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CONDUCTING EXPERIMENTS WITH NEWLY DESIGNED SAW GIN RIBS IN THE COTTON CLEANING PROCESS FOR DIFFERENT COTTON VARIETIES

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Abstract: Experiments were conducted to determine the effect of using newly designed convex-surfaced saw ribs in a cotton cleaning machine for removing large impurities, comparing their cleaning efficiency with that of standard ribs across different cotton varieties. The experiments also aimed to assess how much cotton fragments are lost to the impurity bunker when using convex-surfaced ribs compared to conventional ones. The results showed that the cleaning efficiency of convex-surfaced ribs is significantly higher.

Keywords: cotton, fiber, seed, small impurities, cleaning, saw rib, convex rib, efficiency, large impurities, impurity bunker.

Introduction. Around the world, scientific research is being carried out to improve the technology and equipment used in the primary processing of cotton, focusing on developing technologies that help preserve the initial quality indicators of cotton during cleaning and ensure better control over product quality. In this regard, the development of effective technologies for removing impurities from cotton plays an important role.

In Uzbekistan, comprehensive measures are being implemented to develop the cotton industry, modernize and technically re-equip cotton cleaning enterprises, increase the profitability of cotton processing, and improve the competitiveness of manufactured products. Significant results have been achieved in this direction.

In particular, the Presidential Decree of the Republic of Uzbekistan dated January 28, 2022, No. PD-60, *"On the Development Strategy of New Uzbekistan for 2022–2026"*, defines important tasks such as ensuring national economic stability, continuing industrial policy within the framework of gross domestic product growth, and increasing the production volume of industrial goods by 1.4 times, including doubling the production of textile products.

In implementing these objectives, it is especially important to modernize the design and technology of machines that ensure efficient cleaning and prevent the loss of fibers into waste.

Methodology & empirical analysis.

In cotton-textile cluster enterprises, which include cotton ginning plants as one of their main components, various machines and units are used for cleaning raw cotton from both fine and large impurities. The working organs of cotton cleaning machines designed for removing large impurities are generally similar. That is, the raw cotton supplied by the feeders enters the saw cylinder, where a stationary brush evenly presses and feeds it onto the saw teeth. As the cotton attached to the saw teeth passes over the ribs of the grate (ribs), large impurities larger than 10 mm are separated due to the impact and frictional movement between the saw teeth and the ribs. These impurities then fall

through the gaps (about 40 mm apart) between the ribs into the impurity bunker. The cleaned cotton, in turn, is removed from the saw teeth by a separating brush cylinder and sent to the next processing stage.

Unfortunately, despite numerous improvements made to the design of machines and aggregates for cleaning cotton from large impurities, their cleaning efficiency remains insufficient. Moreover, some cotton pieces are still observed to fall into the impurity bunker along with the impurities, leading to fiber loss.

According to the results of research conducted within the framework of this dissertation topic, it was found that in most cotton ginning plants today, the UXK aggregate is used to clean raw cotton from both fine and large impurities. Analysis of the large-impurity cleaning section of the UXK aggregate showed that the cleaning efficiency for low-grade cotton is about 75%, while for high-grade cotton it reaches 81%. Furthermore, it was found that the impurities collected in the bunker contain 18.6–20.5% of cotton lumps suitable for spinning, indicating a significant loss of usable fiber.

To eliminate the shortcomings identified during the research, the design of the main working element of the cotton cleaning machine — the ribbed grate was improved by modifying the surface shape of the ribs. As a result of these design enhancements, the cleaning efficiency of the machine increased compared to the standard model. Furthermore, by determining the optimal diameters of the ribs, it was possible to reduce the amount of cotton fragments that fall into the impurity bunker along with large impurities.

To test the performance of the proposed convex-surfaced ribs, a construction drawing of the cotton cleaning device for removing large impurities was developed (Figure 1).

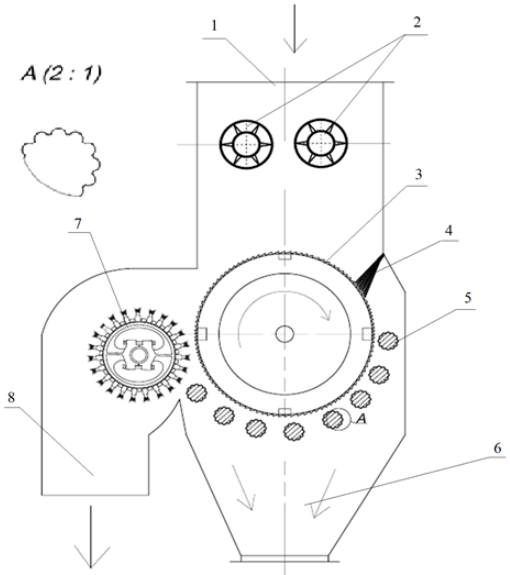

Figure 1. Structural diagram of the cotton-cleaning device for removing large impurities:

1 – inlet pipe;2 – feeding rollers;3 – saw cylinder;4 – stationary driving brush;5 – convex-surfaced ribs;6 – impurity bunker;7 – separating brush cylinder;8 – outlet bunker.

The experimental model of the cotton cleaning device for removing large impurities operates as follows: The raw cotton entering the large-impurity cleaning device passes through the inlet pipe (1) and falls onto the feeding rollers (2). These rollers rotate in opposite directions at a speed of 0–14 rpm, evenly feeding the cotton to the saw cylinder (3). The cotton fed onto the saw cylinder is uniformly adhered to the saw teeth by means of the stationary driving brush (4).

Two ribbed grates are positioned at equal distances from the saw cylinder. Each grate contains five newly designed convex-surfaced ribs (5). The cotton tufts carried by the saw teeth strike against these ribs and slide along their surfaces. The saw cylinder rotates at a speed of 300 rpm. As the cotton slides over the ribs, the large impurities contained in it are separated and fall through the 40 mm gaps between the ribs into the impurity bunker (6). The cleaned cotton tufts are then removed from the saw teeth by the separating brush cylinder (7), which rotates in the opposite direction at a speed of 945 rpm, and are subsequently transferred through the outlet bunker (8) to the next stage of processing.

The main purpose of developing this device, designed to remove large impurities larger than 10 mm, and improving the rib construction, is to determine its optimal technological and structural parameters. The primary requirement for the experimental setup is that it allows for effective and measurable testing under real operating conditions.

The newly designed convex-surfaced ribs were installed on the UXK cotton cleaning unit, and preliminary tests were conducted at the “Toraqo‘rg‘on Cotton Cleaning Enterprise”, which is part of the “Namangan Textile Cluster” LLC (Figure 2).

Figure 2. Process of preliminary testing

The experiments were carried out in accordance with the requirements set for large-impurity cotton cleaning devices.

During the tests, experiments were conducted on different cotton varieties — Bukhara-102 (Grade I Class 1, Grade I Class 2, Grade II Class 3) and Andijan-35 (Grade II Class 1, Grade V Class 3). Before and after cleaning in the device, 300-gram samples of cotton were taken from the cotton feed section (before cleaning) and the outlet (after cleaning). The impurity content of these samples was determined using an LKM-type instrument.

According to the procedure described in UzDST 592–2008, the determination of impurity content in cotton using the LKM instrument is performed by cleaning a 300 g sample in two stages over 180 seconds:

- in the first stage (120 seconds), fine impurities are removed,
- in the second stage (45 seconds), large impurities are removed,
- and within the final 15 seconds, the cleaned cotton is transferred into the clean cotton chamber.

After the device stops, the internal surfaces are wiped to collect all residual dust, and the separated fine and large impurities are weighed on a scale.

After determining the impurity content with the LKM instrument, the cleaning efficiency of the raw cotton cleaned by the proposed convex-surfaced ribs was calculated using the following formula, based on the impurity levels of samples taken before and after cleaning in the large-impurity cotton cleaning device.

$$K = \frac{C_1 - C_2}{C_1} * 100$$

here: K – cleaning efficiency, %; C_1 – impurity content of the cotton before cleaning, %; C_2 – impurity content of the cotton after cleaning, %.

After determining K, the cleaning efficiency from the experiments conducted on the large-impurity cotton cleaning device was compared with the results obtained using conventional ribs. It was found that the cleaning efficiency increased by 15% when using the newly designed convex-surfaced ribs.

Experiments were conducted on different cotton varieties and with cotton containing various levels of impurities, using both the existing ribs and the newly designed ribs. Based on the obtained results, a summary table was compiled

Table 1

Cotton variety (selection)	Cotton grade and class	Cleaning efficiency with conventional ribs, %	Cleaning efficiency with newly designed ribs, %
Andijan – 35	II grade 1 class	74	87
	V grade 3 class	69	80
Bukxara – 102	I grade 2 class	75	90
	II grade 3 class	73	85

Results. For the Andijan-35 cotton variety of II grade, class 1, the cleaning efficiency of the machine using conventional ribs was 74%, whereas with the newly designed ribs, the cleaning efficiency increased to 87%, as shown in Table 1.

For the Bukhara-102 cotton variety of I grade, class 2, the cleaning efficiency using conventional ribs was 75%, while with the new type of ribs, the cleaning efficiency rose to 90%.

Based on the data presented in Table 1, a graph was constructed, clearly demonstrating the difference in cleaning efficiency between the existing and proposed rib designs (Figure 3).

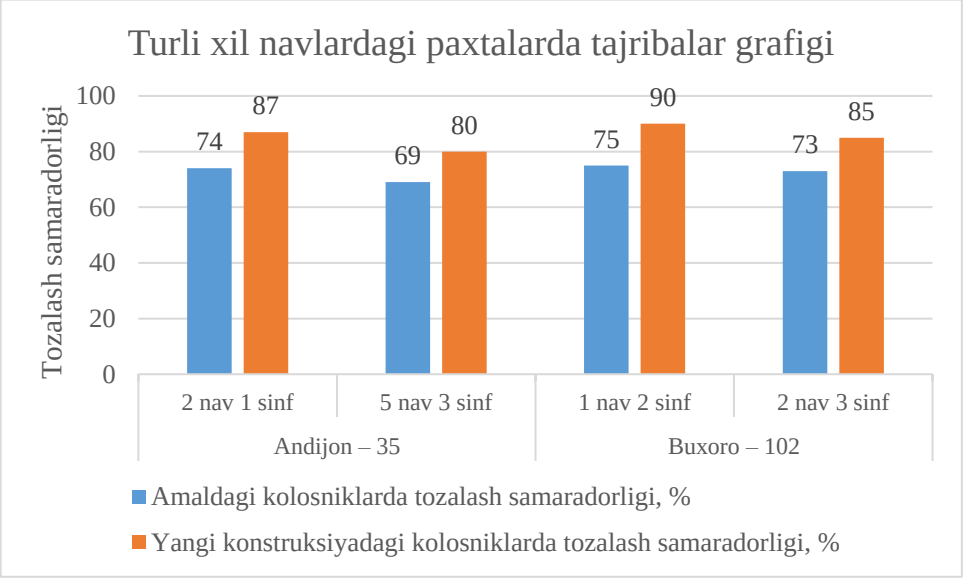

Figure 3. Graph of cleaning efficiency dependence when cleaning different grades of cotton using conventional and proposed ribs

In the device equipped with the proposed ribs, the amount of cotton fragments contained in the separated impurities during the cleaning process was determined. This value was then compared with the amount of cotton fragments found in the impurities discharged from the large-impurity cleaning section of one UXK unit section. The results were analyzed and compared under equivalent conditions (Figure 4).

Conclusions. As a result of the comparison, it was found that the amount of cotton fragments contained in the large impurities discharged from one section of the UXK unit ranged between 18.6% and 20.5%. By installing the proposed ribs with an optimal diameter of 25 mm into the device, the amount of cotton fragments in the discharged impurities was reduced to 12.2%, demonstrating a significant improvement in the cleaning efficiency.


Figure 4. a – large impurities discharged from the device with improved rib design; b – large impurities discharged from the UXK unit.

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