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EXPERIMENTAL TESTING RESULTS OF AN IMPROVED BOTTOM LINT REMOVAL DEVICE FOR SAW GINS

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Abstract: This study presents experimental testing results of an improved bottom lint removal device for saw gins featuring comb-shaped air nozzles. Industrial trials conducted at Kattakurgan cotton cleaning enterprise using "Sulton" variety cotton demonstrated significant improvements in operational efficiency. The proposed device reduced average current consumption from 13A to 7.9A (39-42% reduction) and total power consumption from 6.8 kW to 4.11 kW (39.6% energy savings). Air consumption for lint removal decreased from 0.49 m³/s to 0.34 m³/s while maintaining fiber quality parameters comparable to standard DP-90 gin equipment.

Key words: saw gin, lint removal device, energy efficiency, cotton ginning, resource conservation, air nozzle system.

Introduction. Currently, extensive scientific research is being conducted worldwide on improving machinery and technologies in cotton processing to obtain high-quality fiber, implementing resource-efficient technologies, and developing high-productivity ginning machines. In this direction, priority is given to scientific research aimed at enhancing machine performance, improving the quality and quantity of produced fiber, and refining the structural design of equipment and machinery. Concurrently, developing resource-efficient and cost-effective designs to reduce production costs, substantiating the parameters and operating modes of working components, and improving product quality indicators during seed cotton delinting constitute critical tasks in this field.

Scientific investigations conducted on increasing saw gin productivity, developing resource-efficient working cylinder components, and enhancing ginning efficiency have addressed certain aspects of improving cotton fiber separation processes and equipment. Specifically, research has focused on refining the ginning process in saw gins, determining optimal saw diameter, rational working chamber profile, and optimal saw cylinder speed. These efforts have advanced cotton primary processing technology to a considerable degree, yielding substantial results. However, the development of resource-efficient technology for lint removal devices that completely extract fiber from saw teeth in a uniformly distributed manner while preserving natural fiber properties remains inadequately investigated [1-5].

To address these deficiencies, a bottom lint removal device was developed featuring air nozzles arranged in a comb configuration within air channels, effectively removing lint from saw gin teeth and increasing operational efficiency by reducing energy consumption during the process. The developed device was implemented in production for experimental testing [6, 7].

Materials and Methods. For conducting experimental trials, a new prototype of the fiber separation device, developed jointly by the Tashkent Institute of Textile and Light Industry and "Paxtamash" LLC, was installed in the technological process of the Kattakurgan cotton cleaning enterprise under "Kattakurgan grain cluster" LLC in Samarkand region. Testing was performed in accordance with current methodological guidelines and standard requirements.

During the experimental process, first-grade industrial cotton raw material of the "Sulton" variety with 7-8% moisture content was utilized. The cotton processing technological line consisted of: 2SB-10 drum dryer; two AXOK cleaners for large and small impurities; four DP-90 saw gins; four VP-90 lint cleaners; 2KVU lint condenser; and fiber pressing equipment.

The following activities were conducted during production trials:

- Monitoring gin and auxiliary equipment operation and downtime periods
- Evaluation of technological indicators, maintenance convenience, and repair capabilities
- Aerodynamic parameter measurements
- Power consumption measurement under idle and load conditions
- Accounting for produced fiber quantity
- Sample collection from the following points for laboratory analysis:

✓ Incoming cotton raw material

✓ Fiber from condenser tray

✓ Seeds from collection screw

Laboratory analyses were performed on composite samples for cotton raw material parameters including moisture content, trash content, mechanical seed damage, total fiber defects, trash percentage, mechanical seed damage, residual fiber content, and complete linting degree.

Results and Discussion. Testing results are presented in the following tables.

Table 1. Cotton Raw Material Indicators

Indicators	Initial	Before Ginning
1. Moisture, %	7,5	6,6
2. Entanglement, %	7,3	0,7
3. Trash, %	0,35	0,38
4. Mechanical seed damage, %	0,2	2,1

Table 2. Fiber Quality Indicators

Indicators	Standard DP-90		Proposed Device DP-90	
	After Gin	After Cleaner	After Gin	After Cleaner
1. Moisture, %	6.1	6.1	6.1	6.1
2. Fiber defects, %, including:	3.91	2.83	4.08	2.54
- broken seeds	0.36	0.4	0.27	0.42
- trash	2.0	1.2	2.34	0.9
- pepper trash	0.95	0.83	0.87	0.82
- fiber rings	0.6	0.4	0.6	0.4
3. Physical-mechanical properties:				
- grade	-	31-1	-	31-2
- breaking load	-	29.4 gf/tex	-	29.8 gf/tex
- breaking elongation	-	0.87%	-	0.88%
- maturity coefficient	-	6.1	-	6.4
- short fiber index	-	9.1%	-	8.5%
- staple length	-	1.08 inch	-	1.09 inch

Table 3. Seed Quality Indicators

Indicators	Standard DP-90	Proposed Device DP-90

1. Trash content, %	0.3	0.3
2. Mechanical damage, %		
- initial	0.2	0.2
- before ginning	2.1	2.1
- after ginning	2.9	2.8
3. Linting degree, %	11	11
4. Residual fiber, %	0.61	0.59
- free fiber mass, g	0.03	0.029
- residual fiber mass, g	0.109	0.108

Table 4. Aerodynamic Measurement Results

Indicators	DP-90	Proposed Device DP-90
1. Static pressure in air chamber, Pa	+180	+150
2. Air consumption for lint removal, m³/s	0.49	0.34
3. Static pressure in gin-cleaner duct, Pa	+20	+20
4. Air consumption in gin-cleaner duct, m³/s	0.63	0.59
5. Air flow velocity in nozzle, m/s	60	75

During experimental testing, current parameters and additional power consumption for lint removal during single gin operation under load were compared, and overall efficiency indicators were obtained (Figures 1-3).

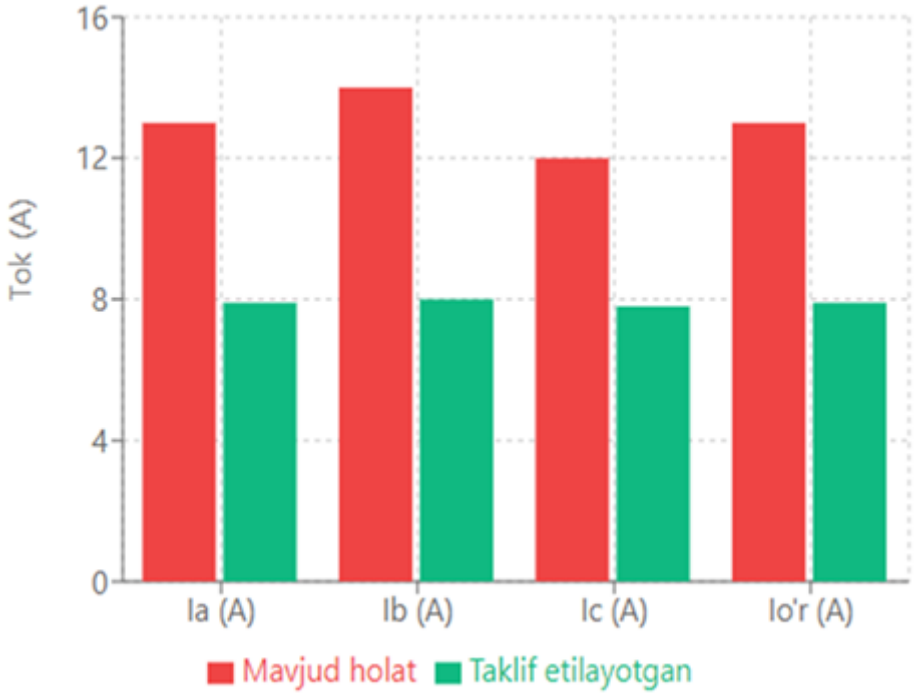

Figure 1. Comparison of current parameters for lint removal during single gin operation under load

Current consumption decreased by 39-42% across all phases. Average current decreased from 13A to 7.9A.

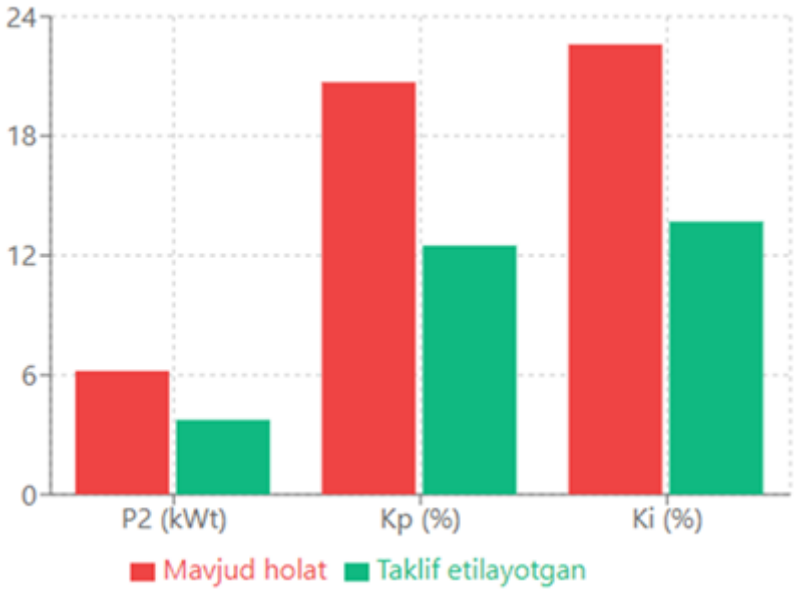

Figure 2. Comparison of additional power consumption for lint removal during single gin operation under load

Total power consumption decreased from P_1 = 6.8 kW to 4.11 kW, resulting in 39.6% energy savings. Power consumption decreased by 39-43% across phases.

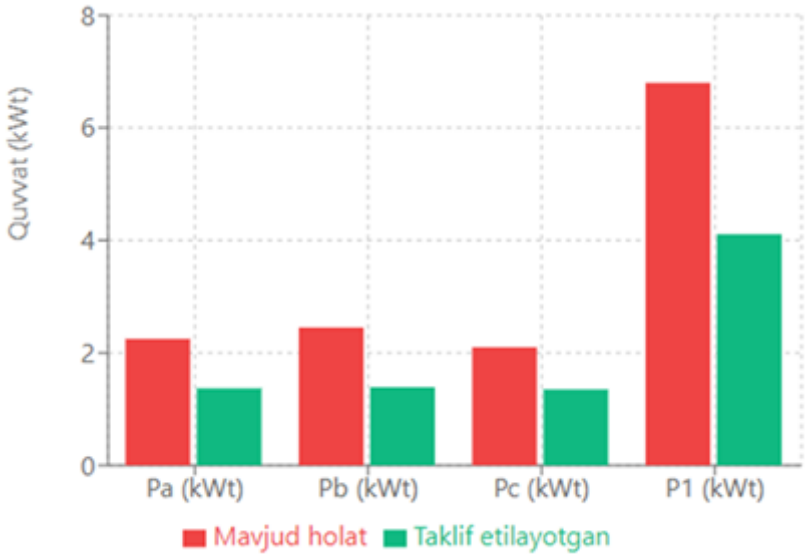

Figure 3. Overall efficiency indicators of additional power consumption for lint removal during single gin operation under load

Useful power decreased from P_2 = 6.2 kW to 3.75 kW, yielding 39.5% energy savings. The load coefficient decreased from 20.7% to 12.5%, representing a 39.6% reduction. The current coefficient decreased from 22.6% to 13.7%, a 39.4% reduction.

Conclusion. Analysis results demonstrate that current parameters decreased by 39-42% across all phases, with average current reduction from 13A to 7.9A. Power consumption showed overall reduction from 6.8 kW to 4.11 kW (39.6% savings), with 39-43% decrease across phases. Efficiency indicators revealed useful power P_2 reduction of 39.5%, load coefficient Kp decreased from 20.7% to 12.5%, and current coefficient Ki decreased from 22.6% to 13.7%.

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