Results of Research Conducted in the Improved Cotton Regenerator

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**Abstract.** In the process of cotton regeneration, the presence of passive impurities mixed with air and added to the cleaned cotton leads to a decrease in the cleaning efficiency of the cotton regenerator. Due to the lack of a clear technology for processing cleaned cotton in a cotton regenerator, the technology for processing regenerated cotton at cotton ginning enterprises varies. This, in turn, leads to a deterioration in the quality indicators of the product fiber. The article presents the results of research conducted on an improved design of a device for regenerating cotton particles separated from impurities during the cleaning of cotton from large trash impurities. An additional shaft-collector, feed rollers, a brush drum, and a guide coating are installed in the supply section of the cotton regenerator. As a result, it became possible to clean cotton up to five times in the saw drum and rib module. The value of the rational angle of inclination of the regenerator guide was 650. When this value was established and research was conducted, a decrease in mechanical damage to seeds was observed, as well as high results of cleaning efficiency and regeneration efficiency were noted. At a cleaning efficiency of 92.97% and regeneration efficiency of 97.35%, product loss is 2.65% of the waste processed in the regenerator. The ratio of the amount of cotton particles in the trash after regeneration to the amount of cotton processed in the UHK unit was 0.15%.

**Key words:** cotton, mechanical demage, drum, fiber

# Introduction

The main working parts of the cotton regenerator include the saw drum, ribs, trapping brush, brush drum, and air system.

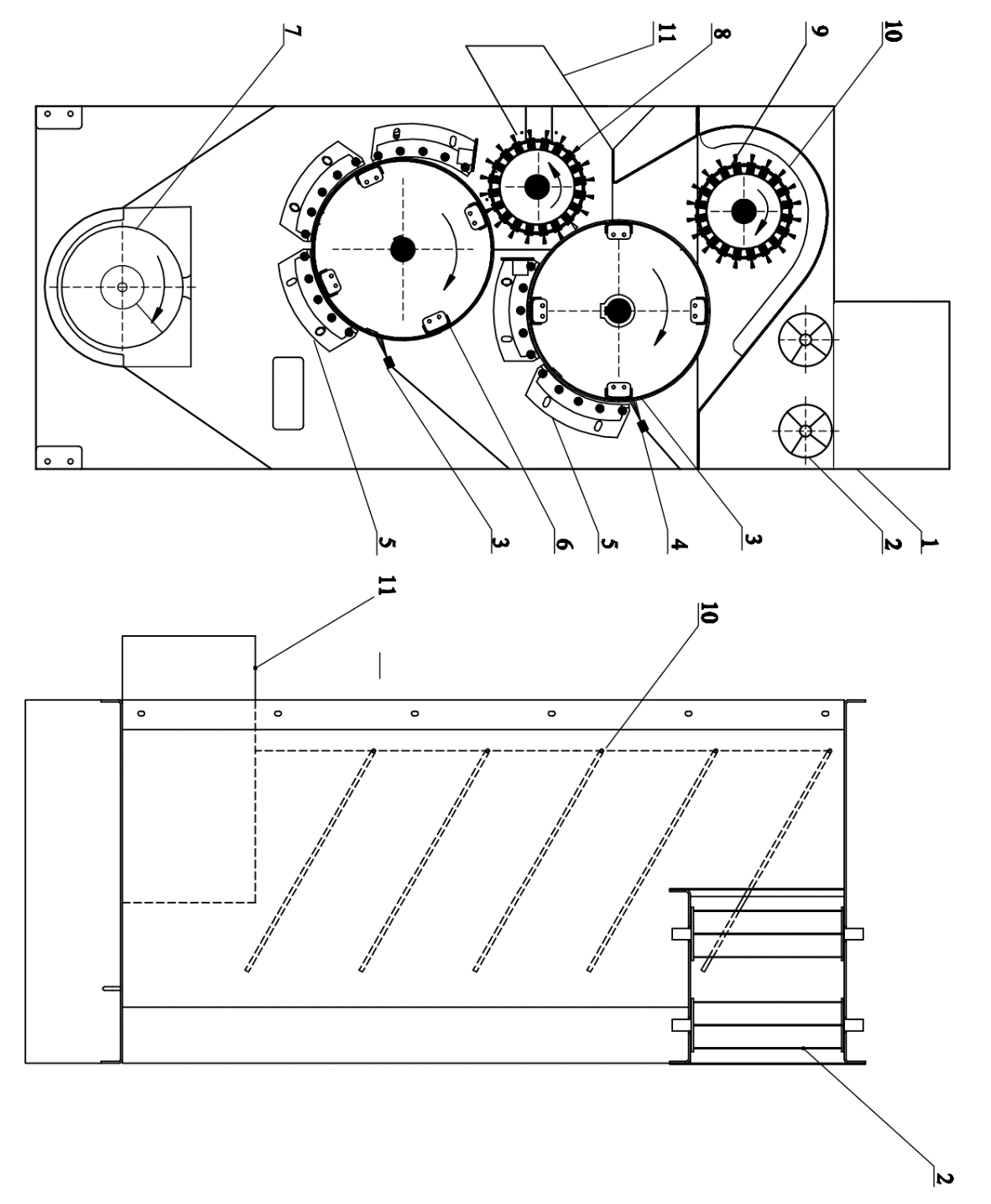
As discussed in the previous chapter, the presence of air in the existing cotton regenerator leads to a decrease in cleaning efficiency due to the transit of untreated impurities. To eliminate this problem, it is recommended to install a feeder, a guide, and a brush drum in the cotton regenerator that allows for multiple cleaning without using an air system [1, 2, 3].

Cotton mixed with impurities separated during the cleaning process of the UHK cleaning stream enters the regenerator feeder shaft. The feeder delivers contaminated cotton to the equipment in one hour. Cotton entering the equipment is cleaned from impurities as a result of its impact on the huller ribs, which are attached to the saw drum with the help of a trapping brush. The cleaned cotton in the saw drum is transferred to the brush drum located above using the separating brush drum. A guide is located at the top of the brush drum, which is positioned at a certain angle and pushes the cotton fed by the brush drum along the saw drum channel by 250-300 mm. In this way, cotton with impurities is cleaned repeatedly on saw drums. In this case, it is also possible to remove impurities that are not firmly attached to the cotton [4, 5, 6, 7].

# Materials and methods

The investigated diagram of the cotton regenerator is shown in Fig. 1.

The cleaned cotton in the saw drum has an outlet throat installed on the other side of the equipment, and a barrier is installed at the top of the separating brush drum in the outlet throat. This barrier prevents the cotton from rising upward and directs the cotton towards the exit throat.



**FIGURE 1.** Diagram of the cotton regenerator under study  
1-mine-collector; 2 - pair of feed rollers; 3-saw drum; 4-adhesive brush; 5 - ribs; 6-regenerating saw cylinder; 7 - trash auger;   
8-brush drum; 9-feed brush drum; 10-guide; 11-cleaned cotton outlet throat

In order to substantiate the main parameters of the proposed cotton regenerator, we set ourselves the task of theoretically studying the trajectory of the movement of the cotton particle at the exit of the brush drum in the outlet zone, the impact effect of the cotton particle on the surface of the inclined guide, and its movement after impact.

In order to determine the influence of the recommended guide angle on the cleaning efficiency of the improved RX regenerator, we conduct practical experiments and determine the rational parameters of the regenerator.

Taking into account that, based on the conducted theoretical studies, it is recommended that the angle of inclination of the guide be in the range of 640÷700, in the experiments it was determined that the angle of inclination of the guide should be 55; Installed at 65 and 750. Taking into account that in the conducted [8, 9, 10] studies it was established that the cleaning frequency is five times, experiments were conducted with the installation of inclined guides in groups of 4, 5, and 6. To prevent clogging of the product under the feed rollers of the regenerator with raw materials, the angle of inclination of the initial guide was set at 550 [10, 11, 12, 13, 14, 15]. Cotton impurities are cleaned once in the saw drum and moved along the length of the saw drum from under the feeder through the first guide, and do not obstruct the movement of the raw material fed from the feeder. In the experiments, raw materials from hand-picked raw materials with a moisture content of 9.6 and 11.5% and a degree of contamination of 6.8 and 14.1% were used in industrial varieties I and III of the Sultan breeding variety. Each experiment was conducted in five repetitions, and the average values were recorded. The diagram of the guide is shown in Figure 2, and the results of the experiments are presented in Table 1.



**FIGURE 2.** Placement of the guides on the upper wall of the improved regenerator

# Results and discussion

We will study the influence of the existing mesh surface and the improved version of the ribbed grates on the change in the amount of impurities in the cotton.

The results of experimental tests conducted under production conditions according to the methodology described in the previous section are presented in Table 1, 2, 3.

**TABLE 1.** Influence of the angle of inclination of the guide and the number of guides installed in the regenerator on the cleaning process by cotton varieties

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameters** | **Guide angle of inclination 550** | | | | | |
| **Number of guides, units** | | | | | |
| **4** | | **5** | | **6** | |
| **I**  **grade** | **III**  **grade** | **I**  **grade** | **III**  **grade** | **I**  **grade** | **III**  **grade** |
| Cleaning Efficiency, % | 82.77 | 84.89 | 85.9 | 87 | 86.0 | 87.2 |
| Structural composition of cotton | 92 | 93 | 97 | 98 | 98 | 98 |
| Mechanical damage to seeds, % | 6.85 | 7.04 | 7.0 | 7.11 | 7.05 | 7.23 |

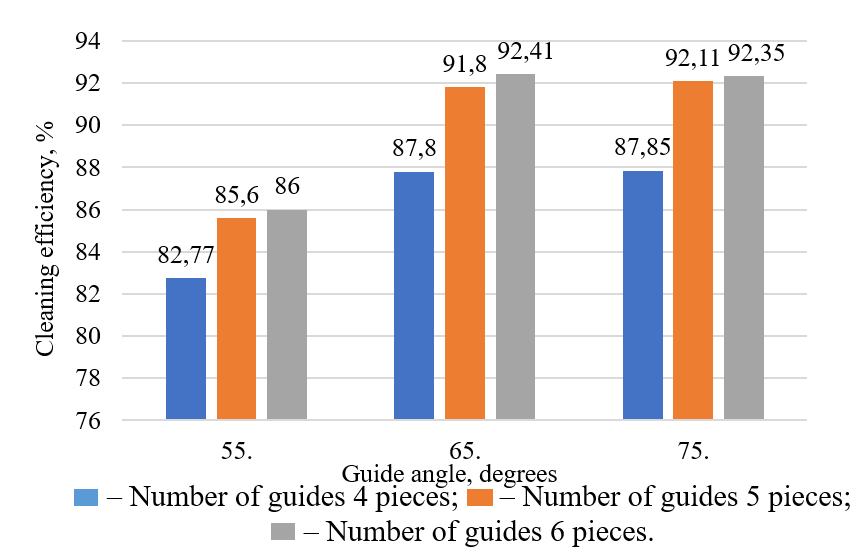
**TABLE 2.** Influence of the angle of inclination of the guide and the number of guides installed in the regenerator on the cleaning process by cotton varieties

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameters** | **Guide angle of inclination 650** | | | | | |
| **Number of guides, units** | | | | | |
| **4** | | **5** | | **6** | |
| **I**  **grade** | **III**  **grade** | **I**  **grade** | **III**  **grade** | **I**  **grade** | **III**  **grade** |
| Cleaning Efficiency, % | 87.08 | 89.27 | 91.8 | 93 | 92.41 | 93.86 |
| Structural composition of cotton | 99 | 96 | 100 | 100 | 100 | 100 |
| Mechanical damage to seeds, % | 5.37 | 5.58 | 5.51 | 5.79 | 5.60 | 5.86 |

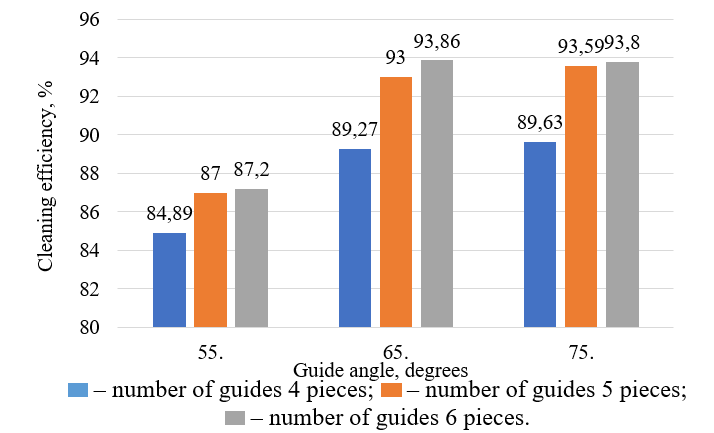
**TABLE 3.** Influence of the angle of inclination of the guide and the number of guides installed in the regenerator on the cleaning process by cotton varieties

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameters** | **Guide angle of inclination 750** | | | | | |
| **Number of guides, units** | | | | | |
| **4** | | **5** | | **6** | |
| **I**  **grade** | **III**  **grade** | **I**  **grade** | **III**  **grade** | **I**  **grade** | **III**  **grade** |
| Cleaning Efficiency, % | 87.85 | 89.63 | 92.11 | 93.59 | 92.35 | 93.80 |
| Structural composition of cotton | 99 | 98 | 100 | 100 | 100 | 100 |
| Mechanical damage to seeds, % | 5.86 | 5.99 | 6.06 | 6.21 | 6.14 | 6.32 |

As can be seen from the results of the conducted experiments, when passing grade I cotton through a regenerator with 6 guides and an angle of inclination of 650, the highest cleaning efficiency of the regenerator was 92.41%, with an inclination of 550, it was 86%, and with an inclination of 750, it was 92.35%. The structural composition of the cotton was 100 with a slope of 750 and 650, and 98 with a slope of 550. The mechanical damage to the seeds was 7.05% at a slope of 550, 5.60% at a slope of 650, and 6.14% at a slope of 750. With a decrease in the value of the slope angle, the separating brush drum carries the cotton along the guide with the help of the brush drum, which causes an increase in mechanical damage to the seeds and a decrease in cleaning efficiency as a result of the flow of layers of cotton entering the saw drum in a thicker state.



**FIGURE 3.** Influence of the angle of inclination of the guide and the number of installations on the cleaning efficiency of the equipment (Grade I)



**FIGURE 4.** Influence of the angle of inclination of the guide and the number of installations on the cleaning efficiency of the equipment (grade III)

In the process of cleaning cotton with impurities in the regenerator, a decrease in cleaning efficiency was revealed as a result of the compression of the cotton flow layer with impurities, which is fed from the brush drum and slides on the surface of the guide, changing the direction of movement, towards the surfaces of the guide at small values of the guide angle.

The cleaning efficiency of the regenerator is higher at the recommended guide angle of 750, while the mechanical damage to the seeds is higher than in the variant with the guide angle of 650.

Taking into account that it is higher by 0.46% and the difference between cleaning efficiency is 0.6%, we selected the value of the rational angle of inclination of the guide at 650.

During the regeneration process, the removal of processed raw materials with impurities leads to the loss of spinnable fibrous products, therefore, we will investigate the influence of the regeneration process on product loss in the experimental variant.

Influence of the regenerator on the elimination of product losses. In the process of cotton processing, up to 4% of cotton particles are removed from the main flow along with large impurities separated in the cleaning units. The regeneration efficiency of the equipment when regenerating cotton mixed with impurities determines the amount of fiber product losses. As a result of the research, experiments were conducted to determine the degree of reduction in product losses of the recommended cotton regenerator.

In these experiments, raw cotton of the 2nd class of the 1st and 4th industrial grades of Sultan selection was used. The initial moisture content of cotton was 10.4 and 14.1%, and the degree of contamination was 8.5 and 13.2%.

Studies were conducted in the regenerator, where the number of guides was 5, and their angle of inclination was 650. Each experiment was conducted in 5 repetitions, and the average values were recorded. The research results are presented in Table 4.

**TABLE 4.** Influence of the regenerator on product loss in the experimental variant

|  |  |  |
| --- | --- | --- |
| **Parameters** | **Cotton grade** | |
| **I grade** | **IV grade** |
| Initial moisture content of cotton, % | 10,4 | 14,1 |
| Initial cotton contamination, % | 8,5 | 13,2 |
| Cleaning efficiency of the UXK unit, % | 91,6 | 92,8 |
| Productivity of the UXK unit, kg/h | 6500 | 4900 |
| Amount of cotton-mixed impurities separated in the UXK unit, kg/hour  including:  trash, %  cotton, % | 506  56 | 600  52 |
| 44 | 48 |
| Cleaning efficiency of the regenerator, % | 90,78 | 92,97 |
| Regeneration efficiency, % | 98,54 | 97,35 |
| Amount of cotton particles in the trash after regeneration, kg/hour | 3,25 | 7,63 |

Analyzing the research results, the cleaning efficiency of the UXK unit was 91.6% at an initial cotton contamination of 8.5% and a productivity of 6500 kg/hour. Of the 506 kg of waste separated during the cleaning process per hour, 44% were cotton particles and 56% were trash.

When processing raw cotton of the I grade with impurities in the UHK unit, the cleaning efficiency was 90.78%, and the regeneration efficiency was 98.54% at a productivity of 700 kg/hour when processing cotton with impurities in the regenerator of the experimental variant. With a regeneration efficiency of 98.54%, product loss is 1.46% of the waste processed in the regenerator. The ratio of the amount of cotton particles in the trash after regeneration to the amount of cotton processed in the UXK unit was 0.05%.

Analyzing the research results, it can be seen that the cleaning efficiency of the UXK unit was 92.8% with an initial contamination of 13.2% and a productivity of 4900 kg/hour. Of the 600 kg of waste separated during the cleaning process per hour, 48% were cotton particles and 52% were trash.

When processing raw cotton of the I grade with impurities in the UXK unit, the cleaning efficiency was 92.97%, and the regeneration efficiency was 97.35% at a productivity of 600 kg/h when processing cotton mixed with impurities in the regenerator of the experimental variant. With a regeneration efficiency of 97.35%, product loss is 2.65% of the waste processed in the regenerator. The ratio of the amount of cotton particles in the trash after regeneration to the amount of cotton processed in the UXK unit was 0.15%.

According to the technical passport of the existing cotton regenerator, the regeneration efficiency is not less than 95% and the cleaning efficiency is not less than 90% when the amount of cotton particles in the waste separated during the processing of grade I cotton (at 8÷9%) is not more than 15%, and the productivity does not exceed 1000 kg/hour. However, experiments conducted under production conditions have shown that even with a regenerator productivity of 500-600 kg/hour, the cleaning efficiency does not exceed 80%, and the regeneration efficiency does not exceed 92.5%. Compared to the indicators given in the technical passport, the efficiency of the improved regenerator is 2.97% higher in terms of cleaning and 3.54% higher in terms of regeneration. As a result of processing the cotton particles in the waste separated in the cleaning technology in the recommended version of the regenerator, a reduction in product losses of 3.54% is achieved.

# CONCLUSION

When studying the influence of cleaning intensity on cleaning efficiency during the regeneration process of cotton in saw drums, it was found that after 5 cleaning of cotton mixed with impurities from the cleaning sections of the UHK unit, the amount of impurities decreases in subsequent cleaning layers. Taking this into account, it is advisable to increase the number of guides in the proposed regenerator to ensure the movement of the brush drum and the cotton above it along the axis of the saw drum to the upper part of the saw drum for repeated cleaning of cotton.

Considering that the cleaning efficiency of the regenerator is higher when the recommended guide has an angle of inclination of 750, and the mechanical damage to the seeds is 0.46% higher than in the variant with an angle of inclination of 650, and the difference between cleaning efficiency is 0.6%, we selected the value of the rational angle of inclination of the guide at 650.

Compared to the indicators given in the technical passport of the existing regenerator, the efficiency of the improved design is 2.97% higher in terms of cleaning and 3.54% higher in terms of regeneration. As a result of processing the cotton particles in the waste separated in the cleaning technology in the recommended version of the regenerator, a reduction in product losses of 3.54% is achieved.

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