ANALYSIS OF TECHNOLOGICAL MACHINES USED IN COTTON RAW MATERIAL PROCESSING

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Abstract. *This paper analyzes the structural features and efficiency indicators of the main technological machines used in the primary processing of cotton raw materials. Modern modifications of machines employed in preliminary cleaning, drying, ginning, separation, and pressing stages, along with opportunities for automation and energy efficiency improvement, are reviewed. The analysis results provide a significant technological basis for modernizing the cotton industry.*

Keywords: *cotton, technological machines, primary processing, energy efficiency, ginning, drying, cleaning, automation.*

1 Introduction

Cotton production is one of the leading sectors of Uzbekistan's economy, and its sustainable development largely depends on the technical level and efficiency of technological equipment used in processing cotton raw materials. Modern requirements demand energy efficiency, labor productivity, automation, and environmental safety in the cotton industry. Therefore, analyzing the machines used in cotton raw material processing is a relevant scientific and technical issue today.

2 Classification and Role of Cotton Processing Machines

The technological process of cotton raw material processing consists of several key stages, each utilizing specialized machines. These machines are classified based on their functions, structural features, and operating principles. They can be grouped as follows:

2.1 Preliminary Cleaning Machines

These machines remove large impurities such as stems, bolls, husks, and foreign objects from cotton.

Examples: 1BXM, SXM-2, XVP-3.

Features: Operate using vibratory and airflow systems.

Scientific Issue: Fiber damage is often observed, leading to quality reduction.

2.2 Drying Equipment

Designed to reduce cotton moisture from 20–22% to an optimal 12–14%. Excessive moisture can cause fiber breakage or poor seed quality in subsequent stages.

Examples: SVP-4, BXW-2M.

Technological Approach: Convection drying with hot air; some modern models use infrared radiation.

Shortcomings: Inefficient use of thermal energy and uneven heat distribution.

2.3 Ginning Machines (Fiber Separation from Seeds)

These are critical continuous machines determining cotton fiber quality, with saw-type ginning machines being the most common.

Examples: 4DP-130, MXM-180, Lummus-series.

Key Structural Elements: Saw drum, grate, seed discharge mechanism.

Innovations: Automatic control of drum rotation speed and working chamber density reduces fiber damage.

2.4 Separation, Cleaning, and Sorting Machines

These machines remove residual impurities (seed remnants, short fibers, dust) post-ginning and sort fibers by quality.

Examples: SSHM, STX-3, TMC Cleaner.

Analysis: High-efficiency air and cyclonic separators are used. Many models employ optical sensors to determine fiber length.

2.5 Pressing Machines

These compress processed cotton fibers into dense blocks suitable for transport and storage.

Examples: PP-200, PWM-500.

Technical Details: Hydraulic pressure produces 220–250 kg cotton blocks.

Analysis Point: Energy recovery through heat waste recuperation is possible but not widely implemented.

3 Main Graph

Figure 1 illustrates the average energy consumption of technological machines used in cotton raw material processing.

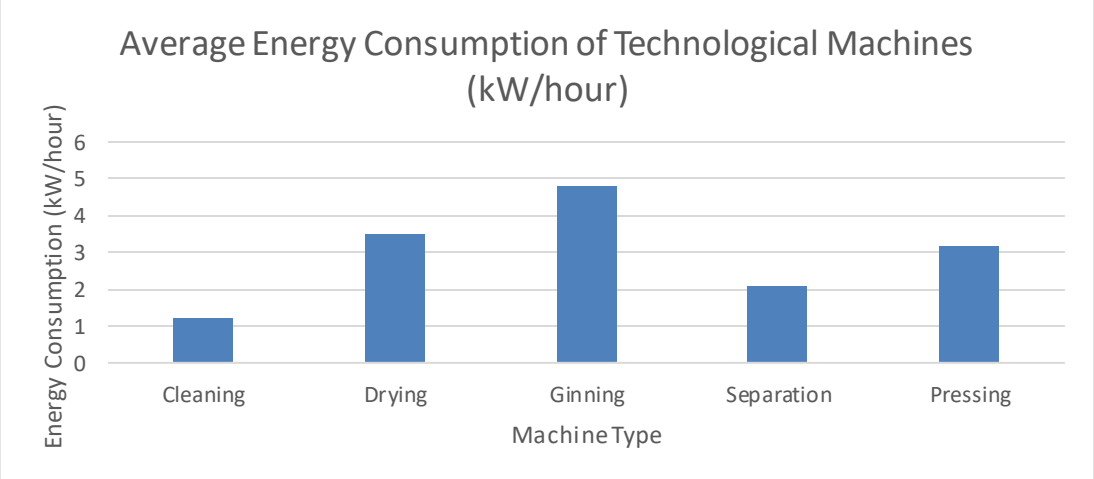

Fig. 1. Average energy consumption of cotton processing machines.

4 Modern Technologies and Improvement Directions

Key directions for enhancing the efficiency of cotton processing machines include:

- Automation and Digital Control: PLC and SCADA systems reduce errors and energy waste in production.
- Artificial Intelligence Technologies: Automatically adjust machine operating modes based on fiber density, moisture, and quality.
- Energy-Saving Systems: Inverter-driven electric motors and heat energy recuperation systems are being implemented.
- Materials Engineering: Wear-resistant composite materials for drums, blades, and grates extend service life.

5 Discussion

Current cotton processing technological lines require significant modernization. Older models like 4DP-130 do not fully meet modern ecological and energy efficiency standards. Therefore, introducing AI-based, automatically adjustable machines is necessary. For enterprises unable to fully replace equipment, partial modernization (retrofitting) serves as a practical solution.

6 Conclusion

The analysis demonstrates that studying and improving technological machines used in cotton raw material processing can significantly enhance production efficiency. Implementing AI, automation, and energy-efficient technologies will boost the competitiveness of the cotton industry in the future.

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