E3S Web of Conferences **434**, 03022 (2023) https://doi.org/10.1051/e3sconf/202343403022
ICECAE 2023

Basis of the improved construction of cotton cleaning equipment

Xamroz Ulugmuradov[1*], *Ilkhom* Abbazov [1], *Bobir* Sharopov[1], *Rustam* Muradov[1], *Maxfuza* Gapparova[2]

[1]Jizzakh Polytechnic Institute, Jizzakh, Uzbekistan
[2]Tashkent Institute of Textile and Light Industry, Tashkent, Uzbekistan

Abstract. In this article, the analysis of news on the development of the cotton industry in our republic is presented. In addition, based on theoretical studies and analyzes of cleaning processes used in foreign countries, ways to improve the cleaning efficiency of the pile drum, which is the main working organ of cotton cleaning equipment from small impurities. It is based on the need to carry out theoretical calculations of the cleaning surface to improve the cleaning efficiency of the cleaning equipment from small impurities. The results of the theoretical research on calculation of useful surfaces of mesh surfaces based on the calculation of the grid surface located in the lower part of pile barbars used in our Republic and abroad are presented. The need to develop new constructions to increase the use of mesh surfaces to 100% and its calculations were made.

1. Introduction

In the world, scientific and research work is being carried out aimed at the application of modern science and technology achievements, modernization of techniques and technologies in cotton ginning enterprises, and their implementation in production processes. In this regard, special attention is paid to the creation of new techniques and technologies based on the theoretical researches of cotton drying and cleaning, cotton ginning and fiber cleaning, which have a positive effect on fiber quality indicators [1, 2].

The implementation of large-scale new economic systems in our republic, including the development of textile clusters, puts a number of demands on cotton ginning enterprises that produce cotton fiber, which is considered the main raw material for textile enterprises. The most basic requirements include increasing the quality and quantity of cotton fiber, high fiber and seed damage in technological processes, i.e. low efficiency of cleaning cotton from small impurities [3, 4]. In fulfilling these requirements, taking into account the achievements and experiences achieved in the theoretical research conducted in the cotton-growing countries, extensive measures are being taken to develop theoretical models of modern techniques and technologies, and certain results are being achieved. In this regard, in the new development strategy of Uzbekistan for 2022-2026, among other things, "...continuing the industrial policy aimed at ensuring the stability of the national economy and increasing the share of industry in the gross domestic product, it is aimed to increase the production volume of industrial products by 1.4 times, in which textile industry products to increase the volume of production by 2 times. In the implementation of these tasks, among other things, it is important to increase the productivity of technological equipment with the introduction of theoretically based improved techniques and technologies to the enterprises of the cotton-textile cluster, to sharply reduce the amount of waste products, to improve the quality of manufactured products, and to reduce the consumption of electricity, materials and fuel.

In recent years, as a result of consistent reforms carried out in the field of modernization and diversification of agricultural production, development of the product processing industry, a new system-cluster method of activity in the agricultural sector has been introduced. Today, 122 cotton-textile clusters are operating in our Republic. 97 of them have 2 million 536 thousand tons of cotton processing plants and 39 clusters have 193.5 thousand tons of fabric production capacity.

In this work, the separation of small impurities from the cotton content in cotton pretreatment is one of the main processes, and this process shows its effect on the quality and quantity of fiber produced during cotton ginning and fiber cleaning [5]. If the cotton is not sufficiently cleaned of small impurities, it will change from passive impurities

* Corresponding author: xulugmuradov@mail.ru

to active impurities during cotton ginning and remain in the fiber without being completely separated from the fiber during cleaning in the fiber cleaner and will lead to a decrease in the quality of the fiber [6].
The effective separation of small impurities from the cotton content is inextricably linked to the mesh surface involved in the cleaning process and the construction of piles in the drum, which is the main working part. Therefore, the research work of many scientists is aimed at improving the design of mesh surface and piles in the drum to effectively separate small impurities from the cotton content.
In all cotton ginning machines, the cotton is cleaned of fine impurities by passing it over a mesh surface in piled drums. This process is repeated several times and results in increased fiber and seed damage.

2. Methods

2.1 Experimental devices

In the process of cleaning cotton from small impurities, taking into account the fact that the level of damage to cotton pieces in the cotton flow is increasing, we put forward the hypothesis that improving the drum piles (instead of fingers in the next sentences) made of elastic material will prevent damage to cotton, and we will theoretically study the cleaning of cotton pieces by the action of elastic fingers. In this case, in the process of cleaning cotton, it is carried out with the help of fingers made of elastic material installed on the drum (Fig. 1) [7].

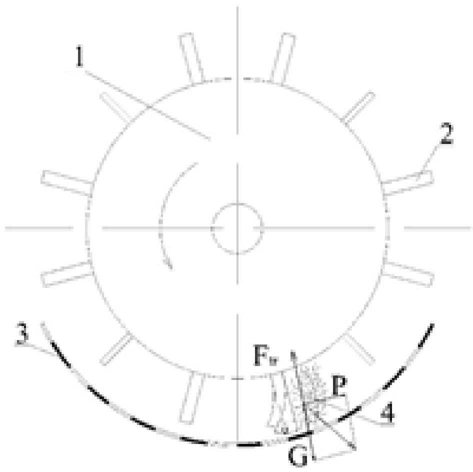


Fig. 1. Suggested elastic finger cleaner: 1-elastic finger-plate drum, 2-elastic fingers, 3-net surface, 4 piece of cotton, P- the effect of an elastic finger on cotton; G- centrifugal force; Ftr- friction force; α- flexion of the elastic finger

2.2 Formulating problems

In the research conducted by Murodov (2021) [8], it was determined that the same mechanical effect on cotton during the cleaning process causes the cleaning efficiency to decrease. In order to overcome this problem, he proposed to prepare the piles of the cleaning drum in different forms. As a result, it has been proven that cotton moves in different trajectories, as well as increased efficiency.

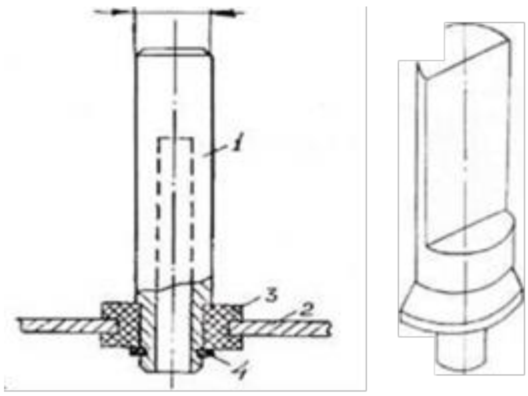
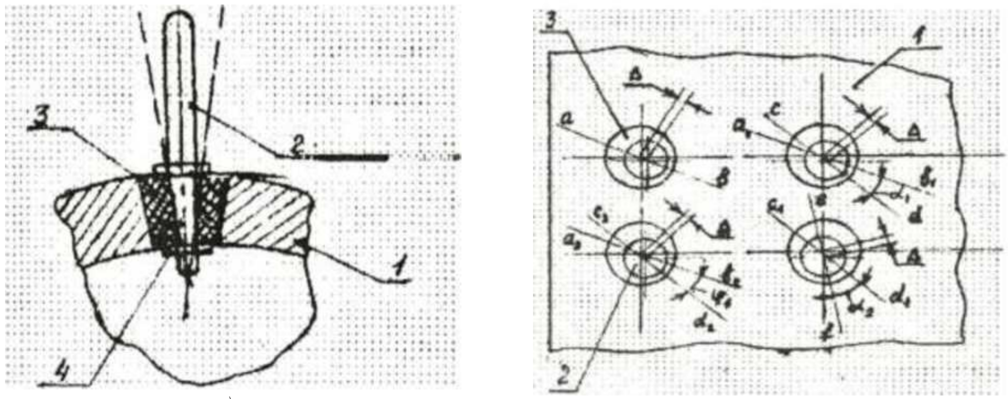


Fig. 2. Constructive schemes of piles: a- pile with a strap base b-scheme of a pile with a straight flat surface

Figure 2 shows a diagram of a drum pile mounted on a belt base (a) and a diagram of a pile with a straight flat surface (b). These structures are also not widely used in production due to their complexity.
The scheme of the pile drum with a strap base is presented in Fig. 3. The constructive feature is that the axis of the pegs 2 and the axis of the rubber bushing (base) 3 are placed eccentrically. During operation, each pile vibrates at a different amplitude, there is no monotopy, and the cleaning efficiency is high [9]. But due to the complexity of the construction, this technology was not used.



a) *b)*

Fig. 3. A drum layout with piles on a strap base: 1-drum base; 2-pile; 3-rubber bushing; 4-pin tightening nut, a- installation of a rubber bushing with a pile; b- layout of the pile

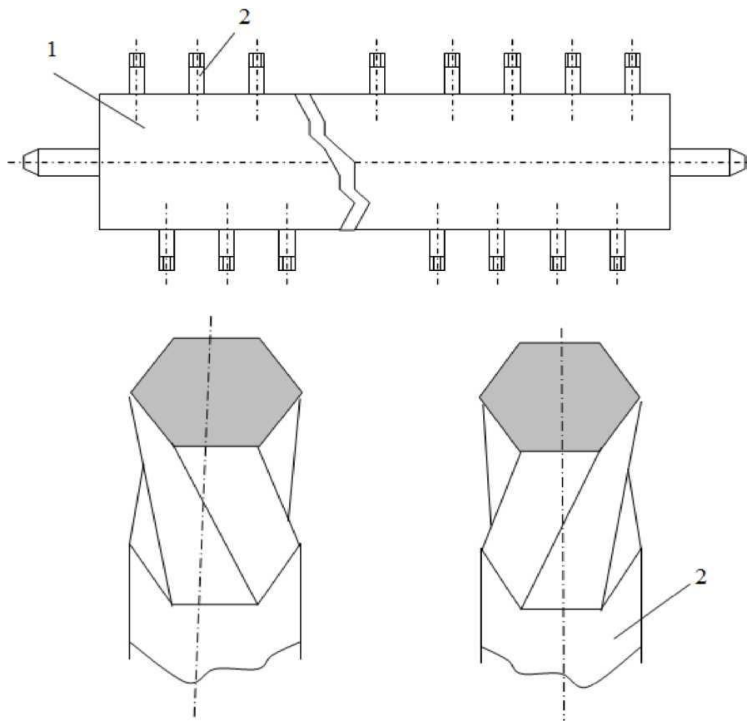


Fig. 4. A drum layout with multi-sided piles: 1- drum, 2- versatile pile

Figure 4 also shows a drum scheme with multi-faceted piles.
In this construction, because the edges of the pile are twisted, damage to cotton and seed is partially increased. But the cleaning efficiency is high [10]. In the technology of cleaning cotton from small impurities, the angular speed of the pile head is effectively increased (Fig. 4, 5).
The disadvantage of the construction is the complexity of its preparation and the resource is not high in the process of work, so it is not widely used in production.

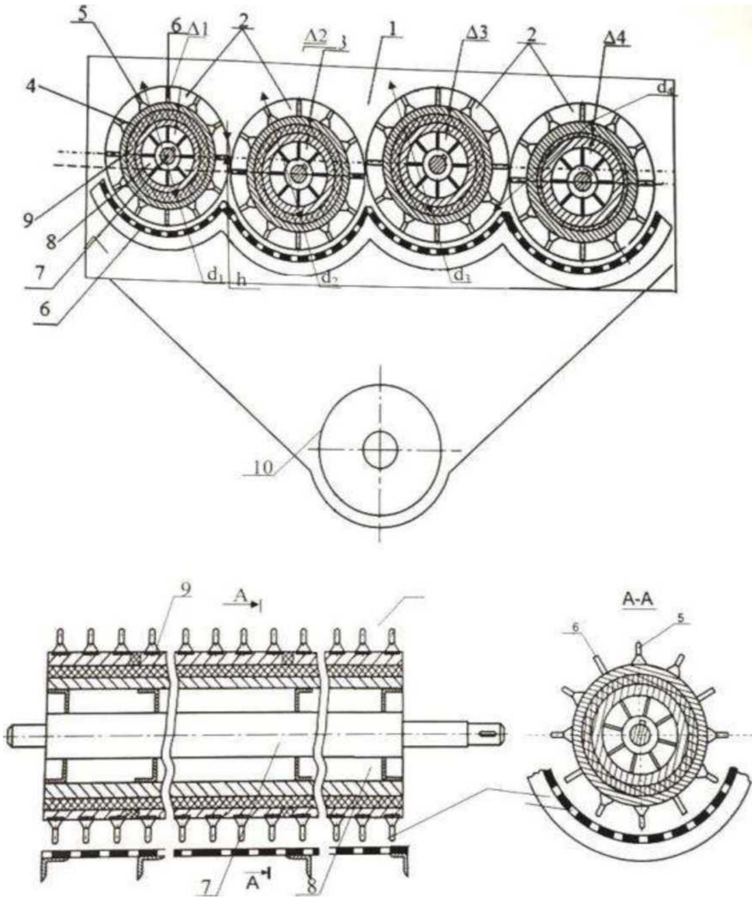


Fig. 5. Scheme of a cleaner with drums with belt elements:1-working chamber; 2-pile-plate drum; 3-metal coating; 4-corjux; 5-pile; 6-plate; 7-shaft; 8-flanes; 9-rubber bushing; 10-contamination auger; d_1-diameter of the drum with the first pile; d_2-diameter of the drum with the second pile; d_3-diameter of drum with third pile; d_4-the diameter of the drum with the fourth pile; h-the distance between the shafts of the drums with upper and lower piles; $\Delta 1$-first pile drum; $\Delta 2$-second pile drum; $\Delta 3$-third pile drum; $\Delta 4$-fourth pile drum

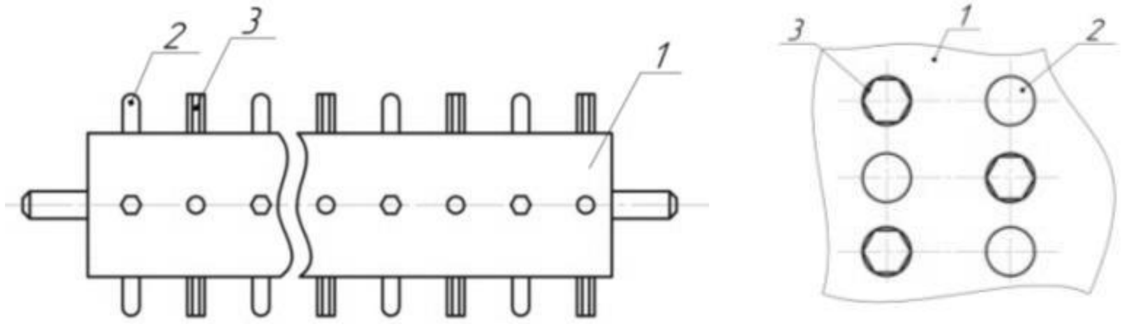
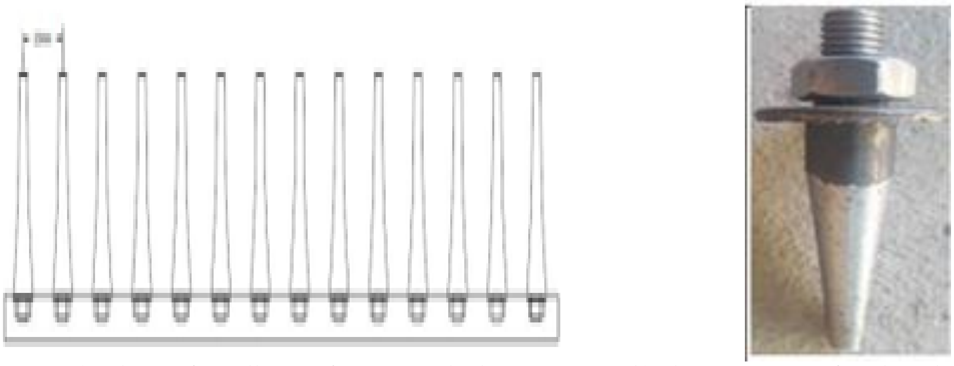


Fig. 6. A drum layout with multi-sided piles: 1- drum, 2- piles, 3- versatile piles

Advantages and possibilities: on the surface of multi-faceted piles (Fig. 6), the cotton piece moves in different directions and at different speeds, and the cleaning of the cotton and the separation of impurities from it are intensified.

When the indicators were compared, when the recommended multi-sided pile drum was used, (3.5÷4.2)% more cleaning efficiency was obtained compared to the existing drum. This indicator was (2.7÷3.1)% when 3-grade cotton was processed.

High cleaning efficiency (38÷41.5)% was obtained when the number of sides of drum piles was equal to 6. In this case, the degree of damage to cotton fibers and seeds changes significantly.



a) Scheme of installation of cone-tipped piles *b) The appearance of a pile with a conical tip*

Figure 7. Scheme of conical piles

In the work of the researcher Sh.Isaev (Fig. 7), the scheme and general appearance of the cone-tipped, exchangeable peg is described, the height of the pegs is equal to the height of the actual pegs (75 mm), its base is 12 mm, and the tip is 6 mm. A 25 mm part of the base of the pile is grooved for fixing it to the cover of the working drum with a nut and a washer [11]

In the scientific work of the researcher S.Sayitkulov, piles (Fig. 9) were made in 3 different diameters and researches were conducted on the cleaning equipment. The results of the experiment were obtained by preparing the drum with the first pile diameter d_1-8 mm, the drum with the second pile diameter d_2-10 mm, and the drum with the third pile diameter d_3-12 mm [12].

Seed damage has been shown to be around 2.0% due to impact and drag of cotton raw material across the mesh surface. This damage creates various defects in the fiber. Therefore, it is necessary to develop a new technology that ensures the efficiency of cleaning from small impurities while keeping the natural quality indicators of cotton as much as possible.

3. Result and Discussion

After the cotton with the initial mass M_0 coming to the cotton cleaning process moves on the mesh surface, its mass M_1 due to the separation of particles should be equal to the mass M_2 of the impurities [13].

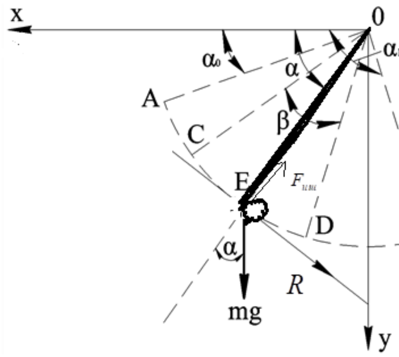


Fig. 8. The movement of cotton on the mesh surface under the influence of elastic fingers

On a cotton mesh surface, the $AB = \breve{S}$ moves along an arc. We take the equation of the curve AB as $r = r(\alpha)$ in the polar coordinate system. The cotton mesh surface moves from point $A(\alpha_0, r_0)$ to point $B(\alpha_1, r_1)$.

Here, at the time $r_0 = r(\alpha_0)$, $r_1 = r(\alpha_1)$, $t \geq 0$, AB is at the point $E(r(\alpha), \alpha)$ of the arc and is at a distance S from point A: we consider the mass of a piece of cotton as a material point, and we use the equation of S.M.Torg to determine its equation of motion on the line AB and its normal expression (Fig. 8).

$$M_0 \cdot \frac{d^2S}{dt^2} = R + M_0 g \sin\alpha \tag{1}$$

We define the normal force as follows.

$$N = \frac{M_0 \dot{S}^2}{\rho(\alpha)} - M_0 g \cos\alpha$$

here $\frac{M_0 \dot{S}^2}{\rho(\alpha)}$ - centrifugal force

$M_0 \cdot g$ – gravity

Figure 9 shows the graphs of the change of the velocity $\dot{\alpha}(\tau)$ s along the arc AB of the cotton with respect to the dimensionless time $\tau = t \cdot \sqrt{\frac{g}{r_0}}$ at different values of ϑ_1. Analysis of the graphs shows that the elastic properties of the cotton surface can affect its speed. If the initial speed of the cotton is $\vartheta_1 < \vartheta_0$, it can be observed that the piece reaches the speed of the elastic fingers over time and partially increases its speed under the influence of the elastic force of the fingers. If it is $\vartheta_1 > \vartheta_0$, the cotton can lose its speed due to the viscous nature of the elastic force.

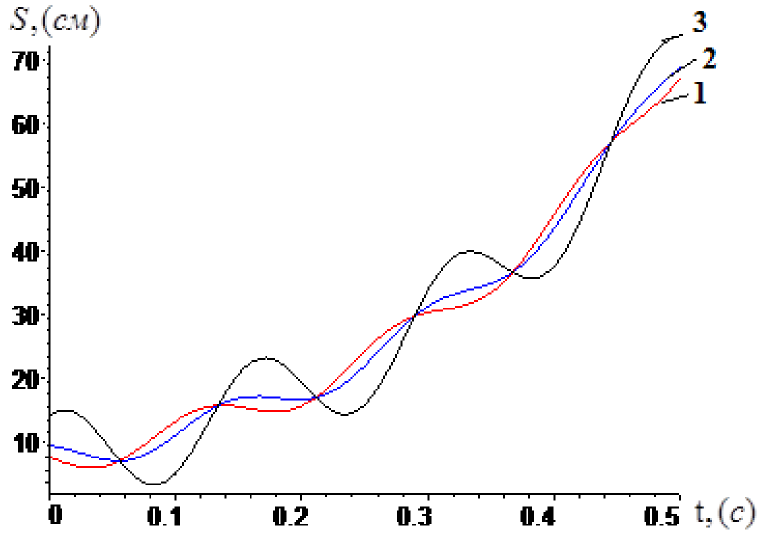


Fig. 9. A graph of the variation over time in the $\vartheta_1 = 3\ m/s$ $\vartheta_2 = 6\ m/s$ $\vartheta_3 = 9\ m/s$ values at different speeds of the elastic fingers

In addition, it is necessary to check the location and length of the piles in the drum, as well as the speed of rotation of the drum by experimenting.

In addition, the authors created a new construction for cleaning cotton from small impurities, which allows to increase the coverage surface of the mesh surface (application No. FAP 20210398). This working design is being reviewed by the Intellectual Property Agency [14].

Overall efficiency. In summary, the result of the effect of elastic fingers on cotton pieces from equation (1) (Figures 9 and 10) shows the movement trajectory of cotton pieces. From the analysis of the graphs, it can be noted that the speed of the cotton flow depends on the vibration of the elastic fingers. At the rational value of the cotton speed $\vartheta = 9\ м/с$ and $\kappa_2 = 0{,}5$ of the elasticity coefficient of the elastic finger, we can see the vibration process of the elastic fingers in the graphs, which can increase the efficiency of separating small impurities from the cotton flow.

Effect on cleaning efficiency of equipment. When ginned cotton was ginned, ginned seed damage was 3.15%, improving the quality by 0.29 (abs) % compared to existing ginning seed damage [15]. When ginned fiber is cleaned in a fiber cleaner, the mass percentage of defective fiber and dirty impurities in the fiber is on average 1.96%, and the quality of the fiber is improved by 0.38% (abs) on average, to the II grade "Oliy" according to the state standard UzDst 632:2016 affiliation was determined [16].

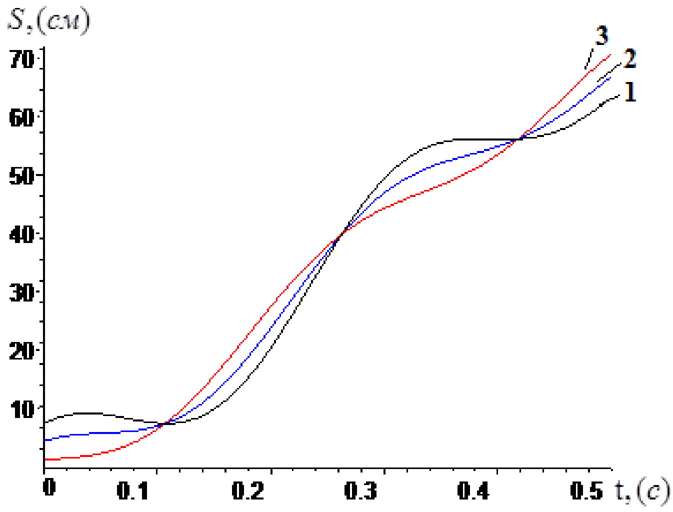


Fig. 10. Graph of change in $\kappa_1 = 0.2$ $\kappa_2 = 0.5$ $\kappa_3 = 0.8$ values of elastic fingers with different uniformity coefficients over time

4. Conclusions

The speed of the drum with elastic piles at rational values of $\vartheta_n = 0{,}9\ m/s$, $\vartheta_n = 1{,}2\ m/s$ increased the effectiveness of the separation of small impurities from cotton by the impact of the piles on the cotton flow.
The cleaning efficiency of the equipment in cleaning cotton under the influence of elastic piles depends on the coefficient λ, and it was determined that the equipment works at a high cleaning efficiency at a rational value of the coefficient $\lambda_0 = 0.05$.

References

1. Kh. Rakhmonov, S. Fayziev, M. Qodirov, A. Temirov, G. Toyirova, Development of a resource-saving technology allowing to increase the environmental sustainability of drying cotton raw materials, *E3S Web of Conferences* **390**, 06019 (2023)
2. F. Egamberdiev, K. Jumaniyazov, I. Abbazov, H. Yodgorova, M. Rajapova, Theoretical study of the impact aimed at improving the efficiency of fiber cleaning, *IOP Conference Series: Earth and Environmental Science* **939**(1), 012032 (2021)
3. C. Li, D. Thibodeaux, A. R. Knowlton, J. Foulk, Effect of Cleaning Treatment and Cotton Cultivar on Cotton Fiber and Textile Yarn Quality, *Applied Engineering in Agriculture* **28**(6), 833-840 (2012)
4. U.E. Kechagia, H. Harig, New Perspectives in Improving Cotton Fiber Quality and Processing Efficiency, Proceedings of the World Cotton Research Conference, Athens, Greece (1998)
5. Q. Jumaniyazov, M. Ismatova, I. Abbazov, D. Kazakova, Study on the influence of the cotton storage process on the quality indicators of fiber and yarn, *IOP Conference Series: Earth and Environmental Science* **939(1)**, 012053 (2021)
6. M. Khodjiev, I. Abbazov, J. Karimov, Influence of Local Resistance on Pressure and Speed Changes in Expanded Pneumatic Conveying, *E3S Web of Conferences* **304**, 03016 (2021)
7. I. Abbazov, A. Usmankulov, B. Sharopov, Investigation of local resistance and air velocity in narrowing pipes for the transport of fibrous materials, *IOP Conference Series: Earth and Environmental Science* **1142**(1), 012093 (2023)
8. O. Murodov, Development of an effective design and justification of the parameters of the separation and cleaning section of raw cotton, *Journal of Physics Conference Series* **1889**(4), 042012 (2021)
9. U. Norboyev, R. Sulaymonov, B. Sharopov, Trial results for the production of the improved 5LP linter, *IOP Conference Series: Earth and Environmental Science* **1142**(1), 012096 (2023)

10. A. Usmankulov, A. Salomov, I. Abbazov, F. Egamberdiev, Creation of improved UXK equipment for cleaning cotton from large impurities, *IOP Conference Series: Earth and Environmental Science* **1142**(1), 012080 (2023)
11. F. Egamberdiev, K. Jumaniyazov, I. Abbazov, H. Yodgorova, Theoretical study of the effect of improving cleaning efficiency and fiber quality from a double-drum fiber cleaner, *IOP Conference Series: Earth and Environmental Science* **1142**(1), 012088 (2023)
12. E.Z. Zikriyoeva, Primary processing of raw cotton, Mekhnat, Tashkent (1999)
13. I. Abbazov, R. Kaldybaev, G. Bektureyeva, Theoretical Researching of Particle Movement in Cleaning Zone of Dust-Arrester, *Pol. J. Environ. Stud*. **32**, 1-8 (2023)
14. R. Muradov, I. Abbazov, Kh. Ulug'muradov, B. Najmiddinov, Equipment for cleaning cotton from small impurities, useful model application № FAP 20210398, Tashkent (2021)
15. R. Muradov, Kh. Ulugmuradov, E. Mukhametshina, A. Kushimov, Principles of making pile of cotton cleaning machines from elastic material, *Universum: Engineering Science* **103**, 5-9 (2022)
16. Q.J. Jumaniyazov, H. Ulug'Muradov, O.G.L. Ulug'Bek Yaxshiliq, changes in the amount of waste and thread depending on the composition of the mixture according to the transitions of the spinning process, *Science and Education* **2**(1), 179-186 (2021)