EFFICIENT ORGANIZATION OF THE SEPARATION PROCESS USING AIR FLOW IN COTTON PRODUCTION

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Annotation

This study focuses on the efficient organization of the airflow separation process and the optimization of separator technologies in the cotton industry. The results of the research offer innovative approaches to increasing the airflow efficiency, improving the quality of cotton fiber and minimizing waste using perforated and spiral surfaces. These approaches not only improve energy efficiency but also ensure environmental sustainability.

Keywords:cotton industry, air flow, separator technology, perforated surfaces,

Introduction

Increasing the efficiency and productivity of labor in the cotton industry is always a pressing issue. The cotton cleaning process is particularly complex and multifaceted, and it involves various technological devices and systems. One of these processes is the air system. The air system plays an important role in cotton processing, especially in the cleaning and separation processes. With this system, it is possible to separate cotton from raw cotton waste and prepare it for further processing. The main function of the air system is to separate cotton fibers from waste. Due to the difference in mass and volume of cotton fibers and waste, they are effectively separated by air flow. Air flow is very important for this, since the speed and direction of the air flow directly affect the efficiency of the cotton separation process. If the air flow is uncoordinated or incorrectly adjusted, this will negatively affect the quality of the cotton and reduce production efficiency.

At the same time, the air system is also of great importance for energy optimization. Modern cotton factories are implementing energy-saving technologies, which helps to reduce production costs. The processes carried out through the air system are an important factor in reducing energy consumption, since technological processes can be carried out more efficiently and economically due to properly adjusted air flow. Air flow plays an important role in the cotton separation process, so the effect of air flow through different surfaces has always been the focus of research. The use of different surface designs, including mesh and spiral surfaces, to improve cotton separation efficiency requires an understanding of how these surfaces interact with the air flow. Studying the effect of air flow through these surfaces can be important for improving productivity in the cotton industry.

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]. The study is devoted to improving the aerodynamic parameters of the separator design and shows practical approaches to increasing the efficiency of the separator. The problems of increasing the efficiency of the separation process by speed and air flow distribution are analyzed [2]. This article highlights the technological capabilities of regulating the air flow during the separation process and their impact on the quality of cotton fiber. Methods for increasing the energy efficiency of cotton mills using new separator systems were proposed [3]. The article shows technological solutions aimed at increasing the energy efficiency of separator systems. The distribution of air flow through mesh and spiral surfaces and its impact on the waste separation process were studied [4]. The study shows the high efficiency of spiral surfaces and their advantages in ensuring stable air flow distribution. Using mathematical models and technological developments, the possibilities of developing separator technologies were studied [5]. This work sheds light on the theoretical foundations of separator design and directions for technological modernization. Scientific approaches to the implementation of new technologies to ensure environmental sustainability of the cotton separation process are proposed [6]. The article emphasizes the importance of environmentally and energy efficient separator systems.

Traditional methods usually use air flow through mesh surfaces, as these surfaces can distribute the air flow evenly, which leads to effective separation of mixed waste with cotton fibers. However, mesh surfaces offer limited opportunities for complete control of the air flow, which can lead to some inaccuracies. Therefore, research is ongoing to further improve mesh surfaces and improve their aerodynamic properties. Spiral surfaces allow more effective control of the air flow. These types of surfaces can provide more precise control of the air flow and, therefore, more effective separation of waste during the ginning process. Spiral surfaces ensure that the air flow is distributed in different directions, increasing the efficiency of the process, which leads to improved cotton fiber quality.

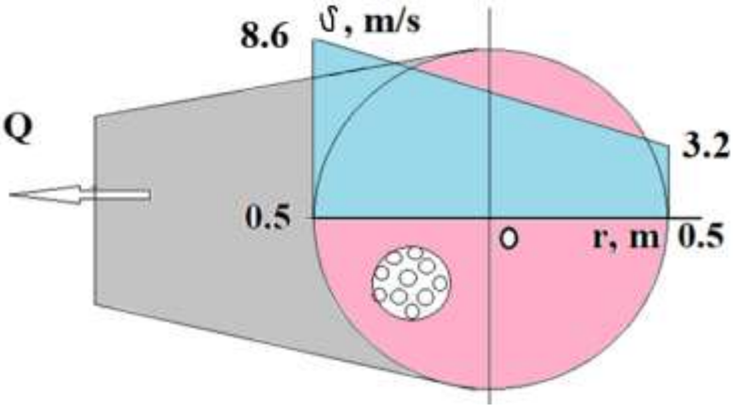

Fig. 1. Change in air velocity on the surface of the mesh when using

The scientific literature also provides valuable information on the distribution of air flow across different surfaces and its aerodynamic properties. For example, mesh surfaces help to distribute the air flow evenly, which increases the efficiency of waste and fiber separation. However, the literature notes that these types of surfaces can in some cases restrict the air flow, which can reduce the efficiency of the process. Scientific work on spiral surfaces has shown that this type of surface allows for more effective control of air flow. The spiral shape allows the air flow to be distributed in different directions, which leads to more accurate and efficient results in the cotton separation process. At the same time, spiral surfaces allow for increased aerodynamic efficiency of the air flow and reduced energy consumption.

Methods

The experimental device is specially designed for accurate and reliable measurement of airspeed. This device is assembled according to the standards used in aerodynamic experiments and is widely used in studying the characteristics of airflow. The experimental device mainly consists of the main components such as an anemometer, fans used to create and control the airflow, and various measuring instruments. The anemometer is the main instrument used to accurately measure the wind speed. It can measure airspeed with perfect accuracy and has the ability to record data electronically. With this device, the airflow speed is measured under various conditions, which ensures the reliability of the measurement results. The anemometer works based on the principle of recording changing pulses depending on the airflow speed.

Fans are the main devices required to create air flow. They can operate at different speeds and voltage levels, which allows you to adjust various air flow parameters during the experiment. The power and rotation speed of the fan are selected depending on the objectives of the experiment, which ensures that the required air speed can be obtained. Methods for measuring air speed, dynamic pressure, and aerodynamic force are an important part of modern aerodynamic research. These measurements provide accurate information about the characteristics of the air flow and its interaction with various surfaces. As we mentioned earlier, an anemometer is used to measure air speed. The anemometer directly measures the air flow speed and records the results electronically, which facilitates subsequent analysis.

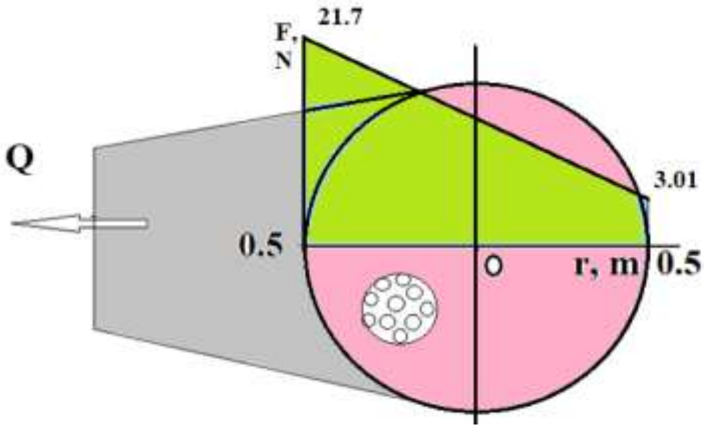

Fig. 2. Change in aerodynamic force on the surface of the mesh when using

Dynamic pressure measurement is performed to determine the relationship between the air flow pressure and its speed. Dynamic pressure is calculated using the formula $Pd=0.5rv^2$, where r is the air density, v is the air speed. Special pressure sensors are used for these measurements, these sensors allow for accurate recording of the air flow pressure, and the sensors are placed in different parts of the air flow. Aerodynamic force measurement is performed to determine the force created by the air flow. This force is caused by the air flow acting on the surface, and $F=P.\cdot s$ is calculated using the formula where P is the pressure and ss is the area of the affected surface. Kraft sensors are used to measure aerodynamic force, these sensors accurately and reliably record the forces acting on the surface.

The next step involves installing an anemometer and pressure sensors. These devices are placed at key points in the direction of the air flow, and these points are selected according to a predetermined pattern. An anemometer is used to measure air speed, and pressure sensors are used to record the air flow pressure. The data obtained by these devices must accurately reflect the characteristics of the air flow at each point. To measure the aerodynamic force, craft sensors are attached to the surface. These sensors record the force of the air flow on the surface, which is directly related to the speed and pressure of the air flow. The force data recorded by the sensors is then analyzed and used to understand how the air flow interacts with surfaces.

Results

The experiment involves testing at different speeds to observe how airflow changes under different conditions. During these tests, key measurements such as air velocity and pressure are recorded, and changes in aerodynamic force are closely monitored. These changes are key to understanding how airflow interacts with surfaces. The results of the experiment showed changes in airflow speed across different surfaces. According to precise measurements, air speed across mesh surfaces varied on average from 3.2 m/s to 8.6 m/s. These changes clearly show how airflow is distributed across different parts, and shed light on how airflow speed across these surfaces varies depending on surface texture.

However, the airspeed data obtained with the helical surfaces are slightly different. On this surface, the average airspeed varied from 2.5 m/s to 6.5 m/s, which is a slower change compared to the conventional mesh surface. These results indicate that the helical surface controls the airflow more effectively and provides a smaller change in flow speed. These analyses allowed us to graphically depict the changes in airspeed across the different surfaces. The graphs clearly show the trends in airspeed and the distribution of airflow across the surfaces. These graphs play an important role in analyzing the experimental results and help to better understand the performance of the airfoils.

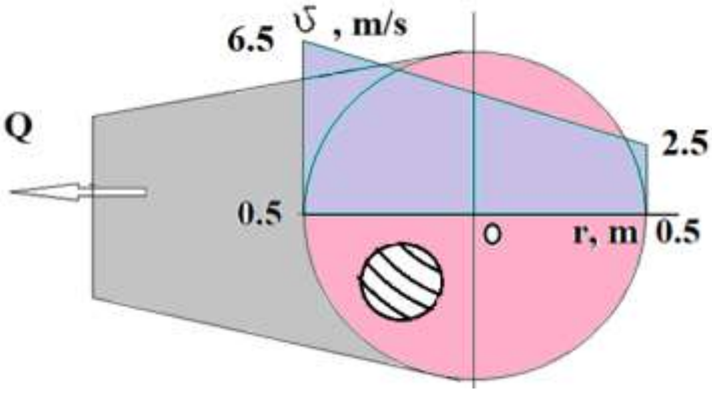

Fig. 3. Change in air velocity on the surface of the spiral mesh

During the experiments, the changes in dynamic pressure and aerodynamic force resulting from the air flow over different surfaces were observed. The dynamic pressure obtained on the mesh surfaces varied on average from 6.144 to 44.376 Pa, which shows how the aerodynamic design of the surface affects the air flow. Meanwhile, the aerodynamic force on this surface varies from 3.01 to 21.74 N, representing the force of interaction of the air flow with the surface. On the spiral surfaces, the changes in dynamic pressure and aerodynamic force were much lower. The dynamic pressure on this surface varied from 3.75 to 23.35 Pa, and the aerodynamic force varied from 1.46 to 9.10 N. These results indicate that the spiral surface is more effective in controlling the air flow and thus provides smaller changes in dynamic pressure and aerodynamic force.

These results provide a better understanding of how airflow is distributed over different surfaces and how their aerodynamic properties differ. When analyzed in graphs and tables, the differences between the airflow effects on different surfaces become more apparent. These graphs and charts clearly show how the dynamic pressure and aerodynamic force change on different surfaces.

Discussion

The results of the study contributed to a deeper understanding of the influence of air flow through different surfaces on the cotton separation process. Of great importance is the distribution of air flow through mesh and spiral surfaces and the influence of this distribution on the separation efficiency of cotton fibers. High values of dynamic pressure and aerodynamic force on mesh surfaces show how important these surfaces are for the effective separation of cotton waste. However, these forces require proper control of the air flow, since excessive force can damage the cotton fibers.

The spiral surfaces keep the dynamic pressure and aerodynamic force at a much lower level, allowing for efficient waste separation without damaging the cotton fibres.

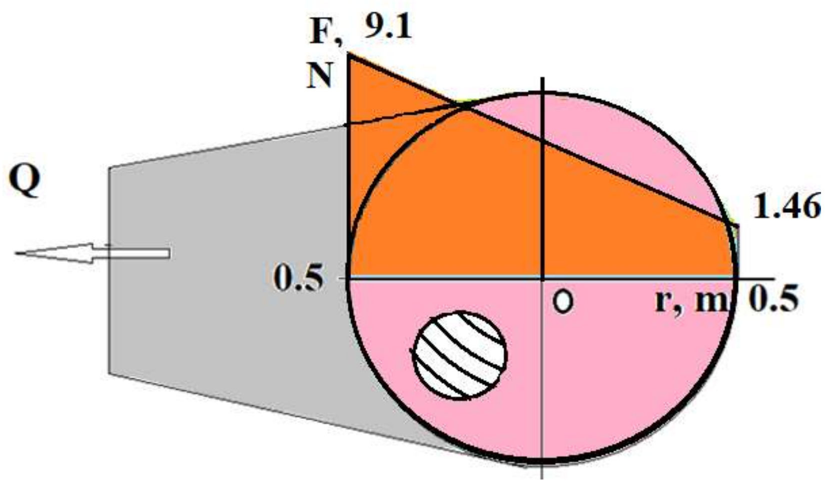

Figure 4. Change in aerodynamic force on the surface of the spiral mesh.

The design of this surface allows for more efficient control of the air flow, resulting in less exposure of the fibres to changes in air speed and pressure. This results in improved cotton quality, as the fibres are neutralised and the yield of clean cotton increases.

The analysis of the results shows that the way the air flow is distributed over different surfaces can significantly increase or decrease the efficiency of the cotton separation process.

Thanks to this analysis, it is possible to develop technical and technological solutions used to optimize the cotton separation process. These solutions also reduce energy consumption in the cotton separation process and increase production efficiency.

In terms of energy efficiency, spiral surfaces provide greater efficiency with lower energy consumption. Effective airflow management helps reduce energy consumption because it is possible to create greater aerodynamic force with less power. This, in turn, increases the overall energy efficiency of the production process and provides the opportunity to reduce energy costs in the cotton industry. Due to the aerodynamic properties of the spiral surface, this type of surface allows for better control of the airflow. This control helps to more accurately control the impact of the airflow on the various surfaces. As a result, the optimal distribution of pressure and speed in different parts of the airflow makes the cotton separation process more efficient. Correctly directing the airflow through these surfaces improves the quality and efficiency of the cotton separation process.

Every scientific study has its limitations and problems, as does the current study. The main limitation is that the experimental conditions cannot fully reflect the real production environment of a cotton gin. For example, experiments conducted in a laboratory environment cannot take into account many factors that occur in real industrial conditions, including various pollutants and working conditions. Therefore, caution is needed when applying the experimental results directly to practice. In addition, the apparatus and equipment used to study the air flow distribution on surfaces were limited. These limitations may affect the accuracy and completeness of the measurements, since more advanced technologies are needed to record all the dynamic parameters of the air flow. Therefore, it is recommended to use more advanced measuring equipment in future studies.

Conclusion

This study was devoted to an in-depth study of the effect of air flow over different surfaces on the cotton separation process. The experimental results showed how the air flow velocity and pressure are distributed over different surfaces and how this distribution affects the cotton separation efficiency. While mesh surfaces create high dynamic pressure and aerodynamic forces, spiral surfaces allow these forces to be maintained at a much lower level, which ensures effective separation without damaging the cotton fibers. The efficiency and energy efficiency of the spiral surface help reduce production costs and improve operational efficiency in the cotton sorting industry. This surface design allows for more efficient control of air flow, which reduces energy consumption and improves overall production efficiency. In addition, this type of surface remains an important area for future research and development.

The limitations of the study were also identified, including that the laboratory experiments may not fully reflect the real industrial environment, and that the equipment used was limited. It is recommended for future research to observe the air flow distribution on the surfaces in different industrial environments, which will increase the practical significance of the experimental results and allow for further optimization of cotton separation processes. In conclusion, this study has provided important approaches and information to make the cotton sorting process more efficient. Spiral surfaces are very efficient in terms of aerodynamics and energy, and their use helps optimize production processes and improve fiber quality in the cotton industry. Future research and development should build on these results and continue to develop new technologies.

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