi}^2 - 2R \cdot S \cdot \dot{\varphi}(\dot{\beta} + \dot{\varphi}) \cdot \cos\beta}, \quad (5)$$

After certain calculations $t = 0{,}005s$, the relative angular velocity of the instantaneous plane on the path between two adjacent grates is taken as follows: $\dot{\beta} = 36{,}944s^{-1}$ - for round grates and $\dot{\beta} = 38{,}63\ S^{-1}$-for triple grates; and the values of the absolute velocity; $v_m = 7{,}86\ m/s$ - for round grates; $v_m = 8{,}10\ m/s$ - for triple grates.

It is established that the absolute velocity of the fibrous mass at the beginning of the impact on the neighboring grate in three-bladed grates is 0.24 m/s higher than in grates with a circular cross-section, which provides an increase in the intensity of separation of raw cotton foreign impurities in comparison with circular grates when three-bladed grates are introduced into the lower part of the sawn drum.

Experimental studies of the impact load and unloading of the plane at the impact of the saw tooth have established that there is a

force dependence between the deformation of the plane at impact and the force N:

$$N = cy^n$$

If c=82.5 and n=1,165, then the shock load and discharge in the system obey a nonlinear law, and the differential equation for this case can be written as:

$$m\frac{d^2y}{dt^2} + C_b\frac{dy}{dt} + cy^n = 0\,, \qquad (6)$$

where m – mass of planes exposed to the impact of the saw teeth; C_b – the coefficient of resistance viscosity is assumed to be equal to zero during loading (conservative model) and greater than zero during unloading (dissipative model.

Let's divide the price interval into *r* equal parts y $[0\,;\, y_{max}]$ and replace the segments of the curve with segments that also coincide with the curve at the ends of the interval. Then the expression (6) for the *i*-th field takes the form of a two-component canonical linear differential equation::

$$m\frac{d^2y}{dt^2} + 2n_{Bi}\frac{dy}{dt} + N_i\, y = 0, \qquad (7)$$

On the graphs N (t) or *y*(t) of the loading of the plane of the saw tooth on impact, the indicators 8.2 (1), 10.5 (2) and 12.8 (3) m/s are indicated, i.e., an increase in the load along whole lines, an increase in the deflection along broken lines (fig.4, a).

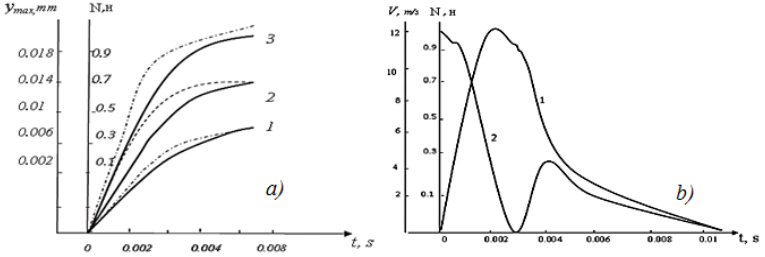

Figure 4. Graphs of *N* (t) or *y*(t) of the saw load on the plane in the event of a saw tooth impact.

The full graphs of N(t) (1) or *y*(t) (2) are shown in figure 6, when the aircraft was at 12.8 m/s on impact $t_{düş}/t_{art}$=4,29, when n_{bi}/N_i = 0,749 = const.

It is established that the obtained load curves of the cotton particle overlap minimally. The microhardness processes of the material are well expressed by the viscosity friction model with an exponential component in the composition (fig. 4, b), while the main reason for the high cost of the fluidity/hardness ratio.

It is established that in cleaners equipped with round-segment profiled grates, the process of separation of edge mixtures is significantly influenced by kinematic and dynamic parameters. Therefore, the scheme of forces arising between the teeth of a circular-segment circular saw is considered in detail (fig. 5).

Since the particle *M* generally moves along the grate with a slip, its center with instantaneous velocity is located at the point *P* below the grate. The absolute water temperature of the point *A* of the particle contact with the grate is perpendicular to $\bar{V}_a$, PA and directed towards the radius of rotation of the drum. When separating the portable and relative units $\bar{V}_a$, it can be seen that the transfer speed is perpendicular to the radius of the drum, and the relative speed is directed to the center, along the radius. Then the friction force $\mu_2 N_2$ will be directed to the center of the drum along the radius *OA*. Let's make an equation of the particle motion along the natural coordinate axes, taking into account that the caries force is small:

$$m\frac{dv_c}{dt} = N_2\cos\varphi_0 - \mu_1 N_1 - \mu_2 N_2 \sin\varphi_0 c v_c^2 - mg\sin(\varphi_0 + \omega t), \quad (7)$$

$$\frac{m d v_c^2}{R+d} = N_1 - \mu_2 N_2 \cos\varphi_0 - N_2 \sin\varphi_0 - mg\cos(\varphi_0 + \omega t). \quad (8)$$

The analysis of the above formulas shows that with an increase in μ1, the N1 reaction increases, as a result of which the mechanical damage to the fiber increases. Therefore, it is necessary to prepare the grate of cotton napkins as smoothly as possible, that is, there should be no obstacles to the movement of flies on the grate. Since $\sin\sin\varphi_0 \approx 0{,}04$ is calculated, this price can be ignored.

$$N_1 = \frac{(R+d)\mu_2 c v_c^2 + m v_c^2}{(R+d)(1-\mu_1\mu_2)}; \qquad N_2 = \frac{(R+d)c v_c^2 + \mu_1 m v_c^2}{(R+d)(1-\mu_1\mu_2)\cos\varphi_0} \quad (9)$$

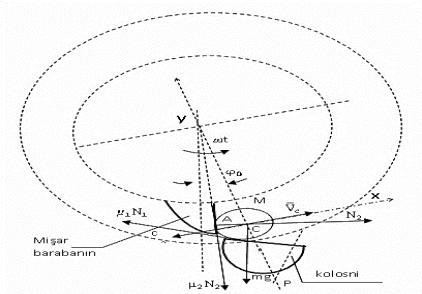

Figure 5. Steep-segment diagram of the power connection between the profile of the grate saw.

From these statements, it can be seen that with increasing VC, the reactions N_1 and N_2 increase. Thus, the optimal velocity value for reducing fiber damage when separating edge impurities from the jet surface is determined by the cost of the impact pulse.

Fourth chapter experimental studies have been conducted to increase the cleaning effect of raw cotton from large impurities. For this purpose, grids consisting of three-sided and round-segment profiled grates were developed and installed on the stand device.

The recirculation section of the saw drum is not installed on the unit, the basic version is taken as round cross-section grates with a diameter of 20 mm, widely used at present in cotton gins, with the number of grates in the lower part of the saw drum 10 pieces, with a distance between the grates 40 mm and with a distance between the saw drum and the grate 16 mm. In the experimental version, three-bladed grates with a cross section of 25×19×12 mm were taken, with an intermediate distance between the saw drum of 16 mm.

In order to select the optimal parameters of the technological process, the method of mathematical planning of poly-factor experiments (TAE) of the 2^3 type is applied. The experiments were carried out on a cotton swab with a saw cylinder, and based on a priori information, three important factors were selected for the study (table 1):

X_1-the angle of change in the diameter of the cylinder of the profiled columns of the round segment relative to the radial plane of the saw drum, $\gamma=30^0 \div 50^0$; X_2 – the speed of rotation of the saw cylinder, ω, m / s; X_3 – the distance between the spikelets, mm.

Table 1. Levels of factors and intervals of their change

Change level and interval	Factors		
	x_1	x_2	x_3
Basic level	40	7	40
Shift interval	10	1	5
Upper level	50	8	45
Lower level	30	6	35

The experiments were carried out on raw cotton of the 1st grade, collected by machine. As a result of the implementation of the planning matrix, adequate mathematical models were obtained for the five output parameters. The planning matrix specifies the "+"upper level, and the specifies the"–" lower level. The TAE-2^3 matrix and the experimental results are shown in table 2

Table 2. Results of the experiment in the planning matrix

Number №	Factors			wastes. fiber	fiber waste	Cleaning effect		
	x_1	x_2	x_3	B	P_B	K	K_{S1}	K_{S2}
1	-	-	-	21	0,048	17	6,4	7,2
2	+	+	-	10,3	0,022	13	6,4	6,8
3	-	+	-	3,7	0,011	20	10,0	11,1
4	+	-	-	2,5	0,008	21	11,6	12,9
5	-	-	+	26,7	0,084	8	7,8	7,7
6	+	+	+	8,3	0,022	21	8,7	9,9
7	-	+	+	8,7	0,035	25	14,7	16,4
8	+	+	+	6,3	0,024	35	11,9	15,4

$$P_v = 0{,}03 - 0{,}013\,x_1 - 0{,}012x_2 + 0{,}01x_2 + 0{,}009x_1x_2$$

$$S^2_{v\,osi} = 0{,}0004; \qquad \overline{P}_v = 0{,}027;$$

$$K = 20{,}0 + 5{,}2\,x_2 + 3{,}2x_1x_3\,S^2_{v\,osi} = 12{,}0; \qquad \overline{K}_0 = 26;$$

$$K_{S_1} = 9{,}7 + 2{,}4\,x_2 + 1{,}1\,x_3\,S^2_{v\,osi} = 3{,}2; \qquad \overline{K}_{S_{1,0}} = 13{,}2;$$

$$K_{S_2} = 10{,}9 + 3{,}0\;\; x_2 + 1{,}4\;\; x_3\,S^2_{v\,osi} = 3{,}8; \qquad \overline{K}_{S_{2,0}} = 15{,}1;$$

$$B = 11 - 4\;\; x_1 - 6\;\; x_2 + 3\;\; x_1x_2\,S^2_{v\,osi} = 12{,}4; \qquad \overline{B}_0 = 7{,}6;$$

As can be seen from the table, at the drum rotation speeds of 6,7 and 8 m / s, the cleaning effect of the device does not differ much from each other. So, after 5 layers of cotton processing in the plant, the cleaning effect is 84.2 % at the saw drum rotation speed of 6 m/s, 86.7 % at 7 m/s and, finally, 87.4% at 8 m / s.

It is confirmed that the best result is obtained when the speed of rotation of the drum is 8 m/s. But since the shoulder damage on the cleaned cotton wool was significant, experiments to refine the speed of rotation of the saw drum were continued. It was found that at the speed of rotation of the saw drum of 8 m/s in the cleaned raw cotton, the damage to the needles is 2.19% (the initial indicator is 0.77%), and the amount of free fibers is 3.26% (the initial indicator is 1.42%). The growth of these indicators is 1.42% and 1.84%, respectively. Thus, the results of the experiment showed that the optimal values of the cleaning parameters were determined based on the mathematical planning of the results:

- saw drum speed, V = 8.4 m/s;
- diameter of the band saw drum, D = 400 mm;
- grate network-alternation of three circular and three triple grates.

Thus, based on the regression equations, it is possible to form a more reasonable idea of the influence of individual factors and their combinations on the course of the technological process.

The fifth chapter is devoted to the results of tests of the improved grate network in production conditions and the calculation of the economic effect of technical and technological developments. Tests carried out at the Terter's and Barda's cotton gin plants confirmed that the new design of the combined grate mesh increases the cleaning effect of raw cotton from foreign impurities (Table 3).

Table 3. Results of testing the characteristics of cotton fibers

Number №-si	Indicators	Unit of measurement	New grate network	Standard grate network
1	Conditional area of garbage	mm^2	0,20	0,20

2	The amount of garbage in fiber	pieces	15	15
3	Fiber Length (2.5 lengths)	mm	27,9	27,9
4	Make a fiber of equal size	%	46,4	46,4
5	Fiber cross-sectional strength	N/teks	21,2	20,0
6	Stretching during stretching	%	6,8	6,3
7	Maturation and tone	%	4,2	4,2
8	Fiber color (white)	%	71,3	71,3
9	Degree of yellowness	%	8,8	9,1
10	Fiber class by color	%	41 – 3	41 – 3

The technical characteristics of the grate network of the new design and the initial data for calculating the economic efficiency are given in table 4.

Table 4. Data for calculating the economic efficiency of the new grate network

Number №	Indicators	Network types		Unit of measurement, %
		serial number	experimental	
1	Cleaning effect, %	52,0	60,0	8,0
2	Number of saw drums	3	2	25
3	Capacity, t / h	5.2	6	-
4	Required power, kW	8,8	6,6	25
5	Cost of one network, manat	2320	2520	8,6

The cost of the new network "grate" in prices as of 1.01.2018 can be calculated as follows:

$$Y_1=A+B+C_d=0,8+0,08+3,0=3,16 \text{ man.}$$

The savings per 1 ton of processed raw cotton are calculated as follows :

$$Y = Y - Y_1 = 4,19 - 3,16 = 1,03 \text{ man.}$$

If we calculate the savings per car per year, we get:

$$E_m=Y\cdot Wc=1,03\cdot 18288=18836 \text{ man.}$$

Note that when assessing the economic effect, such factors as the metal capacity (2 drums instead of 3) and the reduction in the area occupied by the machine were not taken into account in the calculations.

Experimental studies of the new combined mesh on the cleaner have shown that its use can increase the cleaning effect by up to 8% and reduce mechanical damage to the coating by up to 1.5%.

As a result of calculations, it was found that the annual economic efficiency of one machine from the use of the grate network offered in the cleaners at cotton processing plants is 18,836 manats.

Results

1. The generalized theoretical model of the cleaning process shows that a significant reserve for the intensification of the process is a change in the angle of inclination of the grates, which ensures the stability of the process during repeated impacts of the grates on raw cotton.

2. It is established that the absolute speed of fibrous sewing at the beginning of the impact on the neighboring grate is 0.24 m/s higher than that of grates with a circular cross-section in three-bladed grates, and provides an increase in the intensity of separation of impurities from raw cotton compared to circular grates when laying three-bladed grates in the lower part of the sawn drum.

3. The dependence of the slope of the plane on the sawn drum is established, the dimensions are calculated and it is established that the maximum value of the angle of inclination in the zone between two adjacent grates is 70.

4. The differential equations of motion of cotton jets fixed on the sawn drum set in the area between the sawn drum and the grate bars are compiled. Analytical expressions are obtained for finding the absolute and relative velocities of the plane when it moves along the surface of the circular and triple grate and when it separates from the grate, as well as for finding the slope of the plane from the drum.

5. It is proved that when using triple grates in the lower part of the sawn drum, the intensity of separation of raw cotton mixtures and garbage is higher in the calculated values of the absolute and relative velocities in the sawn drum, as well as in the zone between two adjacent grates.

6. During the tests of the developed new grate networks, it was found that the best option for the network is a round-segment and three-segment alternation.

7. As a result of experimental studies, a regression equation is obtained that expresses the dependence of the cleaning effect and mechanical damage to the shoulder on the grate grid, the diameter and design of the drum, which allows us to obtain more complete information about individual factors and their interaction and to form a more reasonable idea of the mechanism of the process.

8. Experimental studies have established that the use of a grate grid consisting of alternating three ring and three triple grates can increase the cleaning effect by up to 8% and reduce mechanical damage to the coating by up to 1.5%. These effects are achieved at a sawn drum speed of 8.4 m/s and a drum diameter of 400 mm.

9. It is established that when using the three-sided and circular segmental grate mesh offered in the lower part of the sawn drum when cleaning raw cotton in cotton gins, the annual economic effect per machine is 18,836 manat.

Recommendations for manufacturing

1. The cleaning section, equipped with new grates, is also recommended for use in suspended-type cleaners of cotton harvesting machines.

2. In order to improve the quality of the solution in cleaning machines, it is recommended to use grate bars of a new design in combination with three-bladed ones.

3. The mathematical model, theoretically and practically justified design technological parameters that justify the cleaning process, can be used in technical tasks for design bureaus of industrial enterprises that design cleaning machines. It is also considered appropriate to include in the textbooks the requirements for the engineering specialty of the received design improvements.

The main content of the dissertation is published in the following scientific papers:

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The defense of the dissertation will be held on «***30***» ***june*** 2021, at ***11^{00}*** at the meeting of the one-time Dissertation council BFD 2.26 of under the Azerbaijan State Agrarian University.

Adress: Az 2000, Azerbaijan Republic, Ganja city, 450, Ataturk avenue.

Dissertation is accessible at the Azerbaijan State Agrarian University library.

Electronic versions of the dissertation and its abstract are avaialable on the official website of the Azerbaijan State Agrarian University

Abstract was sent to the required addresses on «***31***» ***may*** 2021.

Signed for printing: 26.05.2021
Paper format: (210x297) 1\4
Volume: 37921 characters
Number of hard copies: 30