International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-9 Issue-2, December, 2019

Determination of Parameters of Grates on Rubber Brackets of Fiber Material Cleaners

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Abstract*: The article shows the installation scheme of the grate and the principle of operation of the cleaner of fibrous material from large litter. The oscillation of the grates installed in the upper and lower cleaning zones with different thickness of the rubber support was studied. On the basis of theoretical studies of the grate in the form of a single-mass system, regularities of the change in vertical mixing and speeds of grates are obtained. Graphical dependences of the change in the amplitude of oscillations of the mixes and the speeds of the grate are constructed on the variation of the mass of the grate, the disturbing force on the cotton being revealed, and also on the stiffness coefficient of the elastic support. Full-factorial experiments obtained regression equations. By solving the problem, graphical dependencies of the change in the cleansing effect on incoming factors are constructed. The analyzes substantiate the parameters of the fibrous material cleaner.

Keywords: Fibrous material, cleaner, large litter, rubber support, thickness, vibration, stiffness, dissipation, full-factor, optimization.

I. INTRODUCTION

Known constructions of 1CP cleaners and cotton regenerators contain an EN-177 sawing section, which includes a housing, two saw drums, grates under them, a brush drum, a screw discharge conveyor and lapping brushes. The disadvantage of the cleaning saw tooth section is the insufficient effect of cleaning the raw cotton from large litter, as well as the high percentage of cotton flies falling into the waste collector. The UHK cotton ginning unit includes several sequentially installed cleaning sections, both of small litter and large litter, and have a common screw sump. The cleaning saw section of the UHK cotton-cleaning unit contains a housing, two conveying brush drums, two saw drums, grates below them, a removable drum (interacting) between the saw drums, lapping brushes rigidly installed in the housing, a screw for removing

weed impurities. The transporting brush drums can rotate on both sides, clockwise - the operating mode and counterclockwise - in case of exclusion of cotton feeding the saw-cleaning section.

The drawback of the design of the cleaning saw tooth section of the UHK cotton cleaning unit is the clogging of the brush space of the conveying brush drums with cotton and the repeated carrying of cotton by the conveying brush drums.

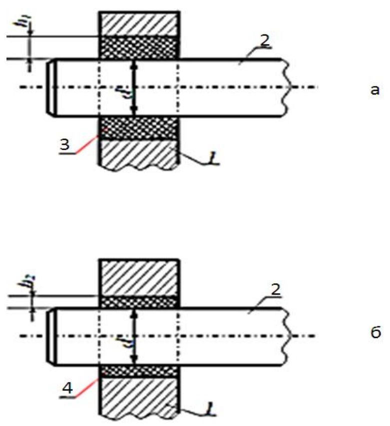
II. RESEARCH METHODS

A. Construction of grates on rubber supports

We have improved the design of conveying brush drums, grates of the cleaning saw tooth section of the ginnery.

The essence of the construction is explained by the fact that the diameter of the output (left) conveying brush drum is 5-10% larger than the diameter of the input (right) conveying brush drum, the grates under the saw drums are installed in the housing on rubber bushings with the same inner diameters, and the thickness of the rubber the grate bush under the upper saw drum is 10-15% more than the thickness of the rubber grate bush under the lower saw drum.

At the same time, due to the increase in the linear speed of the output conveyor brush drum, timely uniform supply and transportation of cotton is ensured. Due to the additional vibrations of the grate with the necessary frequency and amplitude, the cleaning effect of cotton from large litter will increase.



a- upper cleaning zone
б- lower cleaning zone
Fig.1. Grates on rubber supports

Revised Manuscript Received on December 30, 2019.
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The installation of grates 1 and 2 on the rubber bushings 3 and 4 allows a significant release of weed impurities from cotton due to their vibrations. In this case, the grid-irons 1 under the upper serrated drum oscillate with a larger amplitude and lower frequency due to the greater thickness h_1 <h_2 of the rubber bushings 3. In this cotton cleaning zone, mainly large weedy impurities having small adhesion forces to the fibers of the cotton fly will be released. The grates 2 under the saw drum vibrate under the action of cotton with a smaller amplitude and a higher frequency due to the smaller thickness h_2 of the rubber bushings 4. In this area of cotton cleaning, mainly large weedy impurities having significant adhesion forces and deep in the cotton fly will be released.

In the recommended design of the coarse cleaning section of the ginner, the grates are installed in the housing by means of rubber bushings. In contrast to the thicknesses of the grate bushings in the upper cleaning zone, which is known in this case, is adopted more than the thickness of the rubber sleeve in the lower cotton cleaning zone.

III. THEORETICAL RESEARCH

A. Analysis of the vibrations of grates in the upper and lower zones of cleaning fiber material

It is important to determine the nature of the grate oscillations and the justification of the system parameters.

Given that the grate makes complex vibrations, but the vertical cleaning of the grate mainly affects the cotton cleaning process. Therefore, we accept the grate as a single-mass system that performs vertical oscillations (see Fig. 2).

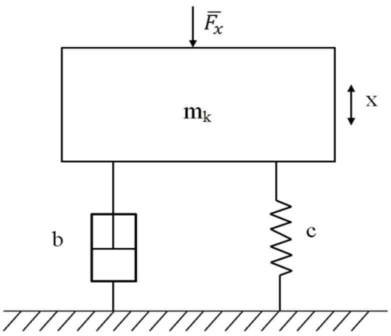

Fig.2. The design scheme of the grate oscillations on rubber supports

To compile a mathematical model that describes the oscillatory motion of the grate, we use the second-order Lagrange equation according to [6,7].

In this case, the potential and kinetic energies of the grate have the form:

$$T = \frac{1}{2} m\dot{x}^2; \qquad P = \frac{1}{2} cx^2 \qquad (1)$$

where, m is the mass of the grate, x, $\dot{x}$ is the movement and speed of the grate; c-coefficient of rigidity of the rubber bushing.

The dissipative Rayleigh function has the form:

$$F = \frac{1}{2} b\dot{x}^2 \qquad (2)$$

where, b-coefficient of dissipation of the rubber bush grate.

In this case, partial derivatives:

$$\frac{\partial T}{\partial \dot{x}} = m\dot{x}; \frac{\partial T}{\partial x} = 0; \frac{\partial \Pi}{\partial x} = cx; \frac{\partial \theta}{\partial \dot{x}} = b\dot{x}; \qquad (3)$$

Besides

$$\frac{d}{dt}\left(\frac{\partial T}{\partial \dot{x}}\right) = m\ddot{x}; Q = F_x = F_1 \sin \omega t \pm \delta F_1 \qquad (4)$$

Substituting (1), (2), (3) into the second-order Lagrange equation, we obtain the differential equation of the oscillatory motion of the grate on the rubber bushings in the following form:

$$m\ddot{x} + b\dot{x} + cx = F_1 \sin \omega t \pm \delta F_1 \qquad (5)$$

where, F_1 - the average value of the disturbance from the cotton; δF_1 - is the random component of the perturbation.

IV. RESULTS AND DISCUSSION

This problem in a simplified form was solved in [8]. But, for the considered grate of the UHK cleaner with different rubber thickness for both cleaning zones and taking into account the initial parameters, it is considered advisable to establish the law of vibrations of the grate of the cleaner and the dependence of the parameters, we present a numerical solution (5). The numerical solution of (5) is given by the Runge-Kutta method for the following initial values of the system parameters: $m = (2.0 \div 3.5)$ *kg*; $c = (0.6 \div 1.6) \cdot 103$ *N/m*; $F_1 = (3.0 \div 10)$ *N*; $\delta F_1 = (0.3 \div 1.0)$ *N*; $b = (2.5 \div 6.5)$ *Nm*. When solving the problem, the random component of the technological load was carried out using a random number generator using a well-known technique [9].

Figure 3 shows the patterns of change in vertical movements and the speed of the grate on the rubber bushings of the recommended upgraded saw tooth section of the cotton gin. The analysis of patterns shows that at the maximum value of the movement of the grate x, the speed $\dot{x}$ will be zero and vice versa. In this case, the influence on the law of movement and the oscillation speed of the grate does not significantly affect the random component of resistance from cotton. When the productivity of the machine cleaner is *3.5 t/h* and the initial values of the parameters of the grate, the amplitude of its movement is on average $0.24 \cdot 10^{-3}$ *m* and, accordingly, the amplitude of the fluctuations of the speed of the grate is within $(3.5 \div 5)$ *m/s*.

With an increase in the purifier productivity up to *7.5 t/h*, Ah reaches $(0.8 \div 0.9) \cdot 10^{-3}$ m and x, $A_{\dot{x}} = (7.1 \div 8.5) m/s$

Based on the processing of the obtained results, graphical dependences of changes in the movement and oscillation speed of the grate for the upper and lower cleaning zones were constructed, which are presented in Fig. 4. Analysis of the graphs shows that an increase in the technological load of raw cotton from *1.5 N* to *10.0 N* leads to increase the amplitude of vibrations of the grate from $0.45 \cdot 10^{-3}$*m* to $1.26 \cdot 10^{-3}$*m* with a grate mass of *2.0 kg*. With a grate mass of *3.5 kg*, the amplitude of the grate movement oscillations reaches only $0.97 \cdot 10^{-3}$*m* (see Fig. 4, curve 1). The grate oscillation velocity also changes in a similar way (see Fig. 4, curves 3.4).

Retrieval Number: B3342129219/2019©BEIESP
DOI: 10.35940/ijeat.B3342.129219
Journal Website: www.ijeat.org

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International Journal of Engineering and Advanced Technology (IJEAT)
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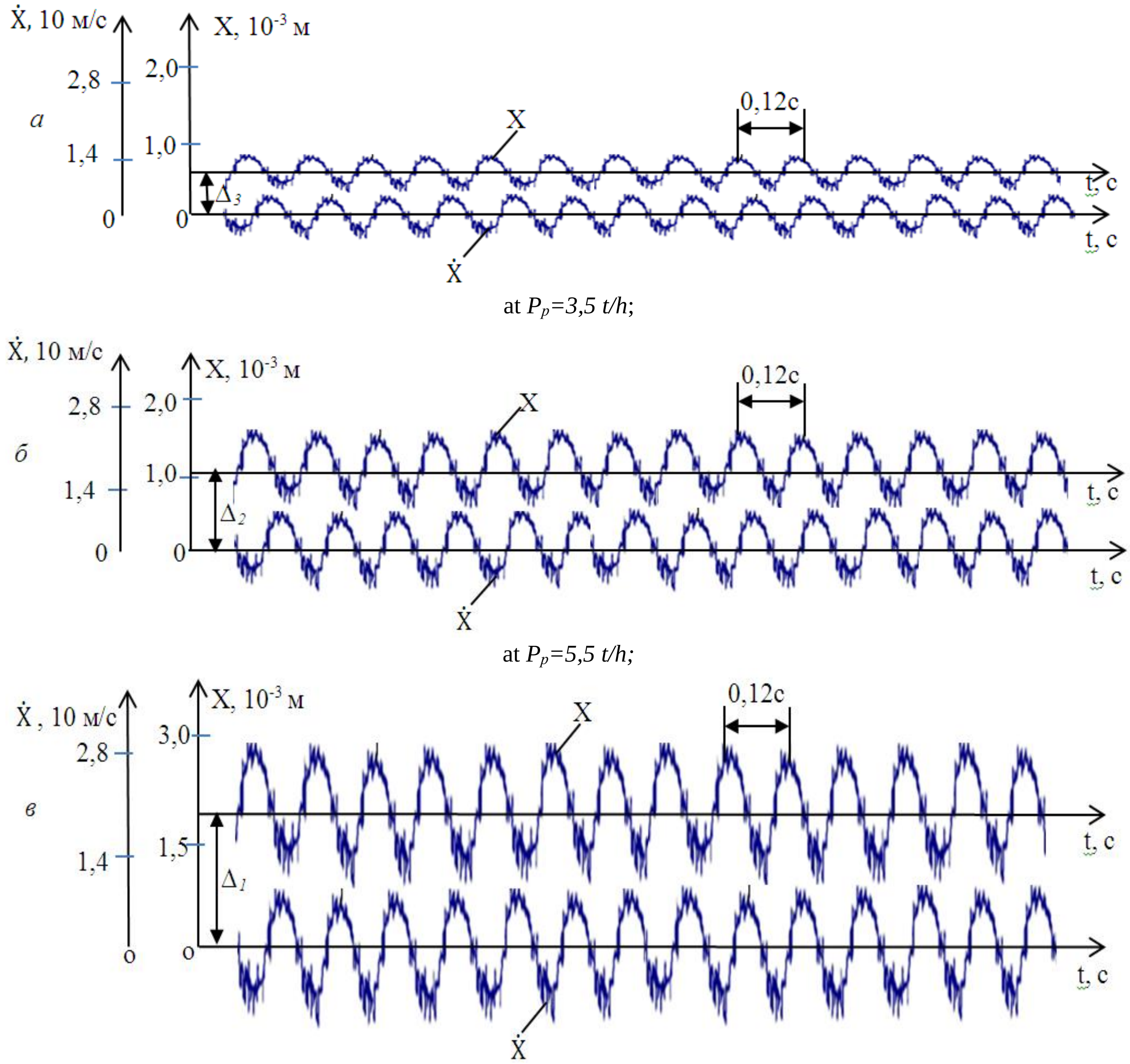
With a grate mass of *2.0 kg*, the amplitude of the velocity increases from *9.9 m/s* to *27.6 m/s* with an increase in load from *1.5 N* to *10.0 N*. With a grate mass of 3.5 kg, the amplitude of the speed of oscillation of the grate reaches *24.8 m/s.*

In fig. 5 shows the patterns of change in the movement and speed of the grate when changing the stiffness coefficient of the rubber bush of the grate. The analysis of the obtained patterns shows that with an increase in the stiffness coefficient of the rubber bush, the amplitude of oscillations of the grate movement decreases. In this case, the oscillation frequency increases to some extent (Fig. 5). This is because an increase in rigidity leads to an increase in the natural frequency of oscillations. Moreover, according to this, the value of ωt increases proportionally, which allows an increase in forced vibrations of the grate. The random component Δ does not exceed *(7.0 ÷ 8.0) %* of the load amplitude from the raw cotton.



at P_p=3,5 t/h;

at P_p=5,5 t/h;

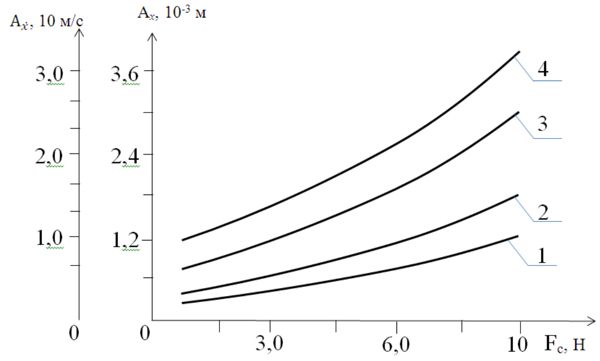
at P_p=7,5 t/h;

Fig. 3. Patterns of changes in the movements and oscillation speeds of the grate on the elastic supports of the cotton cleaner from large litter with a change in machine performance

Fig. 6 shows the graphical dependences of the change in the movement and the speed of oscillation of the grate on the variation of the stiffness coefficient of the rubber sleeve of the support, from which it can be seen that an increase in the stiffness of the rubber sleeve leads to a decrease in the amplitude of the movements and speed of the grate according to a nonlinear regularity (see Fig. 6). So, with an increase in "c" from *0.35 · 10-3 N/m* to *3.0 · 10-3 N/m*, A_x decreases from $1.8 \cdot 10^{-3}$ *m* to $0.26 \cdot 10^{-3}$ m, and the velocity amplitude decreases from *26.3 m/s* to *9.7 m/s* with a technological load from the cotton being cleaned with an amplitude of *3.0 N* (see Fig. 6, curves 1.3). With an increase in the technological load from cotton with an amplitude of *10.0 N*, the value of Ax decreases from $2.38 \cdot 10^{-3}$ *m* to $0.53 \cdot 10^{-3}$ *m*, and the amplitude of the velocity fluctuations decreases from *31.7 m/s* to *11.4 m/s* Studies have shown that the axes of the grates during the deformation of the rubber bushings move parallel down.

It is known that an increase in the amplitude and frequency of oscillations of grates leads to an increase in the cleaning effect. But, at the same time, the damage to cotton increases, and also due to a significant change in the technological gaps between the grid-irons, the departure of volatiles to waste increases. In this case, an increase in the amplitude and frequency of oscillations of the grate leads to an increase in the cleaning effect. Therefore, to ensure the amplitude of vibrations of the grate in the upper zone of large-scale cotton cleaning within the range $A_x \leq (1.5 \div 2.3) \cdot 10^{-3} m$, it is advisable to select the values of the stiffness coefficient of the rubber sleeve in the ranges $c = (1.0 \div 1.3) \cdot 10^{-3}$ N/m. For the lower cleaning zone, ensuring the values $A_x \leq (0.8 \div 1.2) \cdot 10^{-3} m$, it is recommended $c = (1.8 \div 2.2) \cdot 10^{-3} N/m$, at which the cleaning effect increases, damage is reduced cotton fibers and reduced care of cotton flies with litter [10,11,12].

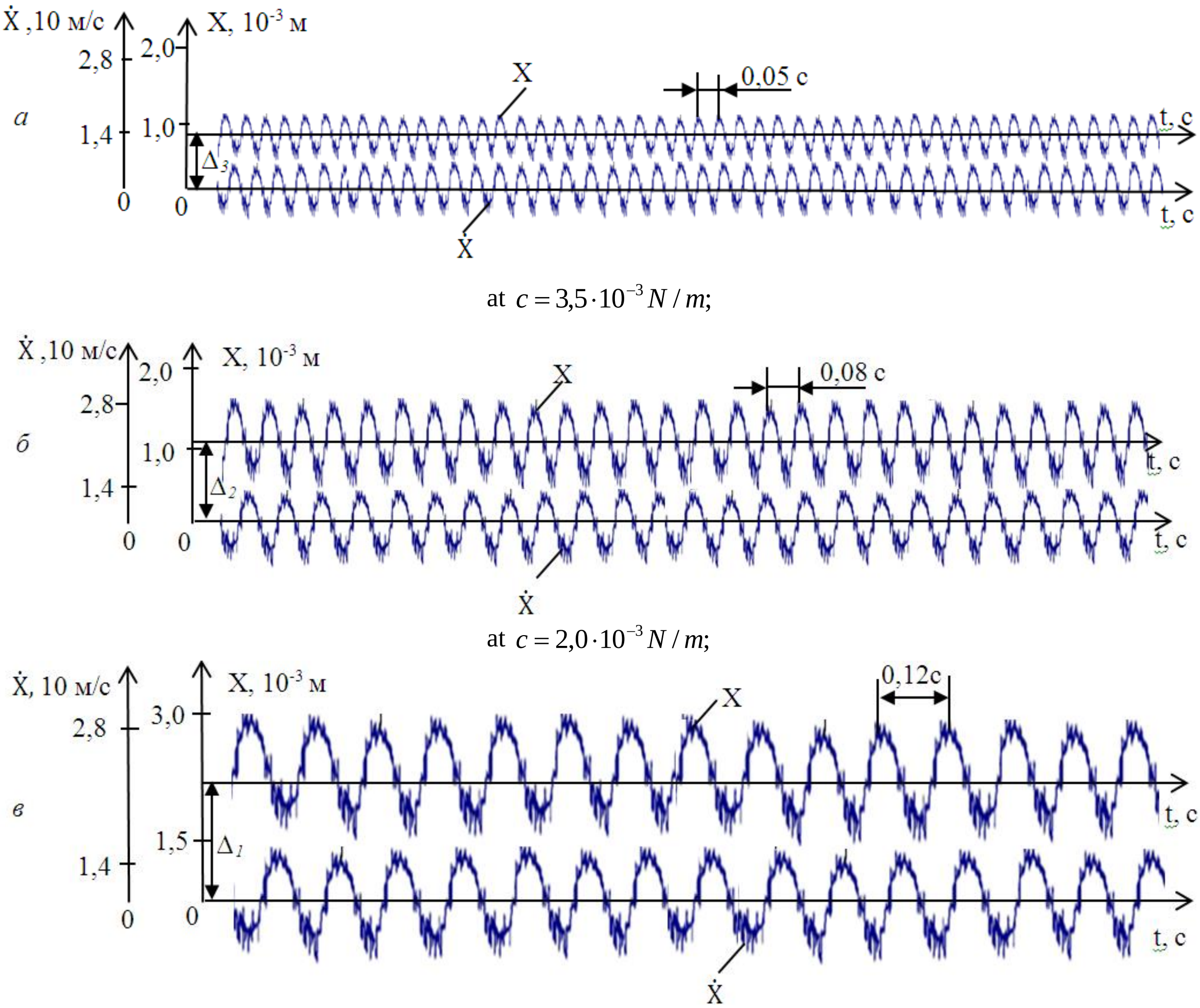
In fig. 5 shows the graphical dependences of the changes in A_x and, $A_{\dot{x}}$ on the variation in the mass of grates on the rubber bushings.



$1,2 - A_x = f(F_c)$; $3,4 - A_{\dot{x}} = f(F_c)$; $2,4 - m_k = 2,0 kg$; $1,3 - at\ m_k = 3,5 kg$,

deviation Δ=(7,0÷8,0)%

Fig. 4. Graphic dependences of changes in the amplitude of fluctuations of movements and speeds of the grate on rubber cushions on the technological load of raw cotton



at $c = 3,5 \cdot 10^{-3} N/m$;

at $c = 2,0 \cdot 10^{-3} N/m$;

at $c = 1,0 \cdot 10^{-3} N/m$; at P_p=5,5 t/h

Fig. 5. Patterns of changes in the movements and oscillation speeds of the grate on the elastic supports of the cotton cleaner from large litter when changing the stiffness of the rubber supports of the grates

Retrieval Number: B3342129219/2019©BEIESP
DOI: 10.35940/ijeat.B3342.129219
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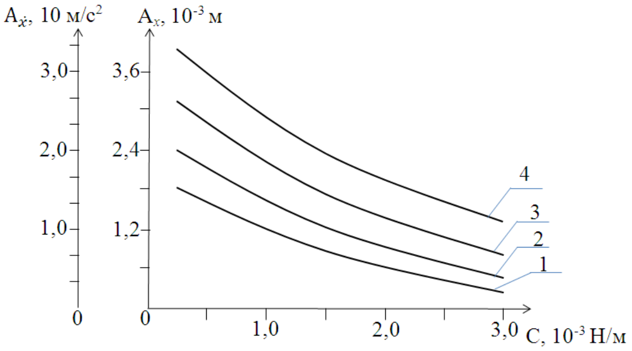
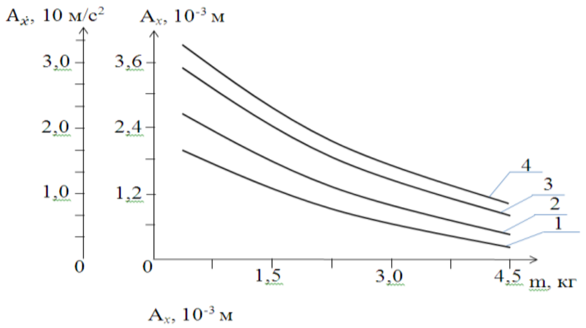
With an increase in the mass of the grate, a decrease in the amplitudes of the oscillations of movement and speed of the grate occurs according to a nonlinear regularity. In this case, an increase in mass from *0.6 kg* to *4.5 kg* leads to a decrease in A_x from $2.62\cdot10^{-3}$ *m* to $0.47\cdot10^{-3}$ *m* and $A_{\dot{x}}$ from *32.5 m/s* to *10.2 m/s* with a coefficient of rigidity of the rubber bush $1.2\cdot10^{-3}$*N/m*. An increase in the stiffness coefficient to $1.6\cdot10^{-3}$ *m* leads to a decrease in A_x from $1.83\cdot10^{-3}$*m* to $0.22\cdot10^{-3}$*m*, as well as to a decrease in $A_{\dot{x}}$ from *28.4 m/s* to *6,1 m/s.*



1,2- $A_x = f(c)$; *3,4-*$A_{\dot{x}} = f(c)$; *1,3–at* F_c*=3,0sinωt* *2,4–at* F_c*=10sinωt;* deviation Δ*=(7,0÷8,0)%*

Fig. 6. Graphic dependences of changes in the amplitude of movement and the oscillation speed of the grate from the variation of the stiffness coefficient of the elastic rubber grate bush



1,2 - $A_x = f(m)$; *3,4 -* $A_{\dot{x}} = f(m)$; *1,3 – at s =1,6·10*^{3} *N/m* *2,4 – at s =1,2·10*^{3} *N/m;* deviation Δ*=(7,0÷8,0)%*

Fig. 7. Graphic dependences of the change in the amplitude of movement and the oscillation speed of the grate from the change in the mass of the grate on rubber cushions

To ensure the amplitude of vibrations of the grate in the upper zone of cotton cleaning from large litter of the cleaner within the range $A_x \le (1.5\div2.3)\cdot10^{-3}m$, it is recommended to choose *m=(1.5÷2)kg*, and for the lower zone, ensuring $Ax \le (0.8\div1.2)\cdot10^{-3}m$, the grate mass is recommended within *(3.2÷3.6)kg*.

V. EXPERIMENTAL RESEARCH

A. Full-factor experimental study of grates on the elastic supports of a cleaner of fibrous material from large litter

To study the performance of the proposed grate design installed on the UHK machine, we analyzed the existing methods and methods of experiments. From an analysis of the studies performed to evaluate the performance of this design, parameters were selected to determine the influence of the parameters of the selected design on the process of cleaning cotton from debris.

During the studies, the following main parameters were taken into account and separated as input and input.

In studies, the following parameters were taken as output parameters:

x_1 – the thickness of the rubber bush of the upper grate, h_1, 10^{-3} m;

x_2 – machine performance, *P, t/h;*

x_3 – thickness of the rubber bush of the lower grate, h_2, 10^{-3} m;

The values of the input parameters are given in table 1.

When conducting experiments output parameter, the cleaning effect of cotton U.

$$x_1 = \left(\frac{E-2.5}{0.5}\right);\ x_2 = \left(\frac{P-6.5}{1}\right);\ x_2 = \left(\frac{\delta-1.6}{2}\right);$$

Table 1

Name of factor	Designation code	True Factor Values			Range of variation
		-1	0	+1	
The thickness of the rubber bush of the upper grate, h_1, 10^{-3} *m*	x_1	1,5	2,5	3,5	1,0
Machine performance, *P, t/h*	x_2	5,5	6,5	7,5	1
thickness of the rubber bush of the lower grate, h_2, 10^{-3} *m*	x_3	1,2	1,6	2,0	0,4

The effect of the input parameters on the cleaning efficiency of the output parameter is studied by experiment. To do this, we compose a planning matrix.

In any conditions, experiments are carried out in 3-fold repetition.

The accuracy and reliability of the experimental results largely depends on the accuracy of control of all input and output parameters and their constancy. Therefore, each experiment was preceded by preparation with multiple control of the input and output parameters of the cotton cleaner from large litter. Only significant coefficients are included in the mathematical model of the process. Thus, the system of equations obtained as a result of data processing using the EXCEL computer program has the form:

regression equation for 2-grade cotton:

$$U = 83.09 + 0.96x_1 - 1.27x_2 - 0.75x_3 - 2x_1x_2 - 0.35x_2x_3 + 0.28x_1x_2x_3 \quad (6)$$

regression equation for 4-grade cotton:

$$U = 82.8 + 0.42x_1 - 1.25x_2 - 1.86x_3 + 0.5x_1x_2 - 1.57x_1x_3 + 0.78x_2x_3 + 0.38x_1x_2x_3 \quad (7)$$

A mathematical calculation of the adequacy of the obtained equations (6) and (7) showed good convergence of the models and experimental results.

In models, the value of the regression coefficients characterizes the contribution of the corresponding factor to the value of the output parameter during the transition of the factor from the main level to the upper or lower. The contribution of the factor during the transition from the lower to the upper level in the value of the output parameter is called the factor effect. The higher the regression coefficient, the higher the effect of this factor, i.e. the stronger the influence of the factor on the output parameter. Thus, according to the magnitude of the regression coefficients in the models, the factors are sorted by the strength of their influence on y, the sign in front of the regression coefficient determines the nature of the influence of the factor on y.

Consider the influence of input factors on the studied factor, that is, on the cleaning effect. Analysis of the regression equation shows that the main influence on the cleaning efficiency -y is exerted by the thickness of the rubber bush of the lower cleaning zone (x_1), productivity (x_2), the thickness of the rubber bush of the upper grate (x_3) and the interaction of factors (x_1x_3, x_2x_3, $x_1x_2\,x_3$).

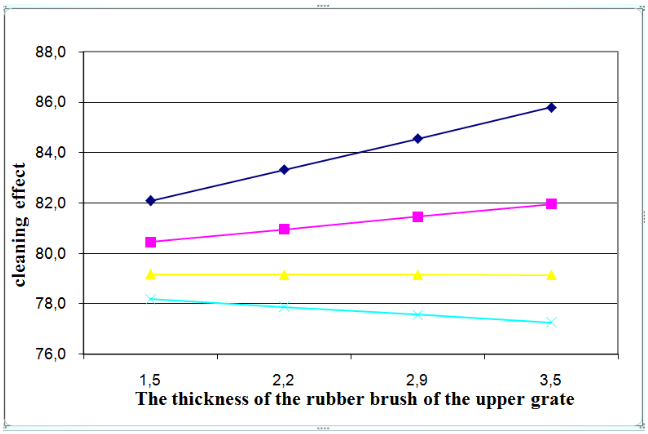
B. Results of experiments and analysis of regression equations

The results of calculations after processing are presented in the form of graphs (Fig. 8.). In fig. 8a shows the dependences of cotton cleaning efficiency on the thickness of the rubber bush of the upper grate, where four curves $y = y(x)$ are given. The first curve corresponds to the minimum, the second and third to intermediate, the fourth to the maximum values of the factors x_2 and x_3. On the first curve, at $x_2 = 5.5$ *t/h*, $x_3 = 1.2$ *mm*, the cleaning effect increases from *83.04%* to *89.01 %*, on the second curve with x_2=*6.2t/h*, x_3=*1.53mm*, respectively, from *82.8% to 83.7%*, on the third curve with x_2=*6.47t/h*, x_3=*1,67mm*, respectively, from *83.04% to 83.7%*, on the fourth curve at x_2=*7.5 t/h*, the cleaning effect x_3=*2.0 mm*, respectively *82.47% to 80.9%*

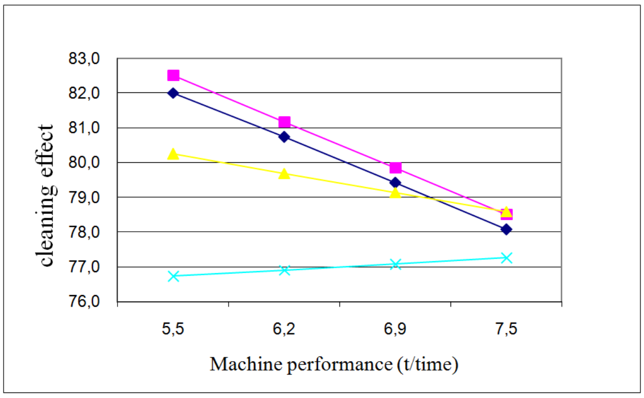
In fig. 8b shows the graphical dependences of the efficiency of raw cotton cleaning on machine performance. The curves presented show that with an increase in productivity from *5.5 t/h* to *7.5 t/h*, depending on the set x_2 and x_3, the cleaning efficiency is characterized by downward. On the first curve with x_1=*1.5mm;* x_3=*1.2mm* from *82.5%* to *85.2%*, on the second curve with x_1=*2.2mm*, x_3=*1.53mm* from *84.4%* to *83.3%* on the third curve with x_1=*2.9mm*, x_3=*1.67mm* from *86.17%* to *82.12%*, on the fourth curve with x_1=*3.5mm*, x_3=*2.0mm* from *87.63%* to *80.9%*.

In fig. 8c shows the effect of changing the thickness of the rubber bush of the lower grate on the cleaning effect of raw cotton.

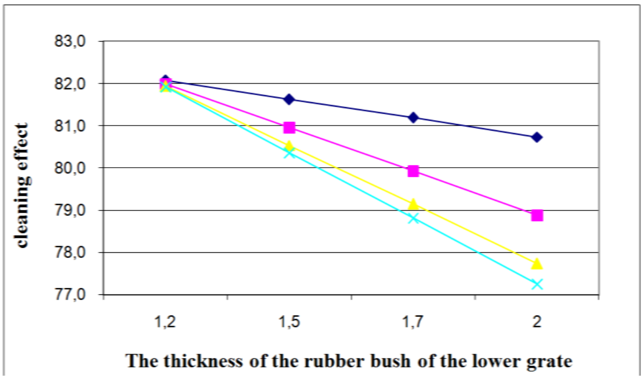
The curves show that with an increase in the gap from 1.2 mm to 2.0 mm, depending on the given x_1 and x_2, the cleaning efficiency is characterized by downward curves, on the first curve with x_1=*1.5mm;* x_2=*5.5t/h* from *82.59%* to *82.25%*, on the second curve with x_1=*2.2mm;* x_2=*6.2t/h* from *84.6%* to *83.35%*, the third curve with x_1=*2.9mm;* x_2=*6.9t/h* from *83.6%* to *82.9%*, the fourth curve with x_1=*3.5mm;* x_2=*7.5 t/h* from *82.5%* to *80.9%*.



The presented a-graphs of the changes in the cleaning effect from variations in the thickness of the rubber bush of the upper grate, where, 1-at x_2=*5.5t/h*, x_3=*1.2mm*, 2- at x_2=6,2 t/h, x_3=1,53 mm, 3- at x_2=6,9 t/h, x_3=1,67 mm, 4-at x_2=7,5t/h, x_3=2,0mm.



b-graphs of the changes in the cleaning effect of the variation in productivity of the machine, where, *1-* at x_1=*1.5mm;* x_3=*1.2mm*, *2-* at x_1=*2.2mm;* x_3=*1.53mm; 3-* at x_1=*2.9mm;* x_3=*1.67mm; 4-* at x_1=*3.5mm;* x_3=*2.0mm.*



c - graphs of changes in the cleaning effect of variations in the thickness of the rubber bush of the lower grate, where 1-at x_1 *=1.5mm;* x_2 *=5.5 t/h*, 2-at x_1*=2.2mm;* x_2*=6.2 t/h*, 3-at x_1*=2.9mm;* x_2*=6.9t/h*, 4-at x_1*=3.5mm;* x_2*=7.5t/h.*

Fig. 8. Graphic dependencies of the cleansing effect

The results of calculations after processing are presented in the form of graphs (Fig. 9). In fig. 9a shows the dependences of the cotton cleaning efficiency on the rubber hardness, where four curves *y=y(x)* are given. On the first curve with factors x_2*=5.5t/h*, x_3*=1.2mm*, the cleaning effect increases from *82.08%* to *85.8%*, on the second curve with x_2*=6.2 t/h*, x_3*=1.53mm* increases from *80.45%* to *81.9%*, on the third curve with x_2*=6.9t/h*, x_3*=1.67 mm* decreases from *79.17%* to *79.14%*, and at maximum values i.e. x_2*=7.5t/h*, x_3*=2.0mm*, the cleaning effect decreases *82.47%* to *80.93%*.

In fig. 9b shows the graphical dependences of the efficiency of raw cotton cleaning on machine performance. The curves presented show that with an increase in productivity from *5.5t/h* to *7.5t/h*, depending on the given x_2 and x_3, the cleaning efficiency is characterized by downward. On the first curve with x_1*=1.5mm;* x_3*=1.2mm* from *82.01%* to *78.52%*, on the second curve with x_1*=2.2mm*, x_3*=1.53mm* from *85.52%* to *78.6%* on the third curve with x_1*=2.9mm*, x_3*=1.67mm* from *80.25%* to *78.08%*, on the fourth curve with x_1 *=3.5mm*, x_3*=2.0mm* from *76.4%* to *77.26%*.

In fig. 9c shows the effect of changing the thickness of the rubber bush of the lower grate on the cleaning effect of raw cotton. The presented curves show that with an increase in the thickness of the bush from *1.2mm* to *2.0mm*, depending on the specified x_1 and x_2, the cleaning efficiency is characterized by downward curves, on the first curve with x_1*=1.5mm;* x_2*=5.5t/h* from *82.08%* to *80.74%*, on the second curve with x_1*=2.2mm;* x_2*=6.2t/h* from *82.0%* to *78.89%*, the third curve with x_1*=2.9mm*; x_2*=6.9t/h* from *82.04%* to *77.74%*, the fourth curve at x_1*=3.5mm*; x_2*=7.5 t/h* from *81.9%* to *77.2%*.

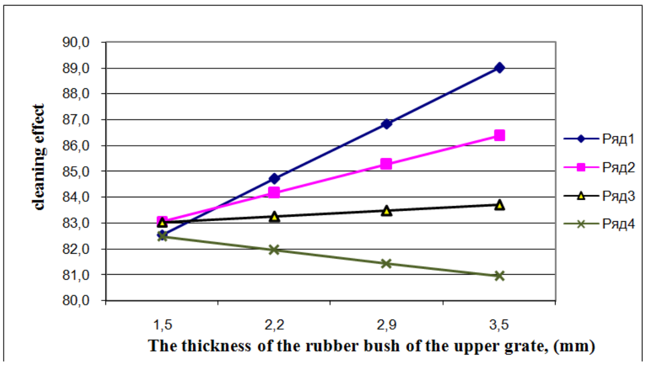
The gap between the grate and the saw drum directly affects the cotton cleaning process. By changing this clearance, the cleaning effect can be adjusted.

The main result of a full-factor experiment is to determine the influence of incoming factors on the outgoing factor. All of the above parameters and their ratios affect the cleaning process of raw cotton. It is necessary to select such parameters of the input factors that would work to improve the cleaning process.

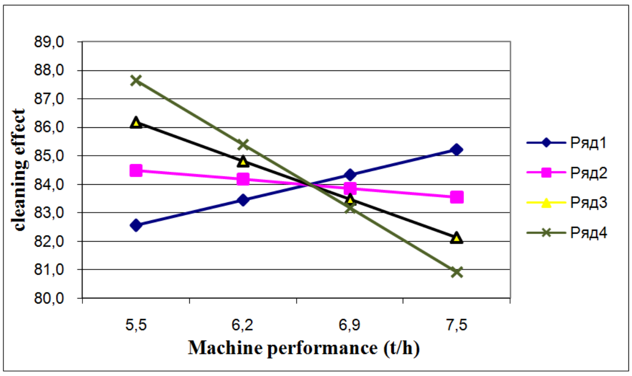
An analysis of the results of a full-factor experiment allows us to recommend the following values for the selected main factors:

- performance – *6,15 t/h;*
- The thickness of the rubber bush of the upper grate – *2,6·10*$^{-3}$ *m;*
- The thickness of the rubber of the lower grate – *1,3·10*$^{-3}$ *m*.

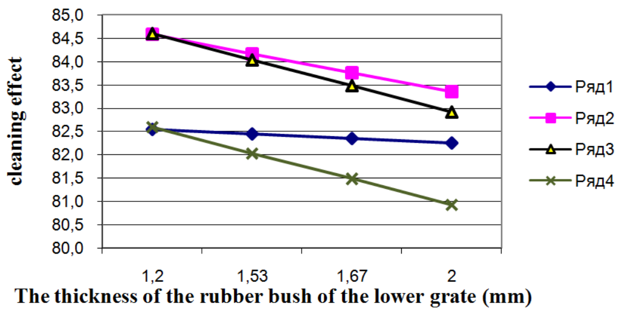
With these values of the factors, the effective work of the raw cotton cleaner is observed, that is, the cleaning effect is above 90%.



a-graphs of the change in the cleaning effect of the variation in the thickness of the rubber bush of the upper grate, where, 1-at x_2*=5.5t/h*, x_3*=1.2mm*, 2- at x_2*=6.2t/h*, x_3*=1,53 mm*, 3- at x_2*=6.9t/h*, x_3*=1.67mm*, 4-at x_2*=7.5t/h*, x_3*=2.0mm.*



b-graphs of the changes in the cleaning effect of the variation in productivity of the machine, where, 1- at x_1*=1.5mm;* x_3*=1.2mm*, 2-at x_1*=2.2mm;* x_3*=1.53mm;* 3-at x_1*=2.9mm;* x_3*=1.67mm;* 4-at x_1*=3.5mm;* x_3*=2.0mm.*



c - graphs of changes in the cleaning effect of variations in the thickness of the rubber bush of the lower grate, where 1-pr x_1*=1.5mm;* x_2*=5.5t/h*, 2-at x_1*=2.2mm;* x_2*=6.2t/h*, 3-at x_1*=2.9mm;* x_2*=6.9t/h*, 4-at x_1*=3.5mm;* x_2*=7.5t/h.*

Fig. 9. Graphs of changes in the cleansing effect

VI. CONCLUSIONS

Based on the numerical solution of the problem of grate vibrations on rubber supports, regularities were obtained for the changes in the grate movements and vibration rates on the elastic supports of the cotton cleaner from large litter with a change in machine performance. Graphical dependencies of changes in the amplitude of fluctuations of movements and speeds of the grate on rubber cushions on the technological load of raw cotton are constructed. An increase in the stiffness of the rubber bush leads to a decrease in the amplitude of oscillations of displacements and the speed of the grate according to a nonlinear regularity. Studies have shown that the axes of the grates during the deformation of the rubber bushings move parallel down, which depends on the load, mass of the grate and the stiffness of the rubber. In this case, an increase in the amplitude and frequency of oscillations of the grate leads to an increase in the cleaning effect. The analysis of the results obtained during the full-factor experiment allows us to recommend the following values for the selected main factors:

- productivity - *6.15 t/h*;
- the thickness of the rubber bush of the upper grate $2.6 \cdot 10^{-3}$ *m*;
- the thickness of the rubber bush of the lower grate is $1.3 \cdot 10^{-3}$*m*.

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

REFERENCES

1. A.D.Djuraev, K.Olimov, A.S.Abzarov, O.M.Anvarov. Dynamics of vibrating working bodies of raw cotton cleaners. Publishing house « The science», Tashkent, Uzbekistan, 2003, 192 p.
2. A.Juraev, O. Rajabov. Analysis of the Interaction of Fibrous Material with a Multifaceted Grid of the Cleaner. // International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-8, Issue-1, May 2019 P.2661-2666
3. Bitus E.I., Plekhanov A.F., Razumev K.E., Djuraev A, Tashpulatov D.S. Fiber grate cleaner grate // Patent RU№2668544. Bulletin №28 01.10.2018. by application № 2017143328, 12.12.2017.
4. Maksudov R.H. and others. Cleaning saw section cotton gin // Patent Republic Uzbekistan FAP00947.30.09.2014. Bulletin №9.
5. 5.Tashpulatov D.Sh., Plekhanov A.F., Djuraev A. Questions of the rationale preparation of the parameters of the grates on elastic supports of the fiber material cleaner // European Sciences review Scientific journal № 5–6 2018 p. 350-352.
6. Ballaney P.L.. Theory Machines and Mechanisms // A textbook for engineering students. Khanna publishers 2003.
7. R.S.Khurmi, J.K.Gupta. Theory of machines // A textbook. Eurasia publishing house 2011.
8. Djuraev A., Rajabov O.I. Experimental study of the interaction of multifaceted and cylindrical spunky cylinder in cotton cleaner from small waste // International Journal of Advanced Research in Science, Engineering and Technology Vol. 6, Issue 3, March 2019p.8376-8381
9. Orif Murodov. Perfection of Designs and Rationale of Parameters of Plastic Koloski Cleaning Cleaners // International Journal of Innovative Technology and Exploring Engineering (IJITEE)', ISSN: 2278–3075 (Online), Volume-8 Issue-12, October 2019, Page No. 2640-2646.
10. M. T. Khojiev, A. Juraev, O.Murodov, A. Rakhimov' 'Development of Design and Substantiation of The Parameters of the Separator for Fibrous Materials // International Journal of Recent Technology and Engineering (IJRTE), ISSN: 2277-3878 (Online), Volume-8 Issue-2, July 2019. Page No.: 5806-5811.
11. Tashpulatov D.Sh., A.F.Plkhanov A.F., Djuraev A. Grate oscillations on elastic supports with nonlinear rigidity with random resistance from cotton-raw maternity // European Sciences review Scientific journal № 5–6 2018 p. 353-355.
12. R.X.Rosulov, D.V.Norbaeva, A.Djuraev. Study of air flows in the cross wine zone r.h. // Academicals: An International Multidisciplinary Research Journal. ISSN: 2249-7137. Vol. 8/ Issue 8, August 2018. p. 33-39. www. saarj.com.

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