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Improving the Design and Justification of the Parameters of the Saw Section of the Cotton-Cleaning Unit

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ABSTRACT : The article presents a new design of the serrate section of a cotton-cleaning unit with transporting brush drums having different diameters and grate on elastic supports with a certain thickness; the design features of the working parts of the serrate section of the cotton-cleaning unit are considered in detail, as well as the principle of its operation. On the basis of preliminary experimental studies, the parametric operation modes of the working parts of the serrate section of a cotton-cleaning unit are substantiated. The results of the full-factor experiment of grate on elastic supports are given. The results of testing the serrate section are given, along which the ways to improve the cleaning effect of raw cotton from coarse litter are identified, as well as the possibilities for increasing the productivity of a cotton-cleaning unit in accordance with the flow line of primary cotton processing at a cotton-cleaning plant.

KEYWORDS: raw cotton cleaning, spun litter, serrated grate, elastic support, oscillation, frequency, amplitude.

I.INTRODUCTION

The cotton cleaning unit "Universal Cotton Complex (UHK)" includes several consecutive cleaning sections, both of small litter and large litter, and has a common helical drain. The cleaning serrated section of the cotton-cleaning unit UHK contains a body, successively installed two transporting brush drums, two serrate drums, grate bars beneath them, a removable drum (interacting) between the serrated drums, lapping brushes rigidly installed in the body, augers for removing weed contaminants. The transporting brush drums can rotate in both directions, clockwise the operating mode and counterclockwise in the case of excluding the power supply with cotton of the serrate cleaning section.

Figure 1 shows the general scheme of the proposed cotton sawing section of the cotton-cleaning unit. On sections A-A and Б-Б case 1 is conventionally shown together with reinforcing plates welded to it under the grid-irons. The main disadvantage of the design of the cleaning serrated section of the UHK cotton ginning unit is the clogging of the inter brush space of the transporting brush drums and the repeated introduction of cotton with the transport brush brushes to the inter brush area. This leads to a decrease in the uniformity of supply and transportation of cotton.

Also this design has a low effect of cleaning raw cotton from large litter.

In order to increase the reliability and uniformity of supply and transportation of cotton, increase the cleaning effect of raw cotton from coarse litter, and reduce the damage to fiber and cotton seed, the authors have developed an improved design of transporting brush drums, grates of the cleaning serrate section of a cotton cleaning unit. At the same time, due to an increase in the ': linear velocity of the output conveyor brush drum, timely uniform supply and

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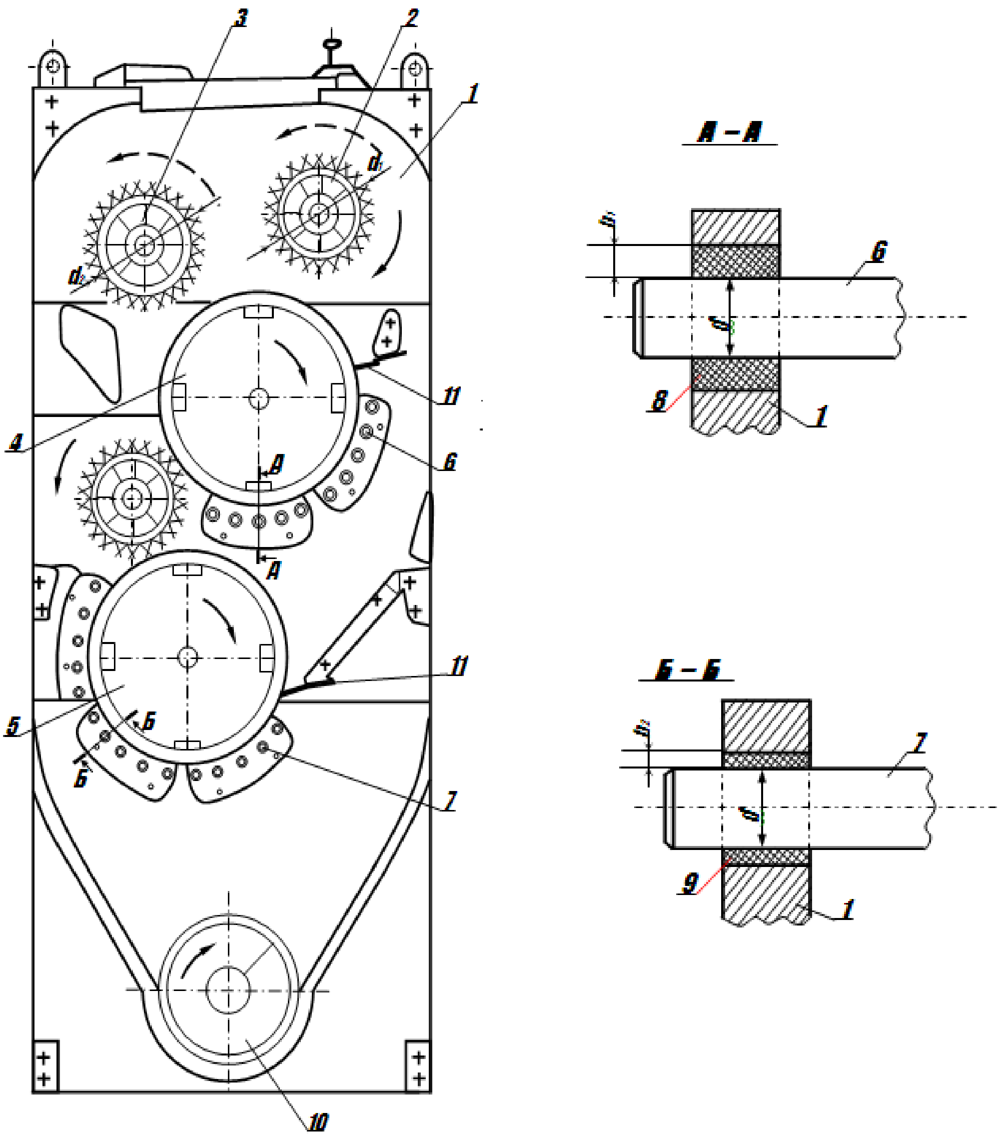

Fig. 1. Cleaning serrate section of a cotton-cleaning unit

transportation of cotton is ensured. Due to the additional vibrations of grates with the required frequency and amplitude, the effect of cleaning cotton from large litter will increase [2,3,4,5,6].

The cleaning serrated section of the cotton-cleaning unit (see Fig. 1) includes a body 1, two successively installed transporting brush drums 2 and 3, and a second (output) 3 of which are made with a diameter greater than 5-10% relative to the diameter of the first transporting brush drum 2, the upper 4 and lower 3 sawtooth drums, the grate 6 and 7 below them, mounted on the housing 1 by means of rubber bushings (elastic supports) 8 and 9, having the same internal diameters "b". The thickness of the rubber bushings 8 of the grate 6 is made more by 10-15% (h1> h2), i.e. rubber grommets thickness 9.

Cleaning serrate section of the cotton gin unit works as follows. The clogged raw cotton transported in the cotton-cleaning unit (only one section is shown in Fig. 1) goes to the transported brush drums 2 and 3, which, in the operating mode, throw cotton on the surface of the serrate drums 4.5. The teeth of the serrated drums 4.5, grabbing the cotton buckets, drag them through the grate b and 7. At the same time, weed impurities fall through the gaps between the grate 6.7 and are retracted by the screw 10. The transporting brush drum 3 allows for timely and continuous throwing cotton stabs to the serrate drum 4 due to the additional speed (d1> d2). In the transporting mode (counter

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clockwise rotation) of the cleaning unit operation, due to the increased diameter of the transporting brush drum 3, the cotton is braked between the drums 2 and 3, the cotton is evenly transported bypassing the cotton girder cleaning unit.

Installing the grate 6 and 7 on the elastic supports (on rubber bushings) 8 and 9 can significantly increase the allocation of weed impurities from cotton due to its vibration. At the same time, the grate 6s under the upper sawed drum 4 oscillate with greater amplitude and lower frequency due to the greater thickness h1> h2 of the rubber bushings 8. In this cotton cleaning zone, mainly large weed impurities with small adhesion forces to the cotton fly fibers will be released. The grate 7 under the serrate drum 5 oscillates under the action of cotton with a smaller amplitude and greater frequency due to the smaller thickness of 1c rubber bushings 9. In this zone of cotton cleaning, mainly large weed impurities with significant adhesion forces that are deeply embedded in cotton will be released. Selected trash (mainly coarse) is discharged by the screw 10.

To substantiate the parameters of the coarse-cleaning zone, full-factor experiments have been conducted. The relative values of the factors are presented in table 1.

According to the results of the analysis, a system of equations obtained as a result of data processing using the EXCEL computer program has the following form: regression equation for 2-grade cotton:

$$У= 84,08+0,96X_1 -1,28X_2-0,76X_3 -2X_1X_2 -0,34X_2X_3 + 0,27X_1X_2X_3 \quad (1)$$

egression equation for 4th grade cotton:

$$У=80,1+0,33X_1-1,24X_2-1,87X_3+0,4X_1X_2-1,56X_1X_3+0,73X_2X_3+0,37X_1X_2X_3 \quad (2)$$

Mathematical calculation of the adequacy of the obtained equations (1) and (2) showed good convergence of models and experimental results.

Table 1.

The name of the factor	Designation code	True factor values			Change range
		-1	0	+1	
Rubber stiffness 10^4N/m	X_1	1,0	1,5	2,0	0,5
Performance Cars тон/t. P	X_2	5	6	7	1
Gap on the grate δ, 10^{-3}m	X_3	12	14	16	2

The results of calculations after processing are presented in the form of graphs (Fig. 2). In fig. 2a shows the dependences of cotton cleaning efficiency on rubber hardness, where four curves y = y (x) are given.

The first curve corresponds to the minimum, the second and the third – to the intermediate, the fourth to the maximum values of the factors x2 and x3. On the first curve at x_2=5.0 t / h, x_3=12 mm, it increases from 83.04% to 89.01%, on the second curve at x_2=5.66 t / h, x_3=13.32 mm, respectively from 82.8% to 83.7%, on the third curve with x_2=6.32 t / h, x_3= 14.64 mm, respectively, from 83.04% to 83.7%, on the fourth curve with x_3=7 , 0 t / h, x_3=16.0 mm, respectively, 82.47% to
80.9%.

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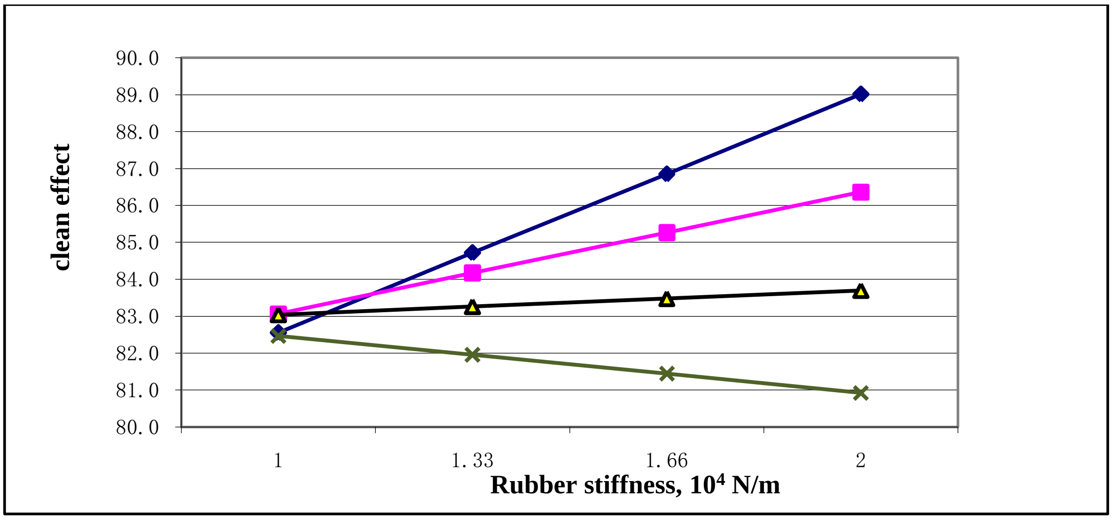
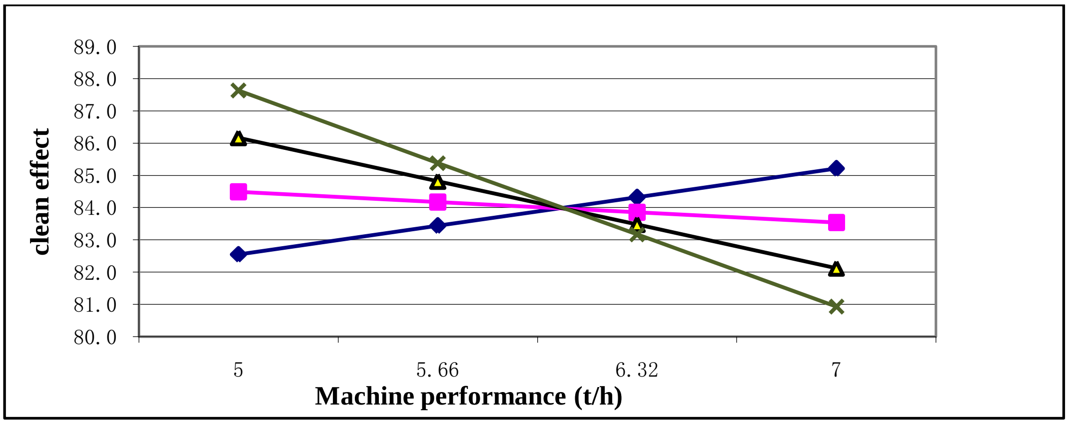
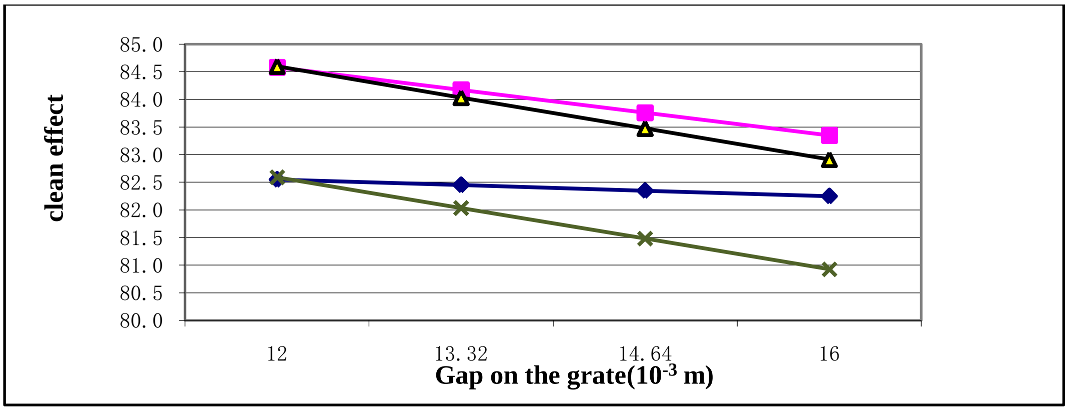


a-graphs of the change in the cleaning effect from variations in the stiffness of the rubber bush of the grate, where, 1-at x_2=5.0 t/h, x_3=12 mm, 2-at x_2=5.33 t/h, x_3=13.32 mm , 3- at x_2=5.66 t/h, x_3=14.64 mm, 4- at x2 = 7.0 t/h, x_3=16.0 mm.



b-graphs of the change in the cleaning effect of the variation in the performance of the machine, where, 1- at x_1=1.0·104 N/m; x_3=12 mm, 2–for x_1=1.33·104 N / m; x_3=13.32 mm; 3-with x_1=1.66·104 N/m; x_1=14.64 mm, 4-at x_1=2.0·104 N/m; x_3=16.0 mm.



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v-graphs of the change in the cleaning effect from the variation of the gap between the grate and the saw cylinder. Where 1-x_1=1.0·104 N/m; x_2=5.0 t/h, 2- at x_1=1.33·104 N/m; x_2=5.56 t/h, 3 at x_1=1.66 104 N/m; x_2=6.32 t/h 4-when x_1=2.0·104 N/m; x_2=7.0 t/h

Fig. 2.Graphic dependencies of the cleaning effect.

In fig. Figure 2b shows the graphical dependences of the efficiency of cleaning raw cotton on the performance of the machine. The presented curves show that with an increase in productivity from 5.0 t / h to 7.0 t / h, depending on the given x_2 and x_3, the cleaning efficiency is characterized by descending. On the first curve at x_1=1.0·104 N/m;

X_1=12 mm from 82.5% to 85.2%, on the second curve with x_1=1.33·104 N/m, x_3=13.3 mm from 84.4% to 83.3% on the third curve with x_1=1.66·104 N/m, x_3=14.64 mm from

86.17% to 82.12%, on the fourth curve with x_1=2.0·104 N/m, x_3=16 mm from 87.63% to 80.9%.

In fig. 2c shows the effect of the change in the gap between the grate and the serrate drum on the effect of cleaning cotton raw. The presented curves show that with an increase in the gap from 12 mm to 16 mm, depending on the given x1 and x2, the cleaning efficiency is characterized by downward curves, on the first curve at x_1=1.0·104 N/m; x_2=5.0 t/h from 82.59% to 82.25%, on the second curve at x_1=1.33·104 N/m; x_2=5.56 t/h from 84.6% to 83.35%, the third curve for x_1=1.66·104 N/m; x_2=6.32 t/h from 83.6% to 82.9%, the fourth curve at x_1=2.0·104 N/m; x_2=7 t/h from 82.5% to 80.9%.

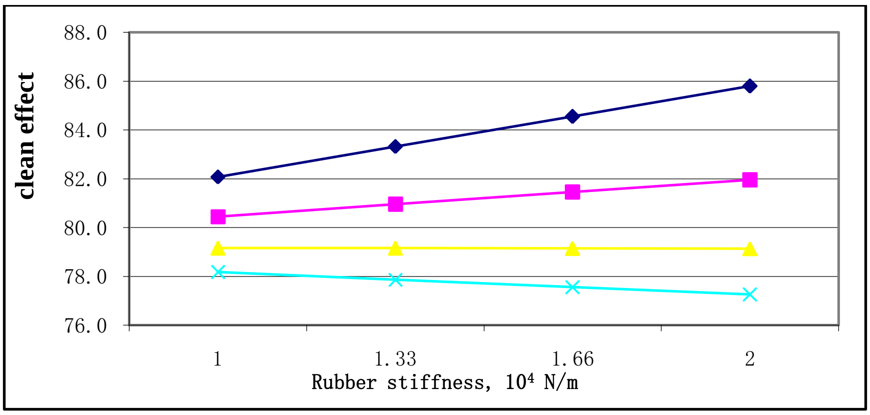
The results of calculations after processing are presented in the form of graphs (Fig. 3). In fig. 3a shows the dependences of cotton cleaning efficiency on rubber hardness, where four curves y = y (x) are given. On the first curve with factors x_2=5.0 t/h, x_3=12 mm, it increases from 82.08% to 85.8%, on the second curve with x_2=5.66 t/h, x_3=13.32 mm increases from 80.45% to 81.9%, on the third curve with x_2=6.32 t/h, x_3=14.64 mm decreases from 79.17% to 79.14%, and at maximum values i.e. x_2=7 t / h, x_3=16 mm, decreases 82.47% to 80.93%.

In fig. 3b shows the graphical dependence of the efficiency of cleaning raw cotton on the performance of the machine. The presented curves show that with an increase in productivity from 5.0 t / h to 7.0 t / h, depending on the given x_2 and x_3, the cleaning efficiency is characterized by descending.

On the first curve at x_1=1,0·10^4N/m; x_3=12 mm from82,01 % before 78,52 %, on the second curve at x_1=1,33·10^4N/m, x_3=13,3 mm from 85,52 % before 78,6 % on the third curve at x_1=1,66·10^4N/m, x_3=14,64 mm from 80,25 % before 78,08 %, on fourth curve atx_1=2,0·10^4 Н/м, x_3=16 мм от 76,4 % before 77,26 %.

In fig. 3c shows the effect of changing the gap between the grate and the serrate drum on the effect of cleaning cotton raw. The presented curves show that with an increase in the gap from 12 mm to 16 mm, depending on the given x_1 and x_2, the cleaning efficiency is characterized by downward curves, on the first curve with x_1=1,0·10^4N/m; x_2=5,0 t / h from 82,08% before 80,74%, on the second curve atx_1=1,33·10^4 Н/м; x_2=5,56 t/h from 82,0 % до 78,89 %, the third curve at x_1=1,66·10^4N/m; x_2=6,32 t/h from 82,04% before 77,74 %, fourth curve at x_1=2,0·10^4n/m; x_2=7 t/h from 81,9 % before 77,2 %.

The gap between the grate and the serrate drum affects the cleaning process in a straight line. By changing the gap, you can adjust the cleaning effect. The main result of the full-factor experiment is the determination of the influence of incoming factors on the outgoing factor. All of the above parameters and their ratio affect the process of cleaning raw cotton. It is necessary to choose the parameters of the input factors that would work to improve the cleaning process. The analysis of the results obtained during the full-factor experiment allows us to recommend the following values for selected key factors:



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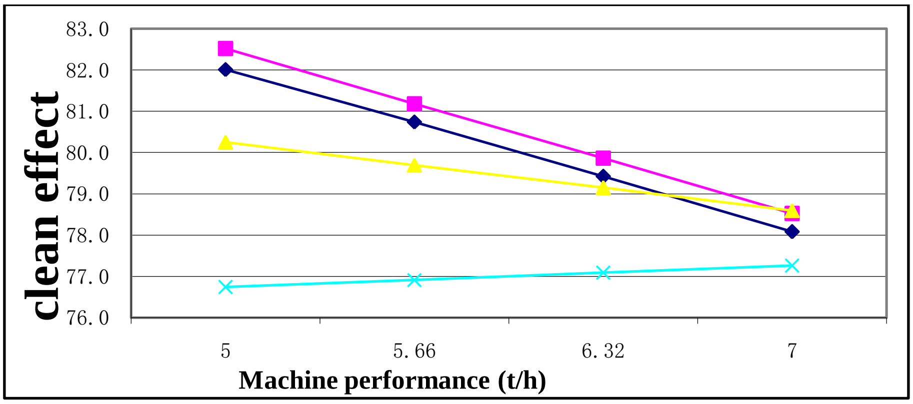

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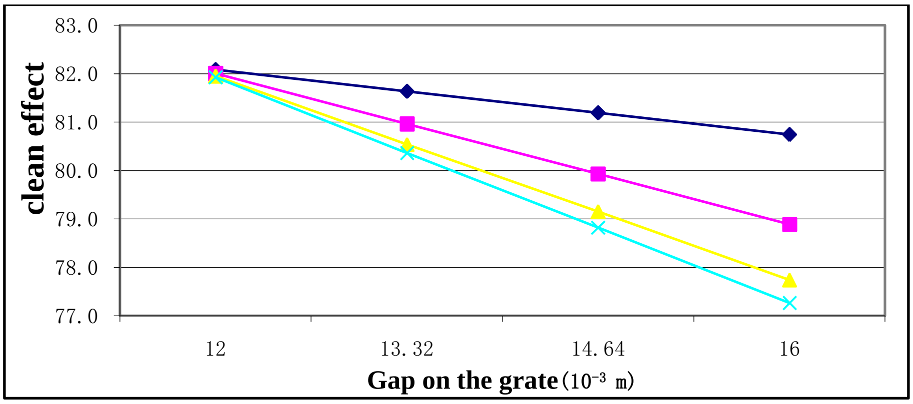

v-graphs of the change in the cleaning effect from the variation of the gap between the grate and the saw cylinder. Where 1-$x_1=1.0\cdot10^4$ N/m; x_2=5.0 t/h, 2-at $x_1=1.33\cdot10^4$ N/m; x_2=5.56 t/h, 3 at $x_1=1.66\ 10^4$N/m; x_2=6.32 t/h?,4-when $x_1=2.0\cdot10^4$ N/m; x_2=7.0 t/h

Fig. 3. Graphs of changes in the cleaning effect

- productivity, t / h - 5.0;
- rubber stiffness - $2.0\cdot10^4$ N / m;
- the gap between the grate and saw tooth drum - 16 mm.

With these values of the factors, effective operation of the raw cotton cleaneris observed, that is, the cleaning effect is above 90%.

A prototype was made of the proposed design of the sawed section of a cotton-cleaning unit. A prototype of a cotton-cleaning unit with a recommended section has passed production tests in comparison with an existing machine.

The tests were carried out using raw cotton I-variety, C-6542 manual; collection. It is known that moisture and the initial contamination of raw cotton have a significant effect on the cleaning effect. During the tests, the humidity and initial contamination of the compared sections of the cleaning of production lines were maintained in the same range. Analyzes were carried out in the factory laboratory.

When testing, the recommended design of the sawed section of the UHK cleaning unit showed high reliability and stability. According to the test results, it can be seen that the cleaning effect of peg compared to the existing grate option increases on average by 16.14%, mechanical damage to seeds decreases by 1.46%, free fibers in raw cotton

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decrease 2.0 times. This is due to the fact that the brush rollers improve the capture of bats, eliminating their inhibition. Due to the additional oscillations of the grates in the serrate zone, an effective selection of trash is ensured. Transporting brush drums allow uniform transportation of raw cotton to the cleaning zone, eliminating the inhibition of cotton. The results of comparative technological tests on production lines of cleaning with serial and experienced designs of sections of cleaning UHK units are given in table. 2table 2

The results of the comparative technological production tests on the 1st and 2nd lines of cleaning UHK Zarbdar cold storage plant Jizzakh vlloyat

Indicators,%	After upgrading the cleaning unit in the 1st line UHK	After the serial unit in the 2nd line of cleaning UHK I
Original Cotton - Raw		
Humidity	8,8	8,8
Weediness	4,15	4,15
Cleaning effect	76,11	59,97;
Deduction of raw cotton	1,32	1,87
Mechanical damage to seeds	1,78	3,21
Loose fibers	0,103	0,216

Note: the experiments were carried out in triplicate. In tab. 1 shows the average values of the indicators (with a likely reliability of the results-0.95).

The recommended design of the cleaning serrated section of a cotton-cleaning unit allows an increase in the cleaning effect of a large litter by 15-25%.

Thus, a new efficient design scheme for the sawed section of the cotton ginning unit has been developed. According to the results of production tests, it was revealed that the effect of cleaning cotton from large litter significantly increases.

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