DYNAMICS OF MACHINE AGGREGATES WITH MECHANISMS OF WORKING BODIES FOR CLEANING COTTON FROM FINE IMPURITIES

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Abstract*. The article presents the experimental results of a new composite ring drum that cleans cotton of small impurities The results of a full-factor experiment of the recommended composite spiked drum with an elastic element are presented. The boundaries of the input factors and the levels of their change are given. The planned central composite experimental matrix was constructed, the calculations were performed on the basis of the constructed table, and a regression equation was obtained that determines the cleaning effect. Dependence graphs were obtained for changing the number of revolutions of the drum, changing the distance between the spikes and the mesh, as well as changing the surface of the mesh, which affect the cleaning effect. From the analysis of the graphs, the optimal values of the composite spiked drum are shown.
Keywords: spiked drum, cotton, elastic element, mesh, number of revolutions, cleaning efficiency.

1. Introduction

Currently, processing plants do not have sufficient ability to clean cotton raw materials from small contaminants with high efficiency. The main reason for this is that the aggregate structures are not sufficiently improved.

Proceeding from this, the design of a spike drum with a flexible element was developed, which can provide high efficiency for cleaning raw cotton from small waste (Fig. 1). The design of the spike drum with a flexible element was prepared and tested at the factory.

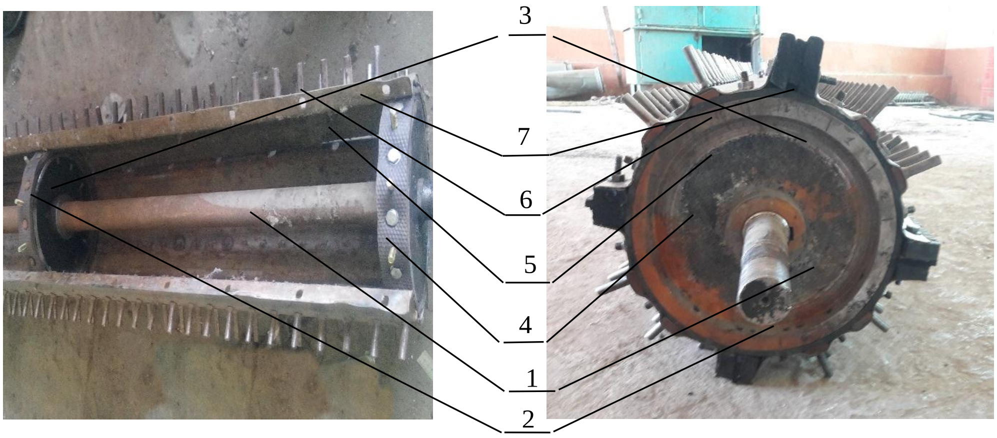
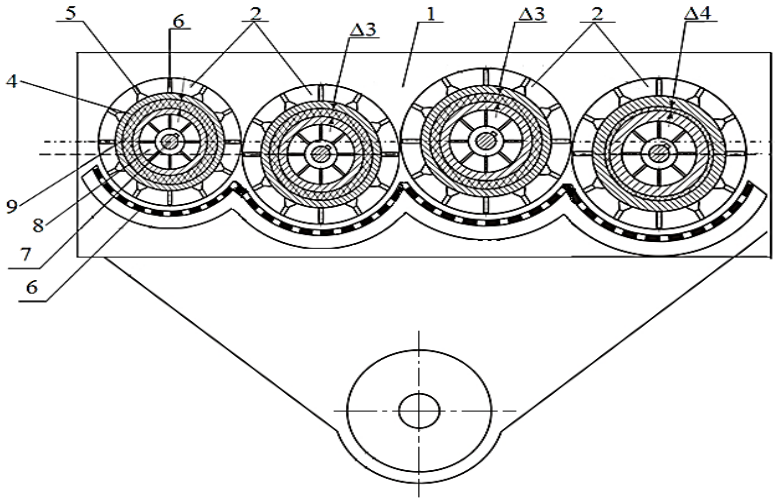


Figure 1. An experimental version of a composite spike drum.

2. Modeling and Methods

In the design, the sleeve 2 is mounted on the shaft 1 with the help of flanges 3 on which the rubber sleeve 4 is fixed. The outer sleeve 5 is mounted on a rubber sleeve 4 with spikes 6 and shafts 7 attached to the surface. There is a mesh surface under the spike drum.

In the process of processing, 4 rubber sleeves are deformed due to the resistance of the cleaned raw cotton to spikes 6 and shafts 7. The value of deformation and the frequency of vibration depend on the stiffness of the rubber and the mass of the outer sleeve 5. Due to the vibration of the spikes 6 and shafts 7, the separation of fine waste from cotton is intensified.



Kinematic scheme

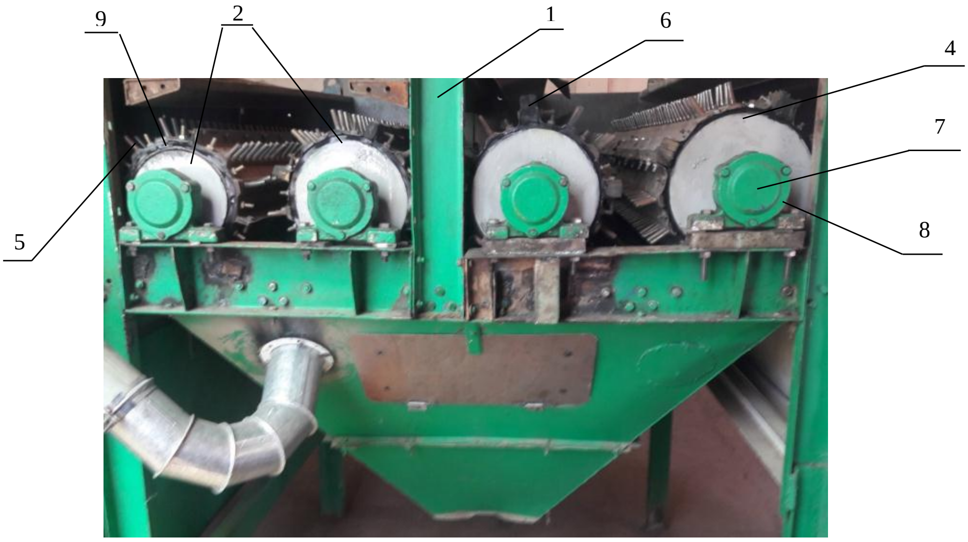


Figure 2. Cleaning section of the new improved cotton ginning unit.

It consists of a spiked drum 5, a cylinder 4 and a shaft 6, which is mounted on the shaft by means of a hub 8 and a circular rubber sleeve 9. The second and fourth shafts of drum 2 are mounted 25÷30 mm lower than the first and third shafts, respectively. The diameter of each subsequent incoming drum 2 was chosen to be 18÷ 30 mm larger than the diameter of the previous incoming drums.

$$d_1 < d_2 < d_3 < d_4$$
$$d_2 - d_1 = d_3 - d_2 = d_4 - d_3 = 18 \div 30 \text{ mm}$$

where, d_1, d_2, d_3, d_4 - diameters of first, second, third and second drums

The cleaning section of the cotton cleaning unit works in the following order. The contaminated cotton raw material transferred to the cotton ginning unit falls into the drums 2, the spike 5, the shaft 6 catches the pilot cotton and squeezes it through the mesh surface 3. The finely contaminated mixture is poured through a horizontal mesh hole and then removed from the cleaning area by pneumatic waste. The angular velocities of all spike-slatted drums 2 are the same and the constructions are similar.

When the cotton is squeezed by rotating the spike-slatted drums 2 spikes 5 and shaft 6, the circular rubber sleeve 9 is deformed, which creates rotational vibrations in the cylinders 4, spike 5, sleeves 6. This condition causes the spikes 5 and shafts 6 of drum 2 to be subjected to additional impulse action, which leads to the intensive separation of finely contaminated mixtures from the raw cotton. Due to the difference in the size of the rubber round sleeves 9, the drums 2, spikes 5 and shafts 6 vibrate with different amplitudes and frequencies. The first drum 2 oscillates at a larger amplitude and smaller frequency than the second drum 2, while the second drum is in the same position relative to the third drum, and so on. Given that the thickness of the rubber sleeve 9 is $\Delta 1 > \Delta 2 > \Delta 3 > \Delta 4$, the next drum corresponding to the number 2 will have a smaller amplitude and a larger frequency of oscillation than the previous incoming drum. In turn, volatile cotton raw materials are initially (the first drum with a spike 5 and a shaft 6) exposed to large amplitudes and low frequencies (low stiffness), in this case, the dirt is separated from the cotton under the influence of a small force, then when the second, third, and fourth spiked and slatted drums 2 are exposed, the vibration of the cotton occurs with a small amplitude and high frequency, and dirty mixtures in the cotton and its deep bottom are released under high force. In addition, the installation of a pneumatic suction 10 to separate contaminants from the cotton raw material prevents dust from the air in the cotton ginning plant.

The proposed composite spiked drum was installed on a cotton-cleaning machine of the UHK unit for cleaning cotton 1XK from small impurities. In this case, rubber was placed between the cover of the spiked drum and the base flanges. It is advisable to conduct the experiments using rubbers with different elastic elements with a rotational shear. Based on the results of practical research, it can be said that due to the deformation of the rubber, the efficiency of cleaning cotton from fine waste increases.

As a result of the use of a new composite spiked drum installed on a machine for cleaning small cotton waste, a mathematical modeling method was used to reduce the number of experimental studies. n order to reduce the number of experiments, full-scale experiments were conducted at the ginnery of the Buz of the Andijan Regional Cotton Industry Association.

The following parameters were selected as factors affecting the cotton cleaning process: number of revolutions of the spiked drum; the distance between the spikes and the mesh; mesh square.

These factors, i.e., input factors that affect the process of cleaning cotton from fine contaminants, were coded. Where, X_1 is the number of revolutions of the spiked drum, X_2 is the distance between the spikes and the mesh surface, X_3 is the mesh square. The values of the input factors are shown in table 1. Cotton picking efficiency has been accepted as an output factor. Based on the foregoing, the efficiency of cotton cleaning was adopted as an evaluation criterion for determining the optimal parameters of the spiked drum.

3. Results and Discussions

3.1. The solution of problem and analyzing the results

Borders of factors and intervals of their change

Table 1

Name of the factor	Coded character	The real value of the factor					Interval of the change
		-1,682	-1	0	+1	+1,682	
Number of revolutions of the spiked drum, *n-rpm*	X_1	387	405	430	455	472	25
Distance between the spikes and the mesh surface , *t*-mm	X_2	16	17	20	23	25	3
Mesh square , *t-sq. m*	X_3	3,33	3,4	3,5	3,6	3,67	0,1

The cleaning efficiency of the cotton was taken as the output factor and its true sign was denoted by the letter M. The experimental results and dispersions of the output factor are given in Table 2.

Planned central composition of the experimental matrix

Table 2.

U	X_1	X_2	X_3	$(X_1)^2$	$(X_2)^2$	$(X_3)^2$	X_1X_2	X_1X_3	X_2X_3	$\bar{y}_u$
1	+	+	+	+	+	+	+	+	+	78,45
2	+	+	-	+	+	+	+	-	-	76,6
3	+	-	+	+	+	+	-	+	-	83,0
4	+	-	-	+	+	+	-	-	+	82,3

5	-	+	+	+	+	+	-	-	+	76,4
6	-	+	-	+	+	+	-	+	-	73,0
7	-	-	+	+	+	+	+	-	-	78,6
8	-	-	-	+	+	+	+	+	+	76,1
9	-1,68	0	0	2,822	0	0	0	0	0	75.0
10	1,68	0	0	2,822	0	0	0	0	0	82,1
11	0	-1,68	0	0	2,822	0	0	0	0	81,9
12	0	1,68	0	0	2,822	0	0	0	0	75,2
13	0	0	-1,68	0	0	2,822	0	0	0	76,25
14	0	0	1,68	0	0	2,822	0	0	0	80,9
15	0	0	0	0	0	0	0	0	0	78,5
16	0	0	0	0	0	0	0	0	0	78,2
17	0	0	0	0	0	0	0	0	0	78,6
18	0	0	0	0	0	0	0	0	0	79,8
19	0	0	0	0	0	0	0	0	0	78,3
20	0	0	0	0	0	0	0	0	0	78,9

Based on the planning matrix, three repetitive experiments were performed in each condition. In this case, the number of experiments is determined by the following expression:

$$N = 2^k + 2k + n_0 = 2^3 + 6 + 6 = 20, \qquad (1)$$

Where, N – number of experiments; k – number of factors; n_0- the number of experiments at mean values.

The arithmetic mean of the repeated values of the cleaning efficiency obtained as a result of the experiment was entered in column 11 of Table 2. In this case, the arithmetic mean of the results is determined as follows;

$$\overline{Y} = \frac{Y_{i1} + Y_{i2} + Y_{i3}}{3}. \qquad (2)$$

On a general basis, factors are converted from natural values to coded values.

To obtain a regression model representing a stationary layer, a planned central composition experiment is performed on the following matrix:

Based on the table, we first find the following values to determine the regression coefficients using the above formulas:

$$\sum x_{1u}Y_u = 28{,}18; \qquad \sum x_{2u}x_{3u}Y_u = 2{,}05;$$

$$\sum x_{2u}Y_u = -26{,}81; \qquad \sum x_{1u}^2 Y_u = 1067{,}79;$$

$$\sum x_{3u}Y_u = 16{,}26; \qquad \sum x_{2u}^2 Y_u = 1067{,}79;$$

$$\sum x_{1u}x_{2u}Y_u = -4{,}95; \qquad \sum x_{3u}^2 Y_u = 1067{,}93;$$

$$\sum x_{1u}x_{3u}Y_u = -3{,}35;$$

Now we will construct the regression equation and calculate the regression coefficients.

Regression equation

$$Y = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_{12}x_1x_2 + b_{13}x_1x_3 + b_{23}x_2x_3 + b_{123}x_1x_2x_3 + b_{11}x_1^2 + b_{22}x_2^2 + b_{33}x_3^2$$

(3)

We then determine the regression coefficients:

$$b_0 = a_1 \sum_1^N y_u - a_2 \sum_1^k \sum_1^N x_{iu} y_u = 0{,}1663 \cdot 1568{,}1 - 0{,}0568 \cdot (1067{,}79 + 1067{,}79 + 1067{,}79) = 78{,}5$$

;

$$b_1 = a_3 \sum_1^N x_{1u} y_u = 0{,}0732 \cdot 28{,}18 = 2{,}062;$$

$$b_2 = a_3 \sum_1^N x_{2u} y_u = 0{,}0732 \cdot (-26{,}81) = -1{,}96; \; b_3 = a_3 \sum_1^N x_{3u} y_u = 0{,}0732 \cdot 16{,}26 = 1{,}19;$$

$$b_{12} = a_4 \sum_1^{n_я} x_{1u} x_{2u} y_u = 0{,}125 \cdot (-4{,}95) = -0{,}618;$$

$$b_{13} = a_4 \sum_1^{n_я} x_{1u} x_{3u} y_u = 0{,}125 \cdot (-3{,}35) = -0{,}419;$$

$$b_{23} = a_4 \sum_1^{n_я} x_{2u} x_{3u} y_u = 0{,}125 \cdot (2{,}05) = 0{,}256;$$

$$b_{11} = a_5 \sum_1^N x_{1u}^2 y_u + a_6 \sum_1^k \sum_1^N x_{1u}^2 y_u - a_7 \sum_1^N y_u = 0{,}0625 \cdot 1067{,}79 + 0{,}0069 \cdot (1067{,}79 + 1067{,}79 + 1067{,}93) - 0{,}0568 \cdot 1568{,}1 = -0{,}23$$

$$b_{22} = a_5 \sum_1^N x_{2u}^2 y_u + a_6 \sum_1^k \sum_1^N x_{2u}^2 y_u - a_7 \sum_1^N y_u = 0{,}0625 \cdot 1067{,}79 + 0{,}0069 \cdot (1067{,}79 + 1067{,}79 + 1067{,}93) - 0{,}0568 \cdot 1568{,}1 = -0{,}23$$

$$b_{33} = a_5 \sum_1^N x_{3u}^2 y_u + a_6 \sum_1^k \sum_1^N x_{3u}^2 y_u - a_7 \sum_1^N y_u = 0{,}0625 \cdot 1067{,}93 + 0{,}0069 \cdot (1067{,}79 + 1067{,}79 + 1067{,}93)$$
$$- 0{,}0568 \cdot 1568{,}1 = -0{,}218$$

;

Based on the calculations, the regression equation looks like this:

$$Y = 78{,}5 + 2{,}062 x_1 - 1{,}96 x_2 + 1{,}19 x_3 - 0{,}618 x_1 x_2 - 0{,}419 x_1 x_3 + 0{,}256 x_2 x_3 - 0{,}23 x_1^2 - 0{,}23 x_2^2 - 0{,}218 x_3^2 \quad (4)$$

The values of the output factor solved by the constructed regression equation are given in Table 3.

Output factor values obtained by solving the regression equation

Table 3.

№	$\overline{Y_i}$	Y_{Ri}	$\overline{Y_i} - Y_{Ri}$	$\left(\overline{Y_i} - Y_{Ri}\right)^2$
1	78,45	78,65	-0,203	-0,011
2	76,6	76,60	0,003	0,000
3	83	83,30	-0,302	-0,030
4	82,3	82,27	0,029	0,002
5	76,4	76,60	-0,202	-0,012
6	73	72,87	0,128	0,005
7	78,6	78,78	-0,177	-0,014
8	76,1	76,07	0,029	0,002
9	75	74,71	0,290	0,007
10	82,1	81,64	0,460	0,011
11	81,9	81,47	0,429	-0,003
12	75,2	74,88	0,322	0,018
13	76,25	76,20	0,050	0,001
14	80,9	80,20	0,700	0,013
15	78,5	78,4	0,100	-0,011

16	78,2	78,05	0,150	-0,062
17	78,6	78,3	0,300	0,000
18	79,8	79,2	0,600	0,114
19	78,3	78,05	0,250	-0,078
20	78,9	78,5	0,400	0,116
Total:				0,070

We calculate the variance of the output parameter:

$$S^2\{Y\} = \frac{\sum_1^6 \left(y_{0i} - \overline{y_0}\right)}{n_0 - 1} = \frac{0.625}{6-1} = 0{,}125 \qquad (5)$$

The variance of the regression coefficients is determined using the above expressions:

$\left|S\{b_0\}\right| = \sqrt{S^2\{b_0\}}$; $S^2\{b_0\} = a_1 \cdot S^2\{Y\} = 0{,}1663 \cdot 0{,}125 = 0{,}02$; $S\{b_0\} = 0{,}1$;
$\left|S\{b_i\}\right| = \sqrt{S^2\{b_i\}}$; $S^2\{b_i\} = a_3 \cdot S^2\{Y\} = 0{,}0732 \cdot 0{,}125 = 0{,}009$; $S\{b_i\} = 0{,}09$
; $\left|S\{b_{ij}\}\right| = \sqrt{S^2\{b_{ij}\}}$; $S^2\{b_{ij}\} = a_4 \cdot S^2\{Y\} = 0{,}125 \cdot 0{,}125 = 0{,}0156$; $S\{b_{ij}\} = 0{,}1$;
$\left|S\{b_{ii}\}\right| = \sqrt{S^2\{b_{ii}\}}$; $S^2\{b_{ii}\} = a_5 \cdot S^2\{Y\} = 0.0625 \cdot 0{,}125 = 0{,}0078$;
$S\{b_{ii}\} = 0{,}08$.

The significance of the regression coefficients was estimated by calculating the calculated value of the Student's criterion. We determine the calculated values of the Student's criterion for certain regression coefficients.

$$t_R\{b_0\} = \frac{b_0}{S\{b_0\}} = \frac{78{,}5}{0.1} = 785; \qquad t_R\{b_1\} = \frac{b_1}{S\{b_i\}} = \frac{2{,}062}{0{,}09} = 22{,}91;$$

$$t_R\{b_2\} = \frac{b_2}{S\{b_i\}} = \frac{-1{,}96}{0{,}09} = -21{,}7; \qquad t_R\{b_3\} = \frac{b_3}{S\{b_i\}} = \frac{1{,}19}{0{,}07} = 13{,}2;$$

$$t_R\{b_{12}\} = \frac{b_{12}}{S\{b_{ij}\}} = \frac{-0{,}618}{0{,}1} = -6{,}18; \qquad t_R\{b_{13}\} = \frac{b_{13}}{S\{b_{ij}\}} = \frac{-0{,}419}{0{,}1} = -4{,}19;$$

$$t_R\{b_{12}\} = \frac{b_{12}}{S\{b_{ij}\}} = \frac{0{,}256}{0{,}1} = 2{,}56; \qquad t_R\{b_{11}\} = \frac{b_{11}}{S\{b_{ii}\}} = \frac{-0{,}23}{0{,}08} = -2{,}875;$$

$$t_R\{b_{22}\} = \frac{b_{22}}{S\{b_{ii}\}} = \frac{-0{,}23}{0{,}08} = -2{,}875;$$

$$t_R\{b_{33}\} = \frac{b_{33}}{S\{b_{ii}\}} = \frac{-0{,}218}{0{,}08} = -2{,}725.$$

The calculated value of the Student's criterion was compared with the value selected from the table. In this case, the following condition must be met.

$$t_x \rangle t_{жад}, \quad t_{ж}\left[P_Д = 0{,}95; f\left\{S_M^2\right\} = 6 - 1 = 5\right] = 2{,}57 \qquad (6)$$

If a given condition is met, the calculated regression coefficients are considered significant, but if the condition is not met, this regression coefficient is considered insignificant and is excluded from subsequent calculations. Since the result of the calculations is insignificant because the value of $t_{Rb_{23}}$ is smaller than the value selected from the table, we continue to calculate the next all the coefficients as significant.

Thus, as a result of our calculations, the coefficients b_0, b_1, b_2, b_3, b_{12}, b_{13}, b_{11}, b_{22} and b_{33} were found to be significant, and subsequent calculations were continued with these coefficients. In this case, the regression equation was as follows :

$$Y = 78{,}5 + 2{,}062x_1 - 1{,}96x_2 + 1{,}19x_3 - 0{,}618x_1x_2 - 0{,}419x_1x_3 - 0{,}23x_1^2 - 0{,}23x_2^2 - 0{,}218x_3^2; \quad (7)$$

The resulting regression equation was tested for adequacy based on the Fisher criterion. The calculated value of the Fisher criterion was determined from the following expression:

$$F_R = \frac{S^2_{a\partial}(Y)}{S^2(\overline{Y})}; \quad (8)$$

$$S^2_{a\partial} = \frac{\sum_1^{20}\left(y_u - \overline{y_0}\right)^2 - \sum_1^{6}\left(y_{0i} - \overline{y_0}\right)}{20-6-5} = \frac{0{,}44 - 0{,}377}{9} = 0{,}005; \quad (9)$$

$$F_{расч} = \frac{S^2_{a\partial}}{S^2_{\{y\}}} = \frac{0.005}{0.079} = 0.074. \quad (10)$$

When the value of the Fisher criterion in the table was compared with the calculated value of $F_{ж}$ and F_x, the condition $F_x = 0.074 \langle 3{,}48 = F_{ж}$ was fulfilled and the adequacy of the template was determined. We obtain the table value of the Fisher criterion from the application under the following condition:

$$F_{ж}\left[P_Д = 0{,}95;\ f\left\{S^2_{над}\{Y\}\right\} = 20 - 6 - (6-1) = 9;\ f\left\{S^2_M\right\} = 6 - 1 = 5\right] = 3{,}48 \quad (11)$$

Hence, the resulting regression model is adequate and can be used in future studies. The regression coefficients in the regression equation are of great importance in characterizing the output factor.

Equation (7) is inconvenient for the results obtained and practical calculations. Therefore, the transition from the encoded *(X_1, X_2, X_2)* value to the actual factor value *(n, t, v)* is found by the following formula;

$$X_1 = \frac{n - n_0}{\Delta n}; \qquad X_2 = \frac{t - t_0}{\Delta t}; \qquad X_2 = \frac{v - v_0}{\Delta v}; \quad (12)$$

v_0, s_0, a_0 are the actual values of the basic equation., $\Delta n, \Delta t, \Delta v$ - intermediate values. If we put the values n_0, t_0, v_0 and $\Delta n, \Delta t, \Delta v$ in formula (12), the following equation is formed

$$X_1 = \frac{n - 430}{50}; \qquad X_2 = \frac{t - 20}{3}; \qquad X_2 = \frac{v - 72{,}5}{12{,}5}; \quad (13)$$

The factor equation derived from expression (13) can be written as follows.

$$M_z = -23{,}54 + 0{,}25n + 2{,}11t + 0{,}583v - 4{,}1\cdot10^{-3} n\cdot t - 6{,}7\cdot10^{-4} n\cdot v - 9{,}2\cdot10^{-5}\cdot n^2 - 0{,}025t^2 - 1{,}4\cdot10^{-3} v^2$$

In order to further clarify the research, the numerical solution of the equation was solved in Excel and the dependence graphs of the parameters were obtained.

Figure 3 shows a graph of the dependence of the number of revolutions of the spiked drum on the cleaning efficiency. The first graph in the diagram is at lower values of x_2 and x_3, the second graph is at intermediate values, and the third graph is at higher values.

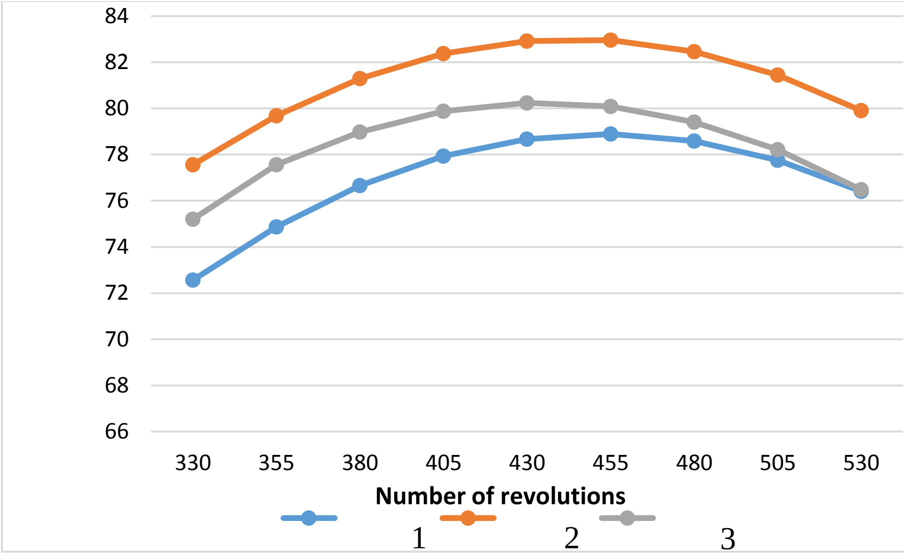


Figure 3. Graph of change of cleaning efficiency depending on the number of revolutions of the spiked drum.

The graphs showed an effect on cleaning efficiency when the number of revolutions of the spiked drum increased from 330 rpm to 530 rpm. In Figure 1, the cleaning efficiency was determined when the lower values of x_2 and x_3 were x_2 =17 mm and x_3=3.4 sq.m. At the same time, when the rotational speed of the spiked drum was 330 rpm, the lowest cleaning efficiency was 72.56%, and when it was increased to 450 rpm, the cleaning efficiency increased, and the highest result was 78.89%. while increasing it to 530 rpm, it was noted that the cleaning efficiency decreased by 76.41% as a result of the rapid release of raw cotton from the working chamber. In Figure 2, the cleaning efficiency of x_2 and x_3 was determined when the mean values were x_2 =20 mm, x_3 = 3.5 sq.m. If the number of revolutions of the pile drum is 330 rpm, the cleaning efficiency is the lowest result of 77.56%, when we increase it to 455 rpm, the cleaning efficiency increases to 82.96%, and when we increase it to 530 rpm, the cleaning efficiency decreased to 79,91%. In Figure 3, experiments were performed by varying the number of revolutions of the spiked drum at high values of x_2 and x_3 at x_2 =23 mm and x_3=3.6 sq.m. At the same time, when the number of revolutions of the spiked drum was 330 rpm, the minimum cleaning efficiency was 75.2%, and when we increased it to 430 rpm, the cleaning efficiency increased to 80.24%, while at 530 rpm the cleaning efficiency decreased by 76.42%. From the analysis of the graphs, it can be seen that the cleaning efficiency of the spiked drum at lower and higher values of the number of revolutions was found to be lower. In experimental studies, when the spiked drum is checked at high values of rotation, that is, at 480 rpm, we can see that the cleaning efficiency of cotton is reduced as a result of the rapid passage of raw cotton inside the chamber. When the number of revolutions of the spiked drum was 440-455 rpm, the cleaning efficiency was highest, i.e. 82.96%.

At lower values of the number of spiked drum revolutions, i.e. 330-380 rpm, the cleaning efficiency showed the lowest result. It can be seen, that at lower values of the number of spiked drum rotations (X1), the efficiency of cleaning the cotton from contaminants was found to be low.

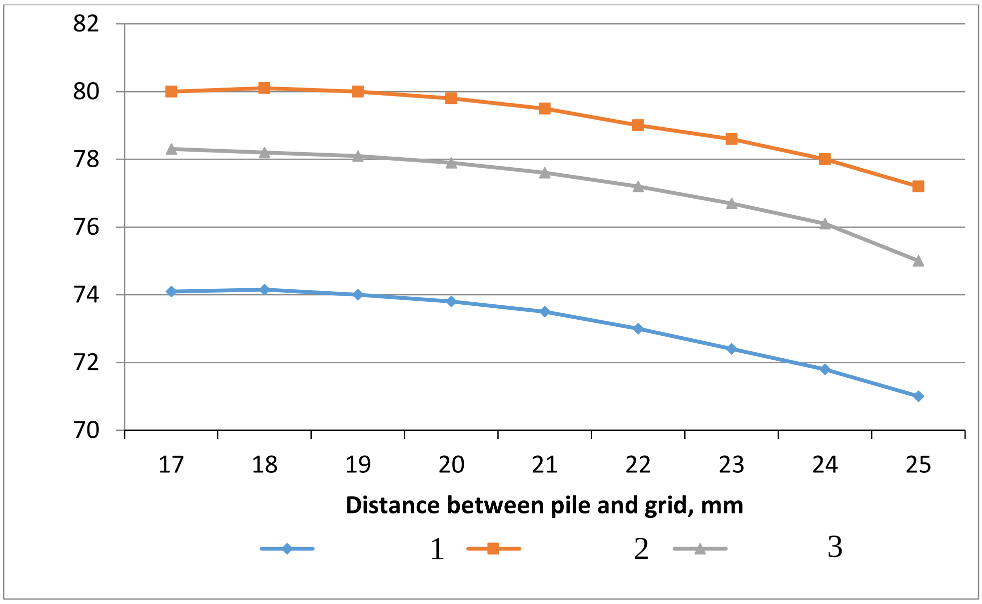


Figure 4. Graph of change in cleaning efficiency depending on the distance between the spike and the mesh

Figure 4 shows graphs of the dependence of the cleaning efficiency on the distance between the spike and the mesh. The first graph in the diagram is at low values of x_1 and x_3, the second graph is at medium values, and the third graph is at high values.

The effect of cleaning efficiency was studied when the distance between the mesh surface and the spikes increased from 17 mm to 25 mm. In Figure 1, the experiment was performed by changing the distance between the pile and the grid at the lower values of x_1 and x_3, i.e., when x_1 = 405 rpm and x_3 =3.4 sq.m. At the same time, when the intermediate distance was checked by 17 mm, it was noted that the cleaning efficiency was 74.1%, with an increase of 19 mm, the cleaning efficiency decreased by 74%, with an increase of 25 mm - by 71%. Figure 2 examines the effect of cleaning efficiency on the mean values of x_1 and x_3, i.e., x_1 = 430 rpm and x_3 = 3.4 sq.m. If the intermediate distance was 17 mm, the maximum cleaning efficiency was 79.357%, and if it was increased to 25 mm, the cleaning efficiency was reduced to 76.8%. In Figure 3, the experiment was performed by changing the distance between the spikes and the mesh at high values of x1 and x3, i.e., when x1 = 455 rpm and x3 =. At the same time, the cleaning efficiency was 78.159% at an intermediate distance of 17 mm. At an intermediate distance of 18 mm, the cleaning efficiency decreased and showed a result of 73.219%. When we increased the intermediate distance to 25 mm, it was observed that the cleaning efficiency decreased to 76.113%.

The results obtained and the graphs show that the cleaning efficiency of raw cotton was optimal when the distance between the mesh surface and the spikes was 17-18 mm.

In this case, the effect on the cleaning efficiency was determined when the surface of the mesh of the spiked drum increased from x_3=3.3 sq.m to x_3=3.7 sq.m. In Figure 1, the experiment was performed by changing the mesh surface at the lower values of x_1 and x_2, i.e., when x_1=330 rpm and x_2 = 14 mm. At the same time, the minimum cleaning efficiency was 72.28% when the қзшлув drum mesh surface x_3 = 3.3 sq.m, and the maximum cleaning efficiency increased to 79.58% when x_3 = 3.60 sq.m.

In Figure 2, the effect of cleaning efficiency on the mean values of x_1 and x_2, i.e., x_1 = 430 rpm and x_2 = 20 mm, was studied.

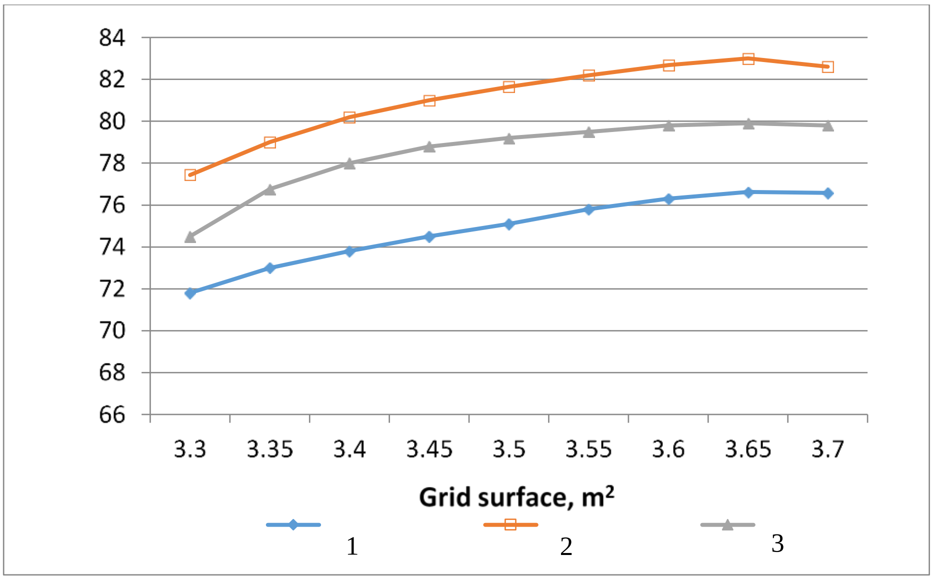


Figure 5. Graph of change of cleaning efficiency depending on the square of the mesh.

If the surface of the grating of the ring drum is x_3=3.3 square meters, the lowest cleaning efficiency is 77.15%, with x_3=3.65 square meters the highest cleaning efficiency is 83.0%, with x_3=3.7 sq. m. it was found that the cleaning efficiency decreased, and this figure was 82.442%. Figure 3 examines the effect of cleaning efficiency at high values of x_1 and x_2 when x_1=480 rpm and x_2=23 mm. In this case, the surface of the spiked drum mesh x_3 = 3.3 sq.m. with a minimum cleaning efficiency of 76.55%, x_3 = 3.62 sq.m. showed that the cleaning efficiency increased to a maximum of 80.95%. The surface area of the annular drum mesh is x_3 = 3.7 sq.m. in which the cleaning efficiency decreased to 80.93%. From a graphical analysis, it was found that a change in the surface of the spiked drum mesh affects the cleaning efficiency.

At the surface x_3 = 3.7 sq.m of the spiked drum mesh, the cleaning efficiency was reduced to 80.93%. From the graph analysis, it was found that the change in the surface of the spiked drum mesh had an effect on the cleaning efficiency. When a flexible element with a mesh surface x_3 = 3.65 sq.m is installed on a spiked drum, it allows to clean the raw cotton at the highest efficiency,

4. Conclusions

Hence, as a result of full-factor experiments, the optimal values of the operating parameters of the improved cotton ginning machine were determined. The analysis of the general graphs and the resulting regression equation were solved to the extremum, and the following optimal values were found, which provided an increase in the cleaning efficiency of the spiked drum. According to this, n = 455 rpm; h = 17.5 mm and the pitch of the spiked drum flexible element is 3.65 sq.m. At the optimal values found, the value of the evaluation criterion, i.e. the cleaning efficiency of the cotton, is 83.01%. Based on the analysis of the graphs, it was found that the cleaning efficiency was higher when using a spiked drum with the recommended composition compared to the existing spiked drum in cotton ginning machines.

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