STUDYING THE INFLUENCE OF CLEANING INDICATORS IN ONE AND TWO-STAGE CLEANING OF COTTON IN UXK UNIT

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Abstract. *In the article, the efficiency of cleaning for machine-picked cotton with a high amount of impurities has been increased due to the installation of a drum with a saw and a drum with a supply brush as an addition to the cleaning section of the UXK unit. The results obtained in the improved UXK aggregate are presented. Due to its special properties, it increases the cleaning efficiency compared to the existing cleaner.*
Keywords: *cotton, cotton cleaner, large dirt, pile drum, working body, construction, cleaning efficiency, cleaning effect.*

Introduction. After the large-scale introduction of new economic systems in our republic, the creation of cotton and textile clusters sets a number of requirements for cotton fiber production enterprises, such as flexibility in production management, efficiency, rational use of resources, and maintaining the natural quality indicators of cotton fiber at a high level during its processing. This confirms the urgent problem of increasing the quality of fiber and reducing its cost by improving resource-saving, modern techniques and technologies, taking into account the achievements and experience of cotton-producing countries.

The results of the analysis of the scientific research carried out to date showed that the research on the cleaning of raw cotton from impurities was carried out in two directions - on the study of the process of cleaning from small and large impurities. In the process of cleaning cotton raw materials, productivity, cleaning efficiency, seed damage and the amount of cotton in the waste were determined as the main indicators.

In the following [1,2,3,4], a number of scientific research studies have been carried out on the theoretical study of the technological process of cleaning raw cotton from impurities. Theoretically, with an increase in the diameter of the saw drum, the impact force of the piece of cotton raw material adjacent to the saw tooth on the colosnik decreases, and with an increase in the number of revolutions, the impact force increases. Based on a practical study, it was determined that the cleaning efficiency of the cleaner decreases when the diameter of the saw drum is changed from 80 mm to 700 mm at the same number of rotations of the saw drum, while the number of colosniks does not change. It was found that the cleaning efficiency increases when the linear speed of the saw drum increases from 5 m/s to 9 m/s, and changes less when it is higher. It is determined that the linear speed of the saw drum should not exceed 7 m/s in order to reduce the mechanical damage of the cotton seed.

In the process of cleaning cotton from large impurities, it was noted that the maximum cleaning efficiency is achieved when the speed of the saw cylinder is 6.6 m/s, and the amount of raw cotton pieces and free fibers in the waste is small.

The optimal distance between saws is determined to be 12.5-13 mm. In this case, it has been proven on the basis of practical experiments that the efficiency of cleaning is high, pieces of raw cotton do not get stuck between the saws, the seed breaks and the amount of free fibers decreases. A formula for determining the distance between saws has been created.

M.S.Aripdjanov and others [5,6] studied the effect of cleaning the distance between the saw drum and the colosnik on the quality indicators, the effect on the amount of cotton added to the waste separated from the colosnik, and gave their recommendations.

Methods. The main working organs of the zone of separation of cotton from large wastes consist of a drum with a saw and colosniks placed under it. During the cleaning process, the saw teeth capture the fibrous seed, which interacts with the colosniks, where large waste is separated. If the main technological mode is the angular speed of the saw drum, the main technological parameter is the distance between the saw drum and the columns. Usually, the size of this gap is determined in the range of $(12\text{-}20)*10^{-3}$ m [7]. It should be noted that when the angular speed of the sawing drum is high, the angle of deviation of the fiber seed caught by the saw also increases, and the arc of vibration increases. As a result, the fiber seed passes through the colostrum without touching it, and the cleaning efficiency decreases. Therefore, it is important to determine the angle of deviation of the fiber seed, that is, its length. If the angle occupied by the columns in the coverage area of the drum is $\varphi_к$, the value of the angle $\alpha_к$ occupied by each two neighboring columns can be determined from the following expression:

$$\alpha_к = \frac{\varphi_к}{n_к}$$

here: $n_к$ – number of colosniks.

The calculation scheme for determining the angle of deviation of the fiber seed caught by the saw tooth of the saw drum is presented in Fig. 1.

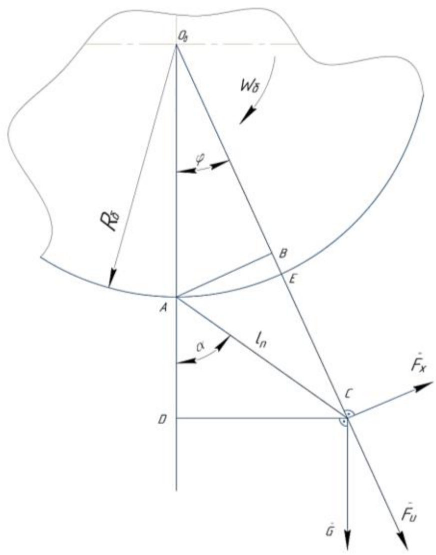


Figure 1. The calculation scheme for determining the angle of deviation of the fiber seed caught by the saw tooth of the saw drum

According to the calculation scheme, the inertial force, gravity force, air resistance force acting on the cotton tuft, taking the moment relative to point A, based on the balance condition [8, 9]:

$$\sum_{i=1}^{n} M_A(F_i) = 0;$$

$$-F_v*AB - GДС + FxBC = 0$$

AB, ДС, BC – the shoulders of the moments of the acting forces relative to the A-point.

Relative inertia force:

$F_и = m_n \ell_n \omega^2$

here: m_n,- fibrous seed mass

ℓ_n – length;

$\omega_б$– angular velocity.

Gravity:

$G = m_n\, g$

Air resistance:

$F_x = \frac{1}{2} F_м k_л V^2 \mathcal{P}_x \ell_n$

here: $F_м$ – the surface of the midlevel section;

$k_л$ – resistance coefficient;

$\mathcal{P}_x$ – air mass density

V – relative velocity of fiber seed.

The drag force is directed along AC and the resultant moment is zero. Based on the account scheme, the following can be written [10]:

$AB = R_б - \sin\varphi$, $AD = \ell_n \cos\alpha$, $DE = \ell_n \sin\varphi$, respectively from △ABC:

$AB = \ell_n \sin(\alpha - \varphi)$

$BC = \ell_n \cos(\alpha - \varphi)$

Then $O_бC = \frac{O_б}{\cos\varphi} = \frac{R_б + \ell_n \cos\alpha}{\cos\varphi}$

Taking into account Ya.B. Panovko's research [11], noting that the oscillating motion of the cotton ball corresponds to the oscillation of a suspended pendulum, the relative movement speed of the fiber seed is expressed by the following differential equation:

$$m_n e_n^2 \frac{d^2\alpha}{dt^2} = m_n w^2 \frac{R_б + \ell_n \cos\alpha}{\sin\varphi} -$$

$$-m_n\, g \frac{R_б + \ell_n \cos\alpha}{\sin\varphi} + \frac{1}{2} F_м к_л \mathcal{P}\, V_n\, \ell_n^2 \sin(\alpha - \varphi) \qquad (1)$$

The resulting (1) was implemented at the following values of the numerical solution parameters:

$m_n = (0{,}38\text{-}0{,}44)\ 10^{-3}$ kg; $\omega_б = (38\text{-}45)\ s^{-1}$; $R_б = (2{,}2 - 2{,}5)10^{-1} m$;

$\ell_n = (2{,}0\text{-}2{,}5)10^{-2}$ m; $g = 9{,}81\ m/s^2$ $V_x = (6{,}5\text{-}8{,}0)$ m/s;

$\mathcal{P} = (0{,}2\text{-}0{,}5)$ g/sm^3.

The numerical solution of the problem was determined on a computer using the Runge-Kutta method.

In order to solve the problem, it is important to determine the law of change of the angle α as well as to determine its maximum range of oscillation. Based on the analysis of the values of $\triangle\alpha$, it is possible to determine the angular speed of the saw drum and the number of colosniks.

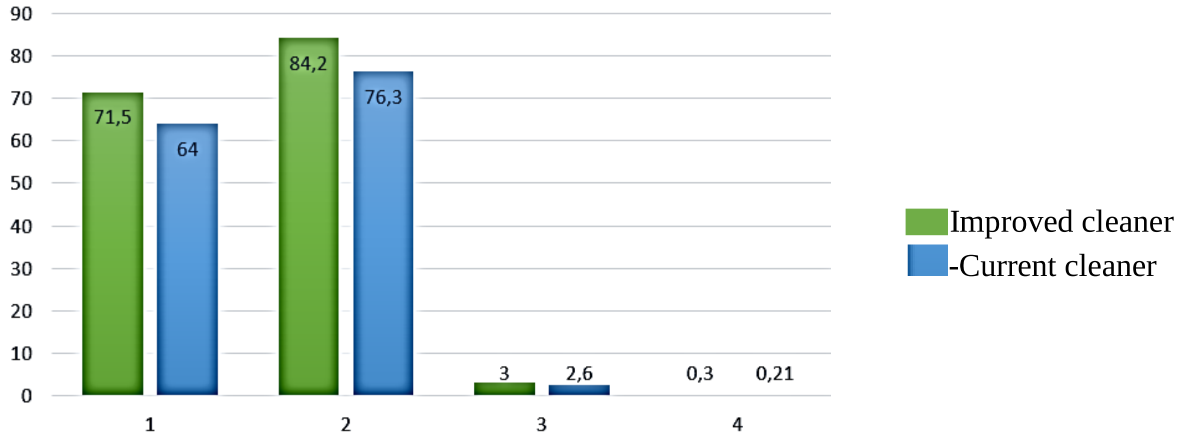
Results and Discussion

It is known that working bodies with saws affect the mechanical damage of the seeds contained in cotton during cotton cleaning. Especially in our version, raw cotton is cleaned in two stages. For this reason, mechanical damage to cotton seed was studied in the experimental options based on the current methodical manuals. In addition, the influence of the gap between the teeth of the saw drum and the softening brush on the quality of cotton cleaning and the mechanical damage of the seed was also studied.

The results of the study of the effect of one-stage (current) and two-stage (improved) cleaning of cotton raw materials on the technological performance of the section of the large impurities removal unit of the UXK unit are presented in Figures 2 and 3.

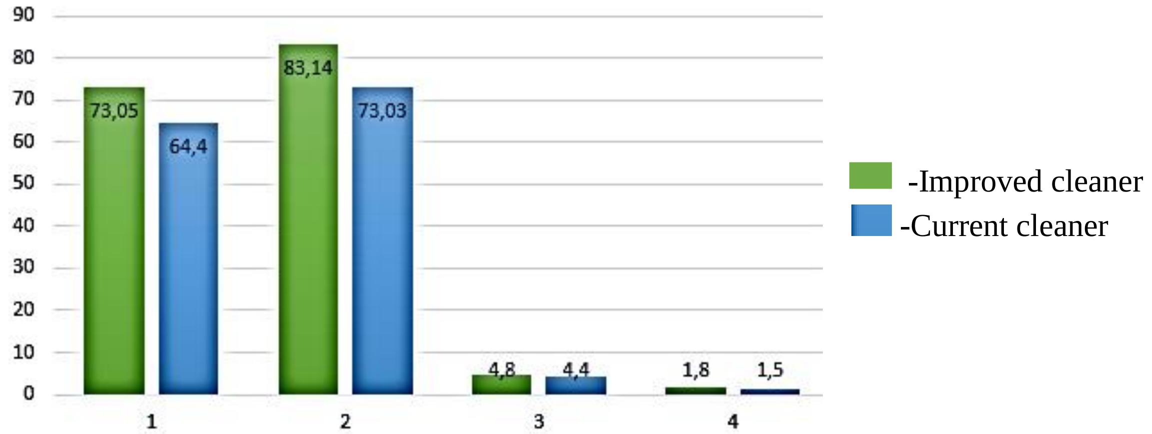
As can be seen from Figure 2 below, two-step cleaning provides relatively higher cotton cleaning efficiency compared to the current single-step cleaning [12,13,14].

As can be seen from the graphs in Figure 2, it was found that in the improved two-stage cotton cleaning section, the overall cotton cleaning efficiency is 7.5% higher than the one-stage (current) cleaning, and the cleaning efficiency is 7.9% higher.



1. overall cleaning efficiency, %; 2. efficiency of cleaning from large impurities, %; 3. mechanical damage of seed, %; 4. Amount of cotton pieces added to impurities, %.

Figure 2. Effect of treatment of raw cotton (current) and improved on the process performance of the section for removing large impurities (Bukhara-102, 1 type cotton)



1. overall cleaning efficiency, %; 2. efficiency of cleaning from large impurities, %; 3. mechanical damage of seed, %; 4. Amount of cotton pieces added to impurities, %.

Figure 2. Effect of treatment of raw cotton (current) and improved on the process performance of the section for removing large impurities (Bukhara-102, 3 type cotton)

Therefore, in order to improve the cleaning efficiency of the cotton raw material picked by the machine, it is better to clean it in the two-stage improved large dirt cleaning section. From the graphs in Figure 2, it can be seen that the mechanical damage of the seed contained in the cleaned cotton is greater in the two-stage improved bulking section compared to the one-stage (practical) cleaning. This is logical, because cotton cleaning is carried out in two stages, so the impact on it with the teeth of saw drums has increased. However, the increase in the mechanical damage of the seeds in cotton is 0.4-0.6% compared to one-stage cleaning, so it is possible to recommend the use of the improved two-stage section for removing large impurities in the cleaning of machine-picked technical cotton raw materials.

It can be seen from the graph in Figure 2 that the amount of cotton particles passing through the colostrums of the regeneration saw drum of the improved two-stage large dirt cleaning section and joining the separated impurities has increased by a small amount (0.03%) compared to the existing one-stage cleaning. The reason for this can be explained by the increase in the amount of cotton particles passing through the colosniks of the cleaning saw drums to the regeneration saw drum, as a result of which the mass to be cleaned in the regeneration drum has increased.

These disadvantages of the two-stage improved heavy soiling section can be ignored as it provides a significant 7.5% increase in the cleaning efficiency of heavily soiled machine-picked raw cotton. Because cotton regenerator 1RX is used in the technological line of initial processing of cotton to separate the pieces of cotton that are added to the impurities separated from the UXK aggregate.

It can also be seen from the graphs in Figure 3 that the results of the experiments conducted on the 3rd type of machine-picked cotton vary according to the laws in the graphs presented in Figure 2. As can be seen from the graphs, it was found that in the improved two-stage cotton cleaning section, the overall cotton cleaning efficiency is 8.6% higher than the one-stage (current) cleaning, and the cleaning efficiency is 10.11% higher. The increase in the mechanical damage of the seed in cotton was 0.8% compared to one-step cleaning.

It was found that the amount of cotton particles passing through the colostrums of the regeneration saw drum of the improved two-stage large dirt cleaning section and joining the separated impurities increased by 0.09% during the cleaning of type 1 cotton compared to the existing one-stage cleaning.

It can be concluded from the experimental results presented in Figures 2 and 3 that if the proposed two-stage section for removing large impurities is used to clean cotton raw materials picked by a machine, its most important indicator - that is, the efficiency of removing large impurities from cotton - is 7.9-10.

It is possible to ensure an increase of 11%. In this case, it is possible to ignore the mechanical damage of the seeds contained in the cotton, the increase in the amount of cotton pieces coming out of the cleaning section with impurities.

Conclusions. It was found that the amount of cotton particles passing through the colostrums of the regeneration saw drum of the improved large dirt cleaning section and being added to the separated dirt increased by a very small amount (0.03%) compared to the current treatment.

The reason for this can be explained by the increase in the amount of cotton particles passing through the colosniks of the cleaning saw drums to the regeneration saw drum, as a result of which the mass to be cleaned in the regeneration drum has increased.

If the proposed improved section for cleaning large impurities is used to clean cotton raw materials with large impurities, it was determined by experiments that its most important indicator - the efficiency of cleaning large impurities in cotton - will increase by 7.9-10.11%.

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