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TEST RESULTS OF THE IMPROVED 5DP-130 MODEL GIN IN PRODUCTION

Nurzod Yunusov
Independent researcher
Fergana State University

Abstract. A grate with an improved design was developed to effectively clean fibers produced from high- and low-ginning cotton varieties during ginning, thereby enhancing fiber quality. The manufactured grate was installed on a 5DP-130 gin at the Uychi Cotton Cleaning Plant of "Uchkurgan Textile" LLC, improving the gin, and comparative tests were conducted with a 5DP-130 gin equipped with the existing grate design using Namangan-77 cotton varieties I and III.

In the tests, in the 5DP-130 gin equipped with the proposed grate, the mass fraction of defective fibers and impurities in fibers cleaned during ginning of I and III varieties averaged 3.14% and 3.95%, respectively, which was reduced by 0.13% (abs.) and 0.24% (abs.) compared to the fibers cleaned by the gin with the existing grate. During fiber cleaning, the fiber content in the waste decreased on average from 2.3% to 2.7% (abs.), and the cleaning efficiency increased by an average of 3.7% (abs.) and 4.2% (abs.) compared to the existing gin.

After ginning, when fibers were further cleaned using a 1VPU fiber cleaner, the mass fraction of defective fibers and impurities in the cleaned fibers averaged 2.0% and 2.96%, respectively, which showed an improvement of 0.14% (abs.) and 0.18% (abs.) in quality compared to fibers produced using a 1VPU cleaner after the gin with the existing grate. According to the O'zDst 632:2010 state standard, varieties I and III corresponded to the "Excellent" class.

The results of the study showed that improving the 5DP-130 gin with a new grate design leads to enhanced fiber quality during ginning, a reduction in waste fiber content, and an overall increase in cleaning efficiency of the roller gin.

Keywords: Roller gin, grate, fiber cleaner, cotton, fiber, impurities, cleaning efficiency, quality.

Introduction. By the mid-1980s, in order to improve the quality of fibers produced at cotton cleaning plants, two individual grates were installed at the rear of the working chamber of the 4DP-130 roller gin, and this design was implemented in the 5DP-130 model [1, 2]. The introduction of the 5DP-130 gin in production allowed the cleaning of fibers directly in the gin during ginning, thereby improving the quality of fibers produced (Figure 1).

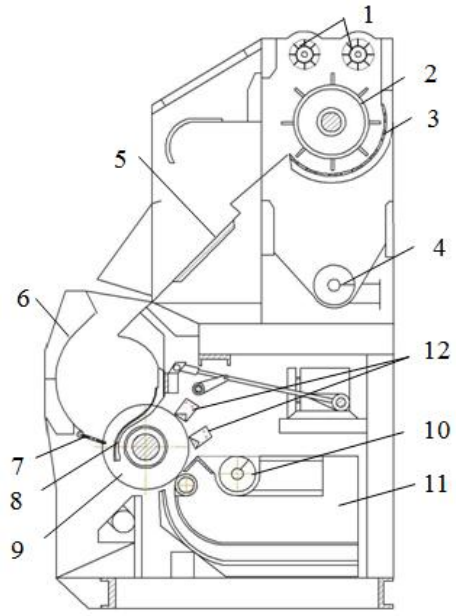
However, due to the individual grates being rigidly fixed to the sides of the gin, loosening sometimes occurred during operation. As a result, the spacing between the grates did not meet the required distance, causing a large amount of fiber to pass into the waste during cleaning from trash and impurities [3].

Moreover, since only two grates were installed, the separation of trash and impurities from the fiber was insufficient, and these contaminants remained in the fiber composition, which was then passed to the post-gin fiber cleaner. As the cleaner operated using a pneumomechanical method, it was unable to separate the necessary amount of impurities from such highly contaminated fiber, leading to suboptimal cleaning efficiency.

After passing through the cleaner, excess impurities remained in the fiber, which led to a decrease in fiber quality. Nevertheless, until today, gins of the 5DP-130 model continue to operate using such grate designs [4].

Theoretical and practical research has been conducted to improve the efficiency of gins by effectively cleaning fibers directly in the gin, thereby enhancing fiber quality [5, 6]. As a result of these studies, a grate with an improved design capable of effectively cleaning fibers in roller gins was developed, and its alternative dimensions were determined [7]. Based on these dimensions, the industrial experimental prototype of the grate was drafted at Fergana State University (Figure 2).

Following the prepared drawings, an industrial experimental prototype of the improved grate with three separating grates was manufactured (Figures 3 and 4).

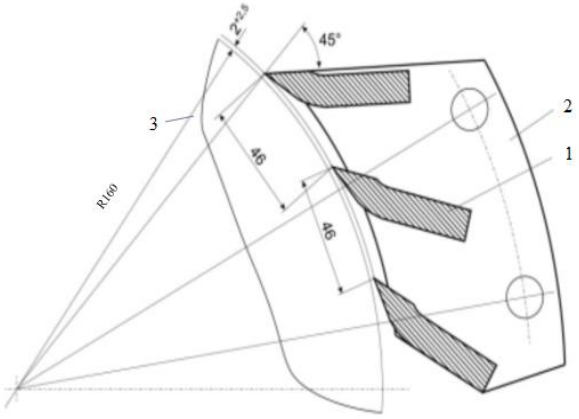


1 – Feeder rollers, 2 – Spike drum, 3 – Mesh surface, 4 – Waste screw, 5 – Apron, 6 – Working chamber, 7 – Cotton comb, 8 – Console grate, 9 – Roller cylinder, 10 – Trash screw, 11 – Air chamber, 12 – Separating grates

Figure 1. Schematic cross-section of the 5DP-130 roller gin.

The manufactured prototype was installed on one of the two 5DP-130 roller gins operating in the cotton ginning technological system at the Uychy Cotton Cleaning Plant of "Uchkurgan Textile" LLC in Namangan region. This gin was upgraded, and comparative experimental studies were conducted with a 5DP-130 roller gin equipped with the existing grate design (Figures 5 and 6).

Both gins utilized the feeder-cleaner system, including the feeder rollers, spike drums, and roller mechanisms, to ensure proper fiber movement and cleaning efficiency.



1 – Improved grates, 2 – Casing, 3 – Roller cylinde.

Figure 2. Diagram of the positioning angles of the improved grates in the roller gin relative to the roller cylinder radius

The rotation speeds of the cylinders corresponded to their technical specifications: the feeder rollers rotated at 0–14 rpm, the spike drums at 500 rpm, and the roller cylinders at 730 rpm [8].

During the comparative experimental studies, to investigate the operational condition, efficiency, productivity of the gins, and the effect on the quality of cleaned fibers, samples were collected from:

- cotton supplied to the gins,

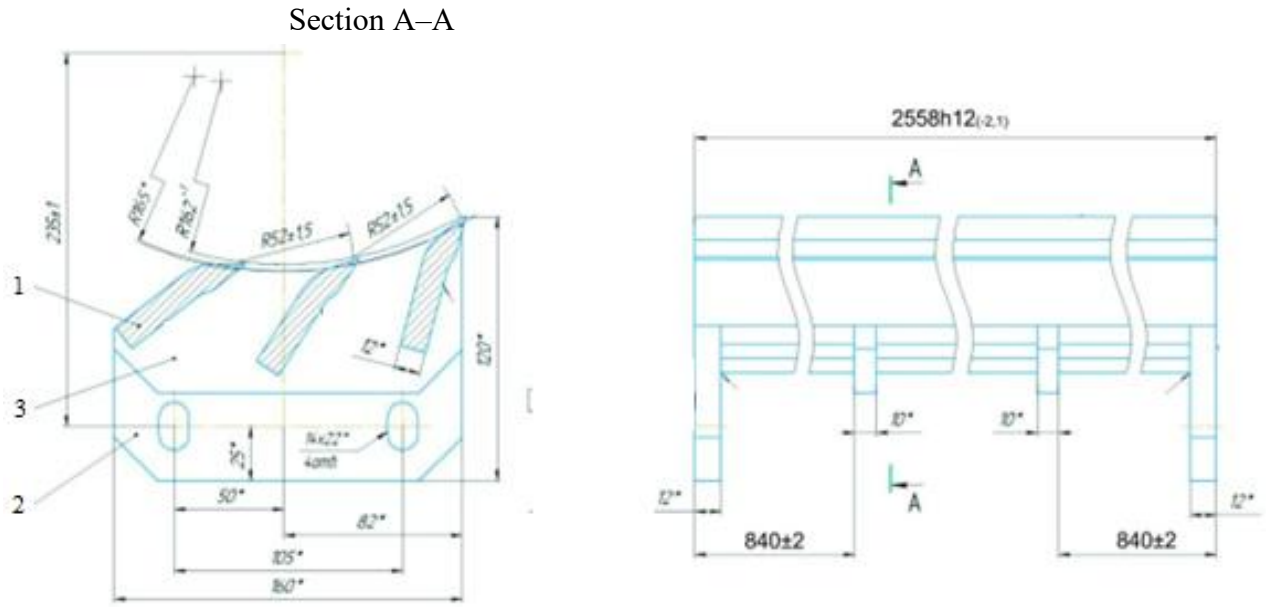
- uncleaned and cleaned fibers after the roller gins, and
- waste separated during fiber cleaning in the gin.

These samples were analyzed in the plant laboratory [9].

The productivity of the gins was determined using the chronometric method. The mass of cotton fed into the gins was taken into account, fibers produced from ginning were weighed, and the hourly productivity of the gins was calculate

During the research period, samples were taken from both gins and analyzed in the plant laboratory. To ensure the reliability of the results, each sample was tested five times, and the average values were calculated.

The experimental studies were conducted on Namangan-77 cotton varieties I and III, grade 2, with initial moisture contents of **10.5% and 12.2%** and impurity levels of **6.8% and 10.1%**, respectively [10, 11]. In this process, the moisture content of grade I, class 2 cotton supplied to the gin feeder averaged **8.5%**, the impurity content averaged **1.33%**, and the seed damage in the cotton composition averaged **1.9%**.



1 – Improved-design grates, 2 – Casing, 3 – Frame

Figure 3. Assembly drawing of the grate consisting of improved-design grates.

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Figure 4. Assembled view of the grate with improved grates.

1 – Saw cylinder, 2 – Improved grates in the grate assembly, 3 – Air chamber

Figure 5. Assembled view of the 130-saw gin with an improved grate assembly.

For Grade III, Class 2 cotton, the average moisture content was 8.9%, impurity content 1.71%, and seed damage 2.34% [12]. After preliminary removal of fine impurities in the gin feeder, the cotton was supplied to the working chamber through the apron.

In this process, the Namangan-77, Grade I, Class 2 cotton delivered to the working chamber had an average moisture content of 8.4%, an average impurity content of 1.1%, and the level of seed damage in the cotton composition remained unchanged at an average of 1.9%.

The fuzz content of the seeds produced from ginning averaged 10.5%, seed damage 2.96%, and the mass fraction of defects and impurities in the uncleaned fiber averaged 4.12% [13]. After this fiber was cleaned in the gin using the existing grate assembly, the mass fraction of defects and impurities in the cleaned fiber averaged 3.27%. In this case, the fiber cleaning efficiency of the gin averaged 20.6%.

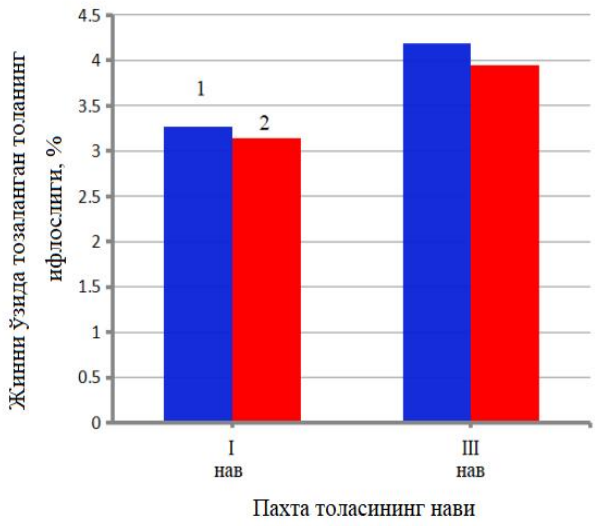
The amount of fiber separated into waste during cleaning averaged 14.4% relative to the total waste mass. Subsequently, the fiber was further cleaned using a 1VPU fiber cleaner installed after the gin [14].

The mass fraction of defects and impurities in the fiber produced after cleaning averaged 2.14%, and the quality indicator corresponded to Grade I, “Good” class according to the O’zDst 632:2010 state standard.

Figure 6. View of the 5DP-130 saw gin with an improved grate installed in the cotton ginning technological system at the Uychi Cotton Cleaning Plant, owned by “Uchkurgan Textile” LLC.

Namangan-77 Grade I, Class 2 cotton with an average moisture content of 8.4%, impurity content of 1.1%, and seed damage of 1.9% was supplied to the working chamber through the apron of the 5DP-130 gin. After ginning, the mass fraction of defective fibers and impurities in the produced fiber averaged 4.15% [15].

After cleaning this fiber in the gin using the improved grate assembly consisting of three newly designed grates, the mass fraction of defects and impurities in the cleaned fiber averaged 3.14%, which represents an improvement in fiber quality of 0.13% (abs.) compared with fiber cleaned in a roller gin equipped with the existing grate assembly (Figure 7). In this case, the gin cleaning efficiency averaged 24.3%, which is 3.7% (abs.) higher than that of the existing gin (Figure 8).

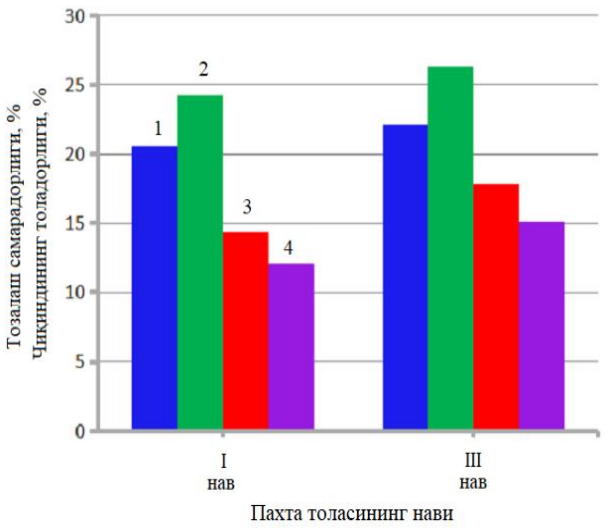


1. Saw gin with the existing grate.
2. Saw gin with the improved grate.

Figure 7. Histogram showing the mass fraction of defective fiber and contaminated impurities in the fiber after ginning, depending on the fiber type.

During fiber cleaning, the fiber content in the waste averaged 12.1%, which is 2.3% (abs.) lower than that observed when cleaning fiber using the existing grate assembly. Subsequently, the fiber was further cleaned using a 1VPU fiber cleaner installed after the gin. The mass fraction of defects and impurities in the fiber produced by the cleaner averaged 2.0%, and the quality indicator corresponded to Grade I, "Excellent" class according to the O'zDst 632:2010 state standard.

Difficult-to-clean Namangan-77 Grade III, Class 2 cotton, with a moisture content of 8.9%, impurity content of 1.71%, and seed damage of 2.34%, was preliminarily cleaned in the feeder of the 5DP-130 roller gin and then supplied to the working chamber through the apron. In this process, the cotton supplied to the working chamber had an average moisture content of 8.75%, an impurity content of 1.38%, and the seed damage in the cotton composition remained unchanged at 2.34%.



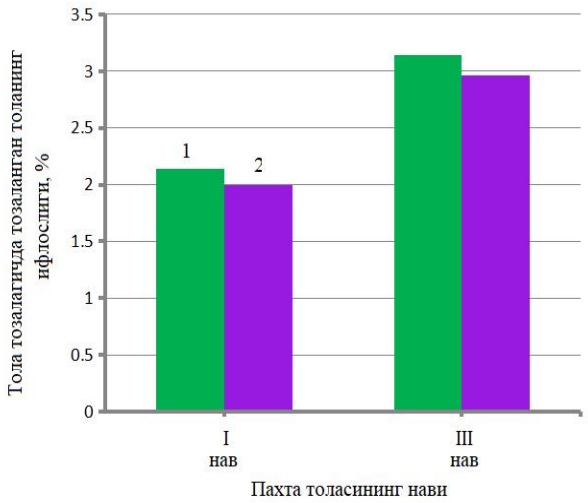
1, 3 – In the gin equipped with the conventional grate assembly
2, 4 – In the gin equipped with the improved grate assembly

Figure 8. Histogram of the mass fraction of defective fibers and impurities in fiber after ginning, depending on the cotton variety

The fuzz content of the seeds produced from ginning averaged 11.3%, seed damage 3.1%, and the mass fraction of defects and impurities in the uncleaned fiber averaged 5.38%. After cleaning this fiber in the gin using the existing grate assembly, the mass fraction of defects and impurities in the cleaned fiber averaged 4.19%, and the fiber cleaning efficiency of the gin averaged 22.1%.

The amount of fiber separated into waste during cleaning averaged 17.8% relative to the total waste mass. After ginning, the fiber was further cleaned in a 1VPU fiber cleaner. The mass fraction of defects and impurities in the fiber cleaned by this unit averaged 3.14%, and the quality indicator corresponded to Grade III, "Good" class according to the O'zDst 632:2010 state standard (Figure 9).

In the apron of the 5DP-130 gin, Namangan-77 Grade III, Class 2 cotton with an average moisture content of 8.75%, impurity content of 1.38%, and seed damage of 2.34% was supplied to the working chamber. After ginning, the mass fraction of defective fibers and impurities in the produced fiber averaged 5.36%. After cleaning this fiber in the gin equipped with the improved grate assembly, the mass fraction of defects and impurities in the cleaned fiber averaged 3.95%, representing an improvement of 0.24% (abs.) compared with fiber cleaned in a roller gin with the existing grate assembly.



1- In the fiber cleaner following a gin equipped with the conventional grate assembly
2- In the fiber cleaner following a gin equipped with the improved grate assembly

Figure 9. Histogram showing the change in fiber impurity after cleaning, depending on the cotton variety

The gin's fiber cleaning efficiency averaged 26.3%, which is 4.2% (abs.) higher than the efficiency of the conventional gin. The fiber content in the waste averaged 15.1%, which is 2.7% (abs.) lower than that observed using the conventional grate assembly.

Subsequently, the fiber was further cleaned using a 1VPU-type fiber cleaner installed after the gin. The mass fraction of defects and impurities in the fiber produced by the cleaner averaged 2.96%, and compared with fiber cleaned by a 1VPU cleaner following the conventional grate assembly, the fiber quality improved by 0.18% (abs). According to O'zDst 632:2010, the cleaned fiber corresponded to Grade III, "Excellent" class [15].

Conclusion. To improve the quality of fiber produced from difficult-to-clean cotton varieties of both high and low selection, an improved grate assembly was developed for cleaning fiber directly in the gin. The developed grate assembly was installed in a 5DP-130 gin at the Uchkurgan Textile LLC, Uychi Cotton Cleaning Plant, and the gin was upgraded. Comparative experimental studies were conducted with the upgraded gin and a conventional 5DP-130 roller gin equipped with standard grates. The experiments were performed using Namangan-77 Grade I and III cotton varieties.

During the study, in the upgraded 5DP-130 gin equipped with the proposed grate assembly, the mass fraction of defective fibers and impurities in fiber cleaned directly in the gin averaged 3.14% and 3.95% for the two cotton varieties, which is 0.13% and 0.24% (abs.) lower compared with fiber cleaned in the conventional gin. The fiber content in the waste decreased on average from 2.3% to 2.7% (abs.), and the cleaning efficiency increased by 3.7% and 4.2% (abs.) compared with the conventional gin.

After subsequent cleaning using the 1VPU fiber cleaner, the mass fraction of defects and impurities in the fiber averaged 2.0% and 2.96%, and the quality of the fiber improved by 0.14% and 0.18% (abs.) compared with fiber cleaned in a conventional gin followed by the 1VPU

cleaner. According to O'zDst 632:2010, the fiber quality corresponded to Grade I and III, "Excellent" class.

The results demonstrate that upgrading the 5DP-130 gin with a new improved grate assembly enhances fiber quality, reduces the fiber content in the waste, and increases the overall cleaning efficiency of the roller gin.

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