

RESEARCH OF THE INFLUENCE OF A SAW GIN WITH IMPROVED WORKING PARTS ON GIN EFFICIENCY AND PRODUCT QUALITY

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Abstract:

Improving the cleaning of raw cotton in the saw gin feeder is essential for raising fiber and seed quality and ginning productivity. The aim of this study was to evaluate, under industrial conditions, the effect of an improved grate feeder-cleaner on the cleaning efficiency, productivity and product quality of a saw gin. An industrial-experimental grate was manufactured and installed on the feeder-cleaner of a 90-saw gin at the "Boyovut techno cluster" LLC ginning plant (Syrdarya region) and compared with a gin equipped with the existing mesh-surface feeder-cleaner. Tests were carried out on Sultan cotton of grades I and III, class 2, at a spiked drum–grate distance of 16–18 mm and a grate-bar spacing of 8 mm; contamination, seed damage and fiber quality were determined by state standard methods, and productivity by timekeeping. With the improved grate, the contamination of cleaned cotton averaged 1.22–1.35 % and the cleaning efficiency of the feeder reached 15.1–21.7 %, which is 2.3–2.9 (abs) % higher than with the mesh surface. Seed damage after ginning decreased by 0.11–0.33 (abs) %, fiber contamination by 0.05–0.15 (abs) %, and gin productivity increased by 40–48 kg/h, reaching 980–1023 kg/h for grade I and 863–916 kg/h for grade III cotton. After lint cleaning, the fiber of both grades met the "Superior" class under UzSt 604:2016. It is concluded that a grate feeder-cleaner with a 16–18 mm drum distance and 8 mm bar spacing is advisable for improving the cleaning efficiency, productivity and product quality of saw gins.

Keywords: saw gin, feeder-cleaner, mesh surface, grate, cotton, fiber, seeds, dirt, cleaning efficiency, productivity, quality

Introduction

Cotton fiber and seed quality depend largely on how effectively raw cotton is cleaned before ginning. In a saw gin, the final cleaning of raw cotton takes place in the feeder-cleaner, where a spiked drum moves the cotton over a mesh surface. The small openings of the mesh limit the removal of small impurities, repeated impacts damage the seeds, and uneven spreading of the cotton flow into the working chamber restricts gin productivity [1, 2]. Earlier studies by the authors examined ways of improving the cleaning of cotton in the saw gin feeder and its influence on gin efficiency [16, 17]; however, the effect of a grate feeder-cleaner on the cleaning efficiency, productivity and product quality of a saw gin under industrial conditions has not been sufficiently studied. The aim of this study is to evaluate, through comparative production tests, the effect of an improved grate feeder-cleaner on the cleaning efficiency and productivity of a 90-saw gin and on the quality of the fiber and seeds it produces.

Materials and Methods

Based on theoretical and practical research, drawings of an improved industrial-experimental model of the grate were prepared in the design department of JSC "Paxtasanoat ilmiy markazi" (Fig. 1).

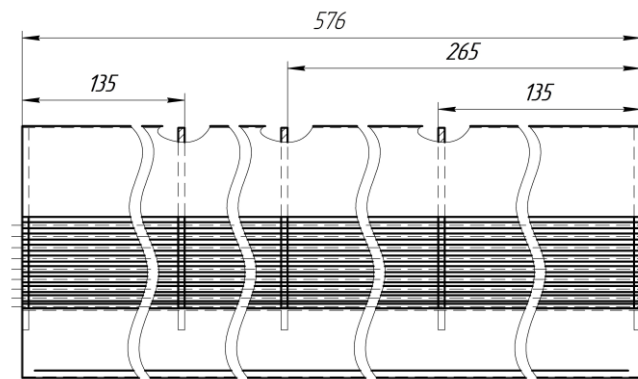


Figure 1. Prefabricated diagram of the improved grate

1-grates, 2-ribs

Based on the prepared drawings, an industrial-experimental sample was manufactured at the enterprise LLC "RIM Workshop" and installed on the feeder-cleaner of a 90-saw gin in the cotton ginning workshop of the cotton ginning enterprise LLC "Boyovut techno cluster" of the Boyovut district of the Syrdarya region, and the gin was improved (Fig. 2, 3).



Figure 2. Improved-design grate

Taking into account that the effective cleaning and ginning process for cleaning and ginning technical cotton on the grate bars proposed as a result of research conducted under laboratory conditions was carried out at a distance of 16-18 mm between the spiked drum and the grate bars, and the distance between the grate bars was 8 mm, the test work was carried out at the above-mentioned values [3, 4].

feeder-cleaner with a selected mesh surface in the technological system with a 90-saw gin with an improved feeder-cleaner. To ensure consistent testing, new saws with an outer diameter of 320 mm with 280 teeth were installed on the shafts of both gins [5, 6].



Figure 3. Production appearance of a 90-saw gin with an improved grate

The research work was carried out on the basis of a special methodological plan. In this case, the rotational speeds of all rotating working parts in saw gins corresponded to the rotational speeds in the saw gin passport [7]. After four hours of operation of the new saws, the tests were carried out on cotton of the Sultan breed of grades I and III of the 2nd class with an initial moisture content of 10.6% and 13.4%, contamination of 7.7% and 9.6% [8].

In this case, the moisture content of cotton of grade I-2 fed into the gin feeder-cleaner averaged 7.9%, contamination averaged 1.46%, seed damage in the cotton composition averaged 1.91%; the moisture content of cotton of grade III-2 averaged 9.8%, contamination 1.76%, seed damage in the cotton composition averaged 2.22% [9, 10].

During the research period, to study the cleaning efficiency of the gin feeder-cleaner, the degree of contamination of the cleaned cotton, and the quality of the fiber and seeds produced from the gins, samples were taken from the cleaned cotton in both gin trays, as well as from the fiber and seeds produced from the ginning of cotton, and analyzed in the enterprise laboratory. The productivity of gins during cotton ginning was determined by the method of timekeeping. In this case, the fiber produced from each gin was taken separately, weighed, and the hourly productivity of the gin was determined. Experimental work was carried out at a distance of 16-18 mm between the spiked drum and the selected grate bars.

Results and Discussion

Initially, the experimental work was carried out on a 90-saw gin with a feeder-cleaner with an existing mesh surface design. In this case, when cleaning the mesh surface with a spiked drum on the feeder of the Sultan selection I grade 2 class at a distance of 16-18 mm, the degree of contamination of the cleaned cotton averaged 1.26-1.28%, and the degree of seed damage in the cleaned cotton averaged 2.16-2.05%. In this case, the cleaning efficiency of the feeder-cleaner averaged 13.7-12.3% for the above-mentioned intermediate distances (Fig. 4). When ginning cotton, the degree of seed fuzziness after ginning was practically the same with a change in the mesh surface of the spiked drum from 16 mm to 18 mm and averaged 10.3%. In this case, the degree of seed damage averaged 3.18-2.98%. When studying the contamination of the fiber after ginning, it averaged 3.25-3.2%. When ginning cotton, the gin's productivity changed from an average of 940 kg/hour to 978 kg/hour. To study the quality of the fiber produced in the technology, the fiber was cleaned in a post-gin cleaner. In this case, the trash content of the cleaned fiber averaged 2.3-2.22%, and the quality

indicator of the produced fiber was classified as grade I "Good" according to the state standard UzSst 604:2016.

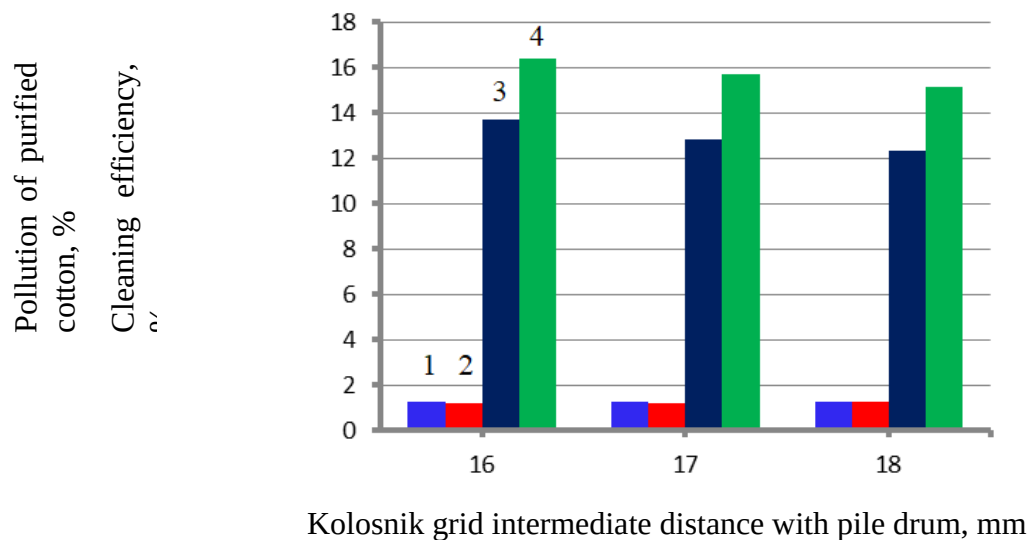


Figure 4. Dependence of the change in the contamination of raw cotton after cleaning and the cleaning efficiency of the feeder on the distance between the spiked drum and the grate on the feeder of the Sultan breed of grade I cotton.

1, 3-on the mesh surface, 2, 4-on the grate

When cleaning cotton of the 1st grade of the 2nd class of Sultan selection with a moisture content of 7.9%, contamination of 1.46% with a spiked drum on the feeder-cleaner of a 90-saw gin with an improved grate feeder-cleaner at a distance of 16-18 mm, the degree of contamination of the cleaned cotton averaged 1.22-1.24%, and the quality of the raw cotton improved by an average of 0.04 (abs)%-0.06 (abs)% compared to the quality of the raw cotton cleaned on the existing mesh surface feeder-cleaner. In this case, the degree of seed damage in the cleaned cotton was on average 2.06-1.95%, and the quality of the seeds improved by an average of 0.06 (abs)%-0.1 (abs)% compared to the quality of the seeds in the cleaned cotton in the existing feeder-cleaner. The cleaning efficiency of the feeder-cleaner during cotton cleaning averaged 16.4-15.1% with a change in intermediate distances from 16 mm to 18 mm, which is on average 2.7 (abs)%-2.8 (abs)% higher than the cleaning efficiency of the existing feeder selected for comparison. The degree of seed fuzziness after ginning with a spiked drum and grate from 16 mm to 18 mm was practically the same, averaging 10.3% [11, 12]. In this case, the degree of seed damage averaged 2.91-2.65%, and the quality of the seeds improved by an average of 0.27-0.33 (abs)% compared to seeds produced from gin with an existing mesh surface. The fiber contamination after ginning averaged 3.17-3.15%, and the fiber quality increased by an average of 0.08-0.05 (abs)% compared to fiber produced from gin with an existing mesh surface selected for the experiment. When ginning cotton, the gin's productivity averaged 980-1023 kg/hour, which is 40-45 kg/hour higher than the existing mesh surface gin. To study the quality of the fiber produced in the technology, the fiber was cleaned in a post-dinning cleaner. In this case, the trash content of the cleaned fiber averaged 1.9-2.0%, and due to the improved quality of the produced fiber, the first grade constituted the "Superior" class.

To study the effectiveness of 90-saw gins with existing mesh surfaces and improved grate feeder-cleaners on low-grade cotton, comparative tests were conducted on cotton of the 2nd class of the 3rd grade of the Sultan breed with an initial moisture content of 13.4% and a trash content of 9.6%. In this case, the moisture content of the 2nd class, grade III raw cotton fed into the gin feeder-cleaner averaged 9.8%, contamination-1.76% and seed damage in the raw cotton composition averaged

2.22% [13].

In a 90-saw gin with a mesh surface of the existing design, when cleaning the mesh surface with a spiked drum on a feeder-cleaner of the 2nd class of cotton of the III grade of Sultan selection at a distance of 16-18 mm, the contamination of the cleaned cotton averaged 1.43-1.47% [14], and the degree of seed damage in the cleaned cotton averaged 2.27-2.25%. In this case, the cleaning efficiency of the feeder-cleaner averaged 18.8-16.4% with the change in intermediate distances at the above-mentioned values (Fig. 5).

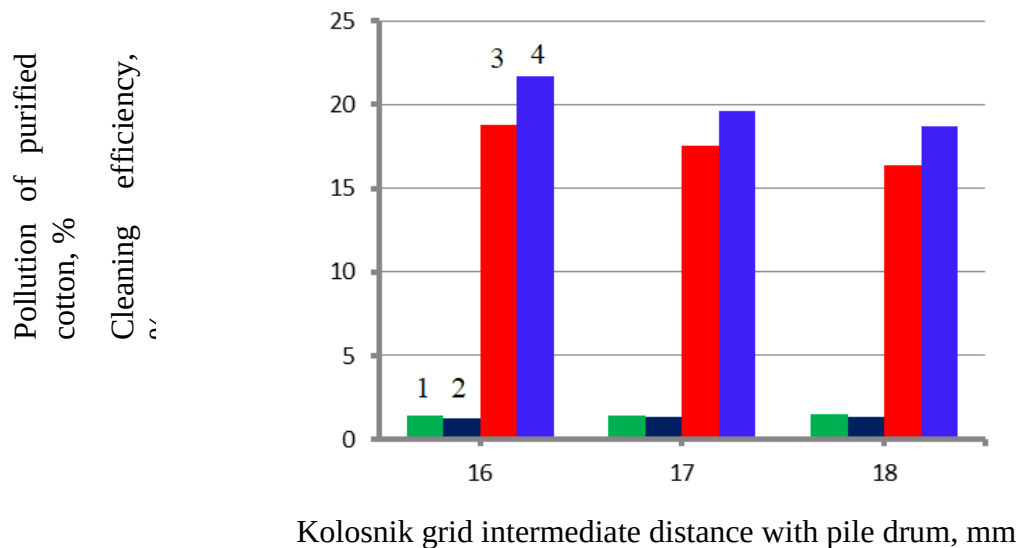


Figure 5. Dependence of the change in the contamination of cotton after cleaning and the cleaning efficiency of the feeder on the distance between the spiked drum and the separator in the feeder for cotton of the III grade of Sultan selection.

1, 3 on the mesh surface, 2, 4 on the grate

When ginning cotton, the degree of seed fuzziness after ginning was practically the same with a change in the mesh surface of the spiked drum from 16 mm to 18 mm and averaged 11.2%. In this case, the degree of seed damage averaged 3.47-3.23%. The fiber contamination after ginning averaged 3.6-3.77%. When ginning cotton, the gin's productivity changed from an average of 821 kg/hour to 868 kg/hour. When cleaning the fiber produced from gin on a two-drum fiber cleaner of the 5VP brand, the fiber contamination averaged 3.14-3.19%, and the quality indicator of the produced fiber was III grade "Good" class according to the state standard UzSst 604:2016.

The degree of contamination of the cleaned cotton with a moisture content of 9.3% and contamination of 1.66% was on average 1.3-1.35%, and the quality of the raw cotton was improved by an average of 0.09-0.07 (abs)% compared to the quality of the raw cotton cleaned on the existing feeder-cleaner with a mesh surface. In this case, the degree of seed damage in the cleaned cotton composition averaged 2.18-2.11%, and the quality of the seeds improved by an average of 0.09-0.14 (abs)% compared to the quality of the seeds in the cleaned cotton composition in the existing feeder-cleaner. The cleaning efficiency of the feeder-cleaner during cotton cleaning averaged 21.7-18.7% with a change in intermediate distances from 16 mm to 18 mm, which is 2.9-2.3 (abs)% higher than the cleaning efficiency of the existing feeder-cleaner with a mesh surface selected for comparison (Fig. 5). When ginning cotton, the degree of seed fuzziness after ginning with a spiked drum and grate from 16 mm to 18 mm was practically the same and averaged 11.3%. In this case, the degree of seed damage averaged 3.31-3.12%, and the quality of the seeds improved by an average of 0.16-0.11 (abs)% compared to seeds produced from gin with a feeder with a mesh surface. The fiber

contamination after ginning averaged 3.48-3.62%, which is on average 0.12-0.15 (abs)% less than the fiber contamination produced from gin with an existing mesh surface feeder-cleaner [15]. When ginning cotton, the gin's productivity averages 863-916 kg/hour, which is 42-48 kg/hour higher than the existing spiked drum gin. When cleaning fiber after ginning on a 5VP cleaner, the mass fraction of defective fiber and trash impurities in the fiber averaged 2.93% and 3.0%, and the quality of fiber obtained from gin with an existing mesh surface improved by an average of 0.21-0.19 (abs)% compared to the fiber obtained from cleaning on a fiber cleaner, and according to the state standard UzSst 604:2016, it constituted grade III "Superior" class.

The main indicators of both gins are compared in Table 1.

Table 1. Comparative results of 90-saw gins with mesh-surface and improved grate feeder-cleaners (spiked drum distance 16–18 mm)

Indicator	Grade I-2, mesh	Grade I-2, grate	Grade III-2, mesh	Grade III-2, grate
Contamination of cleaned raw cotton, %	1.26–1.28	1.22–1.24	1.43–1.47	1.30–1.35
Seed damage in cleaned raw cotton, %	2.16–2.05	2.06–1.95	2.27–2.25	2.18–2.11
Cleaning efficiency of the feeder, %	13.7–12.3	16.4–15.1	18.8–16.4	21.7–18.7
Seed fuzziness after ginning, %	10.3	10.3	11.2	11.3
Seed damage after ginning, %	3.18–2.98	2.91–2.65	3.47–3.23	3.31–3.12
Fiber contamination after ginning, %	3.25–3.20	3.17–3.15	3.60–3.77	3.48–3.62
Gin productivity, kg/h	940–978	980–1023	821–868	863–916
Defects and trash in fiber after lint cleaner, %	2.30–2.22	1.90–2.00	3.14–3.19	2.93–3.00
Fiber class (UzSt 604:2016)	Good	Superior	Good	Superior

Note: the first value refers to a distance of 16 mm and the second to 18 mm. Source: authors' measurements at the "Boyovut techno cluster" LLC ginning plant.

The comparison in Table 1 shows that the improved grate gave better results than the mesh surface for both grades of cotton and at both distances. The gain in cleaning efficiency was greatest for low-grade cotton (grade III), which contains more small impurities: the gaps between the grate bars allow separated impurities to leave the working zone more freely than the small openings of the mesh surface. Lower seed damage, both in the cleaned cotton and after ginning, shows that the grate reduces the mechanical load on the seeds, while better spreading of the cotton flow into the working chamber explains the increase in gin productivity of 40–48 kg/h. For both designs, increasing the distance between the spiked drum and the working surface from 16 to 18 mm lowered cleaning efficiency but reduced seed damage and raised productivity, so the 16–18 mm range is a reasonable compromise between cleaning and seed preservation. These results are consistent with earlier findings on cleaning machine-picked cotton from small impurities in saw gins [18]. The study was limited to one cotton variety, two grades and one pair of gins at a single enterprise; further tests on other varieties, moisture levels and gin models are needed to confirm the results.

As a result of the comparative-test work, it was established that the use of an improved grate on a 90-saw gin feeder-cleaner increases the cleaning efficiency and productivity of the ginning process,

improving the quality of fiber and seeds after ginning, compared to the existing 90-saw gin feeder-cleaner with a mesh surface in the technology for cleaning and ginning cotton of grades I and III of the 2nd class.

Conclusion

To improve fiber quality, test-research work was carried out on cotton of the 2nd class of the I and III grades of Sultan breeding on a 90-saw gin with an improved feeder-cleaner with a grate. As a result of the research work, when cleaning cotton at a distance of 16-18 mm between the spiked drum and the grate bars in the feeder and a distance of 8 mm between the grate bars, the degree of contamination of the cleaned cotton averaged 1.22-1.3%, and the quality of the cotton improved by an average of 0.04 (abs)%-0.09 (abs)% compared to the quality of the cleaned cotton in the existing feeder-cleaner with a mesh surface. The degree of seed damage in the cleaned cotton was 2.06-2.11%, and the quality of the seeds in the existing feeder-cleaner improved by an average of 0.06 (abs)%-0.14 (abs)% compared to the quality of the seeds in the cleaned cotton. At the same time, the cleaning efficiency of the feeder-cleaner was 16.4-21.7%, which is on average 2.7 (abs)%-2.9 (abs)% higher than the cleaning efficiency of the existing feeder-cleaner with a mesh surface. Seed damage from ginning of cleaned cotton averaged 2.91-3.31%, and the quality of the seeds improved by an average of 0.27-0.16 (abs)% compared to seeds from ginning with an existing mesh surface. The fiber contamination averaged 3.48-3.17%, which increased by an average of 0.08-0.05 (abs) % compared to fiber produced from gin with an existing mesh surface. At the same time, the gin's productivity averaged 980-1023 kg/hour, which is 40-48 kg/hour higher than the existing mesh surface gin. During fiber cleaning in the post-dinning cleaner, fiber contamination averaged 1.9-2.93% by grade, and according to the state standard UzSst 604:2016, grades I and III constituted the "Superior" class.

As a result of the conducted research work, it was established that the improvement of the gin feeder with the proposed grate increases cleaning efficiency and gin productivity, improves the quality of the produced fiber and seeds, and also leads to effective cleaning and ginning of cotton.

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