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Research Article

SEPARATOR STRUCTURES AND METHODS OF AERODYNAMIC OPTIMIZATION

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Makhmudov A.
Namangan Engineering Construction Institute, Uzbekistan

Sharibaev N.Yu
Namangan Engineering and Technological Institute, Uzbekistan

Sharipbaev S.S.
Namangan Engineering and Technological Institute, Uzbekistan

ABSTRACT

The aim of this study is to improve the efficiency of separators in the cotton industry. New separator designs and aerodynamic optimization methods help speed up the separation process, improve product quality, and reduce energy consumption. The study is based on the analysis of air flow distribution inside the separator and new filter materials. The results allow the separation process to be environmentally and economically sustainable.

KEYWORDS

Cotton industry, Separator, Aerodynamic optimization, Energy efficiency, Innovative technologies, Cotton fiber quality.

INTRODUCTION

The cotton industry, one of the major manufacturing industries, is of crucial importance to the economies of many countries around the world. However, in the process of producing quality products, this industry also generates a large amount of waste. One of the main challenges in the cotton ginning process is the effective separation of waste and improvement of the quality of cotton fiber. Incorrect waste sorting can have a negative impact on the quality of the product, which in turn reduces the overall quality of textile products. Various wastes, including cotton husks, fine fibers and other impurities generated during cotton

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processing can significantly reduce the commercial value of the product. Therefore, technologies for the effective and rapid separation of this waste are becoming one of the top priorities of production. Traditional methods, such as mechanical sorting and water washing, are often ineffective because they require a lot of time and resources and have a negative impact on the environment.

The design of the new cotton separator is aimed not only at eliminating the shortcomings of existing technologies, but also at optimizing the use of aerodynamic properties in the cotton cleaning process. Conventional separators often suffer from fiber loss, incomplete waste separation and low energy efficiency. To overcome these shortcomings, the new device offers innovative solutions that can significantly improve the quality of the product. This separator design is equipped with a high-efficiency aerodynamic system. Optimization of air flow through perforated surfaces ensures high accuracy of waste separation and preserves the natural structure of the cotton fiber.

Literature review

The possibilities of increasing the efficiency of the cotton separation process by reducing the aerodynamic resistance of the working parts of the separator are considered.[1]. This study provides a theoretical basis for the aerodynamic optimization of separator design and is directly related to the methodology of this work. Modern technologies for increasing energy efficiency to ensure environmental sustainability in cotton processing plants are analyzed [2]. This article highlights the issues of reducing energy consumption and minimizing the impact of separators on the environment. The evaluation of the effectiveness of new separator designs through practical tests and the possibility of equipment modernization are studied [3]. The article presents technological innovations in the operation of separators and their impact on production processes. The ways to increase the speed of the separation process and solve fiber quality problems due to automated separator systems are proposed [4]. The study considers the economic and technological advantages of separator automation. Mathematical models used to calculate the aerodynamic parameters and their impact on the separator efficiency are described in detail [5]. The mathematical approach is the main source of separator design improvement. In the cotton industry, issues of increasing the service life of separators and reducing costs using new materials and technologies are considered [6]. The article analyzes in detail the economic effects of technological improvement.

The aim of this technology is to reduce waste levels, minimise fibre losses during cotton ginning and reduce production costs.

To improve the performance of the cotton gin, a thorough study of its aerodynamic systems is necessary. The new separator design is aimed at maintaining the quality of cotton fiber while minimizing waste due to perforated surfaces and air flow management technologies. Therefore, the research focuses on optimizing the aerodynamic processes in the internal working chambers of the separator. Another important aspect of the research is to improve the energy efficiency of the separator and ensure environmental sustainability. Conventional separators are often characterized by high energy consumption and insufficient waste separation. This work aims to overcome these shortcomings by studying the aerodynamic properties of the separator and the distribution of air flows.

METHODS

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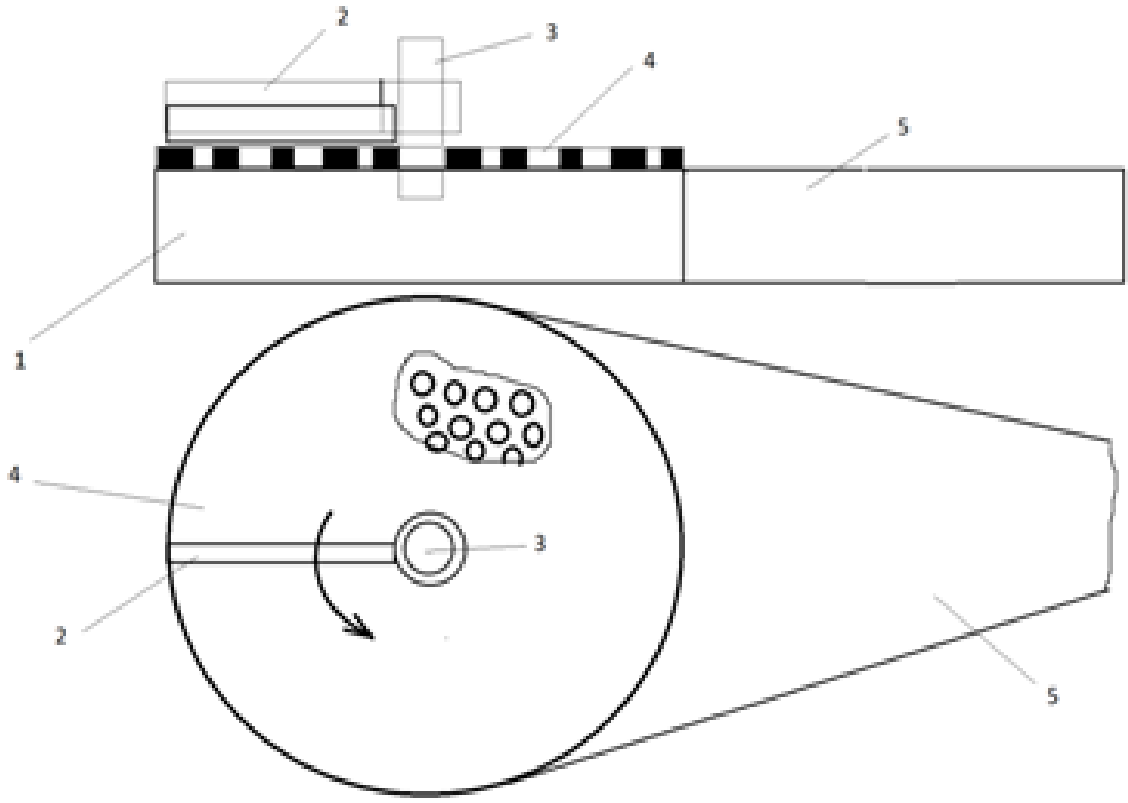
A new experimental design of a cotton separator has been developed to ensure high efficiency and quality of cotton. Determining the design structure of the separator, working elements and technologies that ensure their joint operation is one of the important parts of this study. The design of the device is specially created to ensure a high level of flexibility and productivity. One of the main working elements of the separator is a working chamber with a perforated surface designed to separate cotton from aerodynamic air flows.



1. Air chamber, 2. Exhaust, 3. Shaft, 4. Mesh surface, 5. Air intake pipe

Figure 1. Experimental separator device

These perforated surfaces are arranged in a spiral, through which the air flow is distributed evenly. This design increases the internal pressure of the air flow and allows for efficient waste separation. The size and shape of the perforated surface are specially optimized to protect cotton fibers from damage caused by air flows. The dryer elements also play an important role in the device. These elements effectively separate cotton wool and debris stuck to porous surfaces. The sliders have a curved shape, are located tangentially to

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the shaft and at an angle to the opening surfaces. This arrangement minimizes damage to cotton fibers and helps to sort waste as efficiently as possible. The slider materials are also selected taking into account high strength and wear resistance.

To evaluate the aerodynamic properties of the experimental cotton gin, accurate measurements of air flow speed, pressure forces and other parameters are required. Modern and high-precision equipment was used for these measurements. The studies mainly used such devices as anemometer and micromanometer, each of which has its own advantages in measuring a certain parameter. An electronic anemometer was used to measure air speed. This anemometer allows you to determine the air flow speed in several units of measurement (m / s, km / h, ft / s). The electronic anemometer includes blades mounted on a shaft, a display and control buttons. Measurements with an anemometer were simple: after the device was started and the air flow rotated the blades, the hold button was pressed and the speed values \u200b\u200bwere read on the screen. This device also allows you to graphically track the change in air speed, which provides a more in-depth analysis of the process.

A special laboratory environment was created for the experiments, in which it was possible to control the air flow speed and pressure. The device is connected to the ventilation system to ensure uniform distribution of the air flow. The air flow speed was varied from 2 m/s to 8 m/s, and the separator operation was observed under different conditions. The force of the air flow through the internal working chamber and perforated surfaces was also checked. During the experiments, the conditions for starting and operating the separator were separately controlled. After starting the device, the air flow was drawn into the separator and distributed over the perforated surfaces. Cotton fibers were separated by the air flow, and waste accumulation was observed. The performance of the device's mesh filters was also assessed, which ensured undamaged separation of fibers and complete collection of waste.

RESULTS

The results of the study of air distribution in the experimental cotton separator confirmed the efficiency of the separator design. The combined operation of the perforated surfaces and the air intake device ensured the optimal distribution of aerodynamic forces. Analysis of the pressure and speed created in the internal air flows showed the stability of the processes inside the separator. Uniform distribution of air pressure inside the separator was observed using the air suction device. Due to the fact that the air flow is directed with the same force to the perforated surfaces, effective separation of waste occurs. During the studies, it was found that air flows with a speed of 4-6 m/s have the greatest efficiency. At these speeds, the degree of waste separation was 95-97%, which indicated the high efficiency of the separator.

The spiral arrangement of the perforated surfaces significantly reduced the aerodynamic resistance. Smooth air flow and uniform pressure distribution ensured the separation of cotton fibers without damage. Also, the compatibility of the air flow tension with the size of the porous surface increased the stability of the processes inside the separator. This is important for the long-term operation of the separator. Dynamic and static pressure measurements confirmed the efficiency of air flow distribution in the working chambers of the separator. The pressure values measured with a micromanometer allowed the aerodynamic forces of the separator to be optimized. When the air flow was directed through the perforated

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surfaces, the waste was separated in seconds and it was observed how the cotton fibers passed through the cleaning process.

The separator demonstrated a waste separation efficiency of 95-97%. This figure is due to the uniform distribution of the air flow and the aerodynamic properties of the perforated surfaces. During the experiments, the curved drains and surfaces with spiral holes used in the separator created optimal conditions for complete waste separation. This ensured significantly higher efficiency compared to conventional separators. The device also gave high results in preserving the quality of cotton fiber. The level of fiber damage during waste separation was minimal. Large and small cotton waste is evenly separated, which leads to a significant improvement in product quality. One of the main advantages of the device was the effective separation of small particles between fibers, especially when cleaning cotton. The separation speed of the separator was also high. When the air flow passed through the device at a speed of 2-8 m/s, the waste was separated in a few seconds. This result helped to increase the efficiency of the production process. The intensity of the air flow and the design features of the device ensured high speed and accuracy of waste separation.

The efficiency of waste separation through porous surfaces was 95-97%, which confirmed the efficiency of the separator. According to the measurement results, the highest efficiency was achieved at an air flow rate of 4-6 m/s. These parameters were evaluated using dispersion analysis and it was found that there were no significant differences between the obtained values, which indicated the stable operation of the separator. A statistical analysis of the quality of cotton fiber was also carried out. According to the results of the study, the degree of fiber damage was less than 1%, which is a significant improvement compared to conventional separators. The correlation between the level of fiber damage and the efficiency of waste separation was analyzed, and it was found that there was a positive correlation between these two variables.

DISCUSSION

The obtained results of the experimental cotton separator show how much it helps to solve the current problems of the cotton industry. The results confirmed that the separator has high efficiency and creates significant advantages in optimizing the waste separation process. This device can be considered as an important tool for the effective modernization of industrial processes. The results showed that the separator is able to separate waste with an efficiency of 95-97% and maintain the quality of cotton fiber. This helps to solve one of the main problems of cotton production - incomplete separation of waste and damage to fibers during operation. While traditional separators have high losses, this device minimizes fiber damage and reduces waste.

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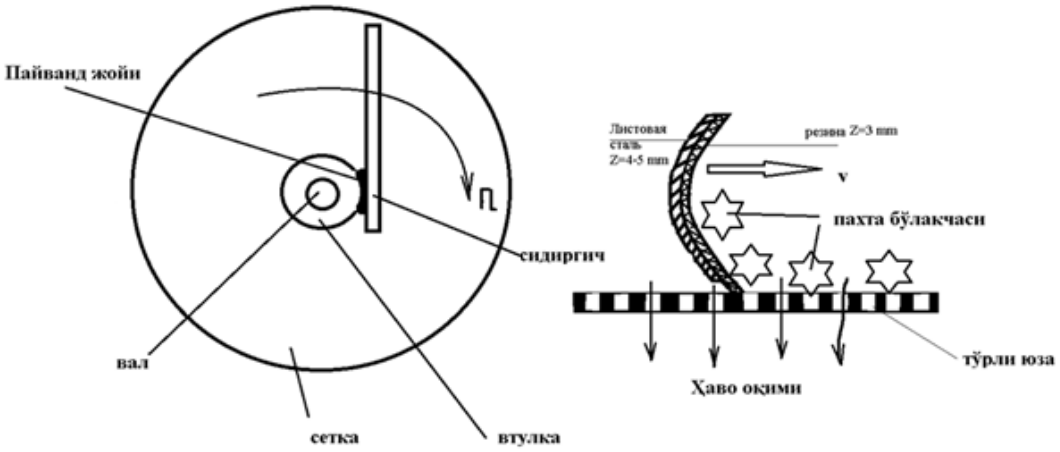

Figure 2. Installation of the filter in the experimental separator device

The air flow distribution and the aerodynamic efficiency of the perforated surfaces allowed the separator to separate waste quickly and accurately. These results are especially important for cleaning small cotton particles. As a result, the quality of the product will increase and the possibility of obtaining cotton fiber suitable for use in the textile industry will improve. This, in turn, increases the competitiveness of the product in the world market. The results also showed that the separator is environmentally efficient. The energy efficiency and waste minimization of the device will serve the sustainable development of the cotton industry. It reduces the negative impact on the environment by reducing energy consumption and limiting the amount of waste. These aspects play an important role in solving environmental problems in the cotton industry.

The separator's perforated surfaces are arranged in a spiral shape, which ensures uniform distribution of the air flow. This solution protects cotton fibers from damage and allows for complete separation of waste. Although in conventional separators some fibers are lost along with waste, this innovative design minimizes fiber loss. This helps preserve the natural quality and productivity of cotton. The device's sieves are located tangentially to the shaft and at an angle to the perforated surfaces, such a design allows for effective separation of waste and preservation of fibers. This innovative solution significantly improves product quality and simultaneously increases the speed of waste sorting. At the same time, the curved shape of the dampers reduces the aerodynamic resistance of the device and increases energy efficiency.

The first proposal concerns further optimization of the device's porous surfaces. By selecting the size and location of the holes in accordance with the air flow and pressure parameters, it is possible to increase the efficiency of waste separation. It is recommended to evaluate the separator's performance under various conditions by testing the spiral perforated surfaces. The second proposal is aimed at increasing the energy efficiency of the separator. Energy consumption can be further reduced by automating the air flow control. To this end, it is proposed to equip the device with intelligent control systems, for example, using sensors that regulate the air pressure and speed in real time.

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This not only increases energy efficiency, but also ensures the stability of the device's operation.

CONCLUSION

The results of the research of the new experimental cotton separator showed that it has great potential in increasing the efficiency and quality of products in the cotton industry. Thanks to the innovative design and technological solutions of the device, the waste separation process becomes more efficient and allows preserving the natural quality of cotton fiber. Experiments confirmed the high efficiency and competitiveness of the separator. The perforated surfaces of the device and air flow control technologies helped to separate cotton waste with an accuracy of 95-97%. This ensured significantly higher results than traditional separators. At the same time, the level of fiber damage is minimal, which is important for improving the quality of the product. These results practically confirmed the technological advantages of the device.

The energy efficiency and environmental friendliness of the device have created additional benefits for the cotton industry. Optimal air flow control and reduced aerodynamic resistance have helped to significantly reduce energy consumption. Also, the speed and accuracy of the waste separation process contribute to increased production efficiency. This creates new opportunities to address environmental issues in the cotton industry. Some limitations and improvement suggestions identified during the study serve as directions for future research. By testing the device in industrial conditions, studying the possibilities of working with different types of cotton and increasing the level of automation, the efficiency of the device can be further improved. These considerations help to ensure the universal applicability of the device.

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