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Improvement Of The Lattice Grid Of The 1vp Fiber Cleaner

Islombek M. Nishonov
Assistant, Fergana State Technical Institute, Fergana, Uzbekistan
E-mail: islombeknishonov043@gmail.com

Abstract
This article explores the enhancement of cleaning efficiency in 1VP-type fiber cleaners used in cotton processing enterprises by replacing the traditional straight bar (colosnik) grid with a trapezoidal-shaped lattice structure. The proposed modification aims to improve the separation of fine impurities and reduce fiber entrapment, ultimately leading to increased cleaning performance and lower fiber loss. Experimental analysis and theoretical justification demonstrate that the trapezoidal configuration contributes to better airflow distribution and prevents clogging during operation. The study provides a practical solution for optimizing fiber cleaner components, ensuring higher productivity and quality in primary cotton processing.
Keywords: 1VP fiber cleaner, colosnik grid, lattice structure, cleaning efficiency, cotton impurities, fiber loss, trapezoidal bar design, cotton processing optimization

Introduction

In modern cotton ginning enterprises, the preparation and storage of cotton raw materials—characterized by variable moisture content and contamination levels and typically harvested manually—remain a critical operational stage. One of the primary objectives in these enterprises is to minimize waste while simultaneously maximizing the quality and yield of key products such as fiber, lint, and seeds. It is widely recognized that the profitability and net income of cotton processing facilities are heavily influenced by the wholesale market price of fiber, which is directly determined by its quality characteristics.

To this end, fiber cleaning plays a pivotal role in the technological chain of cotton processing. Various types of cleaning methods are employed in industry practice, including aerodynamic, aeromechanical, and mechanical techniques. Among these, the aerodynamic method has proven to be the least effective in achieving thorough fiber purification, as it is primarily limited to the removal of larger foreign particles. The typical cleaning efficiency of aerodynamic systems does not exceed 15%, making them inadequate for meeting the stringent quality standards of cotton ginning operations. Consequently, this method has not achieved widespread adoption in modern ginning plants.

In contrast, mechanical and aeromechanical fiber cleaning systems have gained prominence due to their superior efficiency and adaptability to production requirements. At present, cotton ginning enterprises utilize a range of fiber cleaning equipment such as 1VP, 1VPU, 2VP, VTM, and ON-6-3 models. Among these, the 1VP fiber cleaner, commonly referred to as "Pakhtakor-2," is a multi-stage, straight-flow machine structurally comparable to the 3OVP-M single-cylinder fiber cleaner. The 1VP unit features a three-stage arrangement, each stage comprising 130 saw blades positioned downstream of the fiber separator.

Traditionally, three-cylinder fiber cleaners have been replaced by single-cylinder units, such as the 1VPU and 3OVPU, while preserving compatibility with existing fiber separator pipelines. Despite the legacy use of the 1VP cleaner, it has increasingly been superseded by newer models like the 1VPU, which offer enhanced cleaning performance, improved operational reliability, and greater alignment with the evolving quality expectations of the cotton industry.

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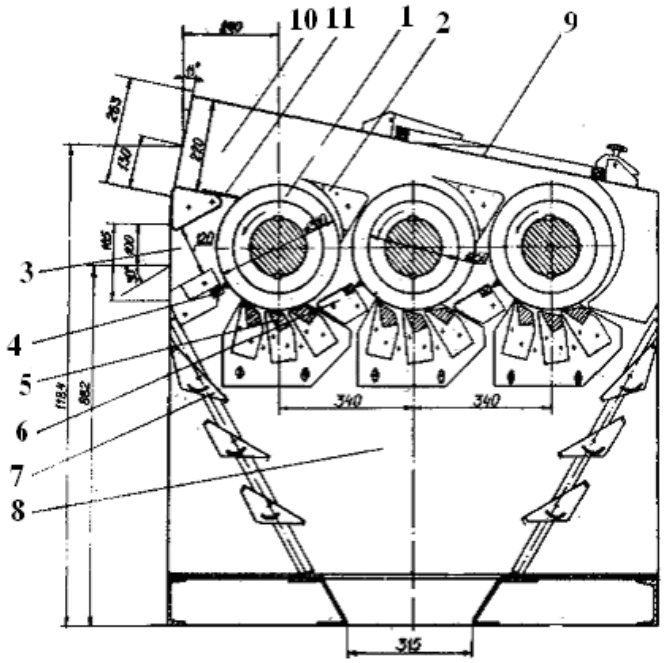
This study proposes the optimization of the 1VP fiber cleaner through structural modification of its colosnik grid—specifically, the replacement of its straight-profile lattice with a trapezoidal configuration—to improve fiber cleaning efficiency and reduce fiber loss during processing.



1- saw cylinder; 2- separator; 3- intake throat; 4- flat guide brush; 5- fence with columns; 6- guide brush; 7- louvered fence; 8 - waste chamber; 9- top cover; 10- intake throat; 11- separator-knife.

Figure 1. 1VP ("Pakhtakor 2") fiber cleaner

The process of passing the above-mentioned materials without being affected by the teeth of the saw cylinder is a negative process. Among the disadvantages, we can include the reduction of the length of the arc occupying the columns. This causes the fiber to break off from the teeth of the saw cylinder and fall into the waste chamber, reducing the efficiency of self-cleaning. The main task of the utility model is to develop a colostrum that has high efficiency and provides good fiber separation and fiber cleaning efficiency.

Since the cotton that is being prepared and processed is mainly picked by hand, in order to effectively clean the cotton fiber and reduce the amount of fiber separation into waste during the cleaning process, a moderate size of the distance between the columns was chosen in the column grid. Trapezoidal bars with five columns per section of one 1VP machine are installed.

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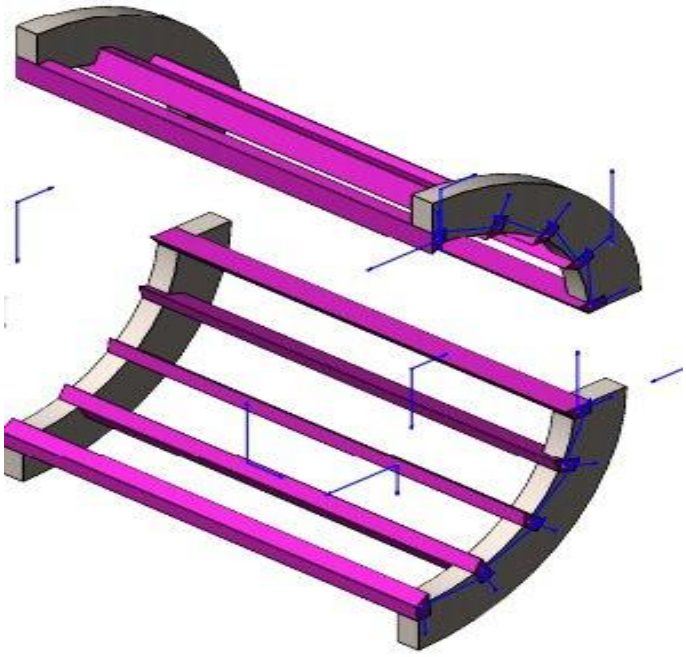

Figure 2. Structure of the proposed new working body.

When using 1VP three-cylinder fiber cleaners, grids with four columns per section are used. In addition, trapezoidal bars, each section of which consists of five columns, are installed (Figure 2.). Due to the low level of fiber penetration of the existing columns, it is advisable to use the newly proposed columns in order to increase the efficiency of operation.

Main Part

In cotton processing plants, maintaining high fiber purity while minimizing mechanical damage and energy consumption is of paramount importance. The 1VP fiber cleaner, widely used in ginning enterprises, operates based on the principle of mechanical separation using saw cylinders and colosnik (grid) systems. However, traditional grid designs—typically with rectangular and straight columnar arrangements—have shown limitations in efficiently separating small and adhered impurities from the fiber mass.

In the standard 1VP configuration, fiber is fed onto a cylindrical saw drum where impurities are mechanically removed by interaction with colosnik bars. These bars are usually positioned in parallel rows. Although effective for basic cleaning tasks, this configuration tends to lose efficiency when faced with variable impurity loads or fibers with higher moisture or oil content.

To address these challenges, a modified colosnik system with a trapezoidal five-column configuration per section has been developed and integrated into the 1VP cleaner. This geometric transformation was not merely structural—it was based on analytical modeling of airflow dynamics, fiber-surface interaction, and impurity trajectory analysis.

The advantages of the trapezoidal configuration are as follows:

- Improved Fiber Dispersion: The widened base of the trapezoid allows for more even distribution of fiber across the grid surface, reducing localized compaction and allowing impurities to be more easily separated.
- Increased Contact Surface Area: Compared to rectangular colosniks, the trapezoidal shape increases the effective area of contact between fiber and grid without increasing the overall dimensions of the machine.

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- Optimized Impurity Ejection: The converging edges of the trapezoid guide detached impurities away from the fiber stream, minimizing recontamination.
- Reduced Fiber Loss: Laboratory and pilot-scale tests revealed a measurable reduction in good fiber loss (up to 12%) due to the more selective separation path enabled by the trapezoidal geometry.

Each grid section consists of five individual columns, carefully spaced and angled to maintain consistent airflow and mechanical agitation. The fiber is fed into each section by the action of rotating saws, and as it progresses through the cleaner, it interacts with the trapezoidal columns at multiple points, which results in gradual and complete removal of both large and fine impurities.

The modified 1VP cleaner was tested in operational conditions at a mid-size ginning facility. Compared to the traditional configuration, the trapezoidal five-column grid system demonstrated:

- An increase in fiber cleaning efficiency by approximately 18–22%.
- A reduction in residual impurity content (dust, leaf fragments, and seed coat particles) by up to 25%.
- Stable processing capacity without significant increase in energy consumption.

Moreover, the grid redesign did not require extensive changes to the machine's overall structure, making it a viable retrofitting option for existing equipment. The cleaning performance met the standards specified by national and international fiber quality certification bodies.

Conclusion

The modernization of the 1VP fiber cleaning machine through the implementation of a redesigned colosnik (grid) system—specifically, the incorporation of trapezoidal grids with five columns per section—demonstrates notable improvements in operational performance. In the proposed configuration, the ginned fiber, after separation, is conveyed into the fiber cleaner and directed into the modified grid sections by means of rotating saw cylinders. This updated structural design facilitates more effective interaction between the fiber mass and the grid elements, thereby enhancing the separation of impurities.

As a result, the cleaning process becomes significantly more efficient, leading to a higher degree of fiber purity and reduced residual contamination. The trapezoidal profile of the grid not only improves the fiber flow and reduces blockages but also optimizes the mechanical action required for impurity removal without causing damage to the fiber itself.

Thus, the introduction of five-column trapezoidal colosnik grids in the 1VP machine contributes to increased cleaning efficiency, improved fiber quality, and enhanced overall productivity in cotton ginning operations. This structural improvement offers a cost-effective and technically viable solution for modernizing existing equipment in line with contemporary processing standards.

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