The results of the experimental nature of the vibrations of the grid cotton cleaner

Z Shodiyev¹, A Shomurodov¹ and O Rajabov²

¹Bukhara branch of the Tashkent Institute of Irrigation and Agricultural Mechanization Engineers, Bukhara, Uzbekistan
²Bukhara Engineering Technological Institute, Bukhara, Uzbekistan

ozodbek4103@mail.ru

Abstract: The article provides a new effective scheme and principle of operation of a multifaceted grid of cotton cleaner from small trash. The results of comparative experimental studies of the grid oscillations and the nature of loading depending on the parameters and modes of cotton cleaning are presented. In the experiments performed, the nature of the vibrations was investigated by studying the component vibrations of two grids simultaneously to compare the results. An analysis of the obtained laws of grid vibrations showed that the amplitude of the recommended multifaceted mesh surface on the elastic supports exceeds the amplitude of vibrations of the existing grid 5–7 times and reaches up to (2 ÷ 2.5) × 10⁻³ m. In this case, the oscillograms are presented for steady-state modes of the work of the cotton cleaner. The results show that an increase in the coefficient of the number of faces of the grid leads to a decrease in the load of the grid to (0.3 ÷ 0.5) N. The parameters of a multifaceted grid of cotton cleaner from small trash are substantiated. Experimental studies have studied the workload and the law of vibrational motion of the grid surface.

1. Introduction
The main working bodies of cleaning machines from small trash are the cylinder and the grid surface. The intensity of the cleaning of raw cotton from small trash depends not only on the rational design of the cylinder but also on the correct choice of cleaning grid surfaces that remove trash from the working area. The requirements for the design of the grid surface come from the general research strategy, in other words, with the minimum impact on raw cotton - the maximum cleaning effect is achieved [1-6].

The object of research: the technological process and the design of the working bodies of the cotton cleaner from fine trash.

The subject of research: the trajectories of the parts of cotton on the surface of a polyhedral mesh surface, the dependencies that determine the interaction of cotton with a polyhedral mesh surface, the design, and values of the parameters of the mesh surface

The aim of the research: is to improve the technology for cleaning cotton from fine trash using multifaceted nets, and to increase the cleaning effect.

The research objectives: determination of small vibrations of a multifaceted mesh surface, products of calculating the stiffness of the elastic support of the mesh; based on experiments, determining the influence of the parameters of the cleaning zone on the cleaning effect in the advanced technology for cleaning cotton from fine trash;
It should be noted that the intensification of raw cotton cleaning, the development of improved designs, the definition of effective new ways of cleaning raw cotton from small trash, as well as the activation of stationary working bodies of machines, is an important task of the cotton-cleaning industry.

One of the promising areas for improving the cleaning process is the use of elastic elements in the design of the working organs of cotton ginning machines [7].

In the existing cotton cleaners of small trash, the main working bodies are the spiky cylinder and the grid surface under it. To increase the effect of cleaning cotton from small trash, it is necessary to intensify the interaction of cylinder pegs on raw cotton, as well as to equip the drainage grid with activating elements. At the same time, it is possible to achieve the necessary cleaning effect with the minimum frequency of cleaning, which allows not only obtaining high-quality products but also reducing energy costs. At the same time, domestic and foreign researchers and specialists, in general, pay great attention to the study and improvement of the cylinder, in particular the design of the hammer. Research and improvement of the design of the grid surface of cotton cleaners from small trash are not conducted sufficiently. High-frequency interactions of pegs with cotton, as well as an increase in the shaking abilities of the grid surface are one of the main directions for improving the design of the working bodies of cotton cleaners from small trash [8-10]. Thanks to this method it is possible to separate the small weed impurities, deeply embedded in the fibers of cotton buds.

Therefore, the development and substantiation of the parameters of a highly efficient drainage new multi-faceted grid on elastic supports of cotton cleaners from small trash, providing a significant increase in the effect of cleaning cotton, reducing damage to cotton fibers and seeds, maximum preservation of the natural properties of cotton fiber is an important task for the cotton cleaning industry.

The main goal of the work is to develop a new, highly efficient design of a new multi-faceted grid surface above the elastic supports of cotton cleaners from small trash and to justify their parameters based on comprehensive experimental studies [11].

2. Materials and Methods

In the cotton-ginning industry, a mechanical method for cleaning cotton is widely used, in which mechanically affects cotton and thereby loosens the bonds between cotton and trash, while such cleaners make it possible to obtain a relatively not high cleaning efficiency [12-14].

The choice of the design of the grid surface of the cotton cleaner is important here. Therefore, the authors have developed an effective design of the grid surface of cotton cleaner from small trash [15, 16].

The grid surface of the fibrous material cleaner consists of a debris network 1, with holes 2 (Fig. 1.). The grid surface is made as a part of a multifaceted prism with ribs 3. The holes are made in rows in each face (planes), and between the adjacent faces of the hole are arranged in a checkerboard pattern. The lateral grid at the edges in the four corners has rigid sleeves 4 connected to it, which include fingers 5 rigidly connected to the cleaner body 7. Elastic (rubber) sleeves 6 are installed between the sleeve and the fingers. A cylinder 8 with pegs 9 is installed above the grid 1 in the housing.
Figure 1. Scheme of a multifaceted grid of cotton cleaner from small trash

Experiments were carried out to determine the nature of fluctuations of the recommended grid compared to the existing one. In fig. 2 shows the measurement scheme and Fig. 3 shows the sensors in the compared grids of cotton cleaners [17-19].

Figure 2. The measurement scheme of the dynamics of the cleaning grid: 1 is existing cleaning grid; 2 are mounting bolts; 3 is recommended cleaning grid; 4 is mounting bracket for elastic elements; 5 are rubber bushings; 6 is caustic cylinder with multifaceted pegs; 7 is existing cylinder; 8 is torque meter; 9 is current collector; 10 is accelerometers; 11 is rotational speed sensor of the cylinder; 12 is ADC; 13 is oscilloscope; 14 are computers; 15 is power supply.
3. Results and Discussion
In the experiments, the nature of the oscillations was investigated by studying the components of the oscillations of the two grids simultaneously to compare the results obtained. The oscillations of the grids working on the machines of the universal ginning complex (UGC) are caused by the action of the disturbing forces [20-22], from the side of the spiky cylinder with the cotton of different weights and therefore are forced. These forces are due to the masses of cotton and the frequency of rotation of the serrated cylinder. In figure 4 shows a characteristic wave form.

![Figure 3. Appearance of the measuring device on the cleaning grids in the working area of the machine: 1 is recommended cleaning grid; 2 is existing cleaning grid; 3 are measuring devices; 4 is measuring device bracket.]

![Figure 4. Oscillogram of the recording of vibrations with a rubber stiffness of 3.103 N/m and an oscillation frequency of 35 Hz: an oscillogram obtained at the productivity of 5t/h.]

Swing range existing grid
Swing Recommended Grid
Ring cylinder revolution
The load on the shaft of the annular cylinder
The readings of the instruments were measured under the conditions of a capacity of 3 t/h, 5 t/h, and 7 t/h. With a rotational speed of 450 rpm of the cylinder and a distance of 14 mm from the pegs to the grid surface. Measurements were carried out for bushings mounted on grids with different stiffness’s, which had values of $1.5 \times 10^3$, $3 \times 10^3$, $4.5 \times 10^3$ N/m.

Analysis of the obtained grid oscillation laws showed that the amplitude of oscillations of the recommended multifaceted grid surface on elastic supports is 5–7 times higher than the oscillation depth of the existing grid and reaches up to $(2 \div 2.5) \times 10^{-3}$ m. At the same time, the waveforms are presented for steady cotton cleaner works. Therefore, the components of the natural oscillations of the system do not actually participate in them. It should be noted that the frequencies of forced vibrations for the compared grids are the same since the resistance (productivity) of cotton cleaning for the compared options is the same.

In fig. 5 shows the graphical dependence of the change in the amplitude of oscillations of a multifaceted grid on the variation of the stiffness coefficient of rubber support at machine productivity of 5 t/h.

![Figure 5. Dependence of the amplitude of oscillations of the recommended grid on the coefficient of the stiffness of rubber with machine productivity of 5 t/h.](image)

Graph analysis in fig. 5 shows that with an increase in the stiffness coefficient of the rubber support of a multifaceted grid from $1.5 \times 10^3$ to $5 \times 10^3$ N/m, the amplitude of the grid vibrations decreases from $1.36 \times 10^{-3}$ to $0.285 \times 10^{-3}$ m according to a nonlinear regularity.

In fig. 6 shows the graphic dependencies of the change in loading of a multifaceted grid surface on the increase in the number of its faces.
4. Conclusions

Analysis of the graphs shows that an increase in the number of grid faces ratio leads to a decrease in grid loading to (0.3 ÷ 0.5) N. This is explained by the fact that as the number of grid faces increases, it gradually approaches the cylindrical surface. This reduces the resistance to the movement of cotton on the grid surface.

The new effective design of the grid surface of the cotton cleaner from small trash is recommended. Experimental studies have studied the loading and the law of the oscillatory motion of the grid surface.

References

[1] Santos A, Bustamante M A, Tortosa G, Moral R and Bernal M P 2016 Gaseous emissions and process development during composting of pig slurry: The influence of the proportion of cotton gin waste J. Clean. Prod. doi:10.1016/j.jclepro.2015.08.084.

[2] Kaewprasit C, Hequet E, Abidi N nad Gourlot J P 1998 Application of methylene blue adsorption to cotton fiber specific surface area measurement Part I. Methodology. J. Cotton Sci

[3] Anthony W S and Mayfield W D 2018 Cotton Ginners handbook US Sci. Educ. Adm.

[4] Díaz M J, Madejón E, López F, López R and Cabrera F 2002 Composting of vinasse and cotton gin waste by using two different systems Resour. Conserv. Recycl. doi:10.1016/S0921-3449(01)00109-4.

[5] Crossan A N and Kennedy I R 2008 Calculation of pesticide degradation in decaying cotton gin trash Bull. Environ. Contam. Toxicol. doi:10.1007/s00128-008-9414-9.

[6] Allen A, Fouk J and Gamble G 2007 Preliminary Fourier-transform infrared spectroscopy analysis of cotton trash J. Cotton Sci.

[7] Burns M, Crossan A N, Kennedy I R and Rose M T 2008 Sorption and desorption of endosulfan sulfate and diuron to composted cotton gin trash. J. Agric. Food Chem doi:10.1021/jf703631j.

[8] Mburu A W, Mwasiagi J I and Anino E O 2016 Optimisation of cotton wax removal using bacteria isolate from gin trash J. Text. Inst. doi:10.1080/00405000.2014.1000014.

[9] Funk P A and Hardin R G 2017 Energy utilization and conservation in cotton gins Journal of Cotton Science

[10] McAlister D D and Rogers C D 2005 The effect of harvesting procedures on fiber and yarn quality of ultra-narrow-row cotton J. Cotton Sci.
[11] Mburu A W, Mwasia J I and Anino E O 2016 Optimisation of cotton wax removal using bacteria isolate from gin trash. J. Text. Inst. doi:10.1080/00405000.2014.1000014
[12] Anvar J and Ozod R 2019 Analysis of the interaction of fibrous material with a multifaceted grid of the cleaner Int. J. Recent Technol. Eng. 8 pp 2661–2666
[13] Hardin R G and Byler R K 2016 Removal of sheet plastic materials from seed cotton using a cylinder cleaner J. Cotton Sci.
[14] Clif Boykin J and Ray S 2010 The effects of seed cotton cleaning on seed coat fragments J. Cotton Sci.
[15] Whitelock D P, Buser M D, Boykin J C and Holt G A 2015 First stage lint cleaning system particulate emission factors for cotton gins: Particle size distribution characteristics J. Cotton Sci.
[16] Muksin K, Ilkhom A and Javlon K 2015 A new technology for dust removal from cotton processing Int. J. Recent Technol. Eng. doi:10.35940/ijrte.B2073.098319.
[17] Capareda S and Parnell C B 2007 Fluidized Bed Gasification and Pyrolysis of Cotton Gin Trash for Liquid Fuel Production ASABE Annu. Int. Meet.
[18] Abbazov I, Sarimsakov O, Xodjiev M and Mardonov B 2017 Improving of the technology of cleaning fibrous waste in cotton ginning plants. Br. J. Innov. Sci. Technol. doi:10.22406/bjist-17-2.6-43-47
[19] Murodov O 2019 Perfection of designs and rationale of parameters of plastic Koloski cleaning cleaners. Int. J. Innov. Technol. Explor. Eng. doi:10.35940/ijitee.K2204.1081219
[20] Urinov N, Abrorov A, Abdullayva D and Amonov M 2020 Influence of cutting edge of lamellar knives on the efficiency of work when cutting food semi-finished products. in IOP Conference Series: Materials Science and Engineering doi:10.1088/1757-899X/734/1/012178
[21] Urinov N, Saidova M, Abrorov A and Kalandarov N 2020 Technology of ionic-plasmic nitriding of teeths of disc saw of the knot of saw cylinder In IOP Conference Series: Materials Science and Engineering doi:10.1088/1757-899X/734/1/012073
[22] Khojiev M T, Juraev A D, Murodov O D, and Rakhamov A K 2019 Development of design and substantiation of the parameters of the separator for fibrous materials International Journal of Recent Technology and Engineering doi.org/10.35940/ijrte.B2835.078219