Theoretical analysis of the process of separating cotton particles from heavy impurities

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Abstract: One of the main disadvantages of stone traps used in cotton ginning enterprises is that a certain amount of cotton falls into the pocket part during their operation. It is recommended to manually remove the cotton that has fallen into the pocket together with heavy impurities and, using air, throw it back into the pipe of the pneumatic conveying device. However, in some cases, the cotton there becomes mixed with various impurities, its trash content increases, and it becomes impossible to separate it manually. Many enterprises do not pay attention to these disadvantages, and the cotton is discarded as waste. When inspecting stone traps installed in the pneumatic conveying device during the cotton processing technological process, a number of similar disadvantages can be observed. This article analyzes these processes using the example of the cotton cleaning process, and presents a new technological solution and advantages, conclusions, and suggestions.

Keywords: heavy impurities, technological process, stone trap, inlet pipe, separation chamber, pocket, outlet pipe, spring, conical ring, efficiency

Introduction

The ongoing measures for the development of cotton textile clusters set a number of tasks for the cotton primary processing industry. The output of fiber, seeds, lint, and fibrous waste - which are the main products of cotton ginning enterprises - in accordance with established standards, with high quality and at a competitive level, depends primarily on the technological process and the proportionate interaction of the technological machines installed within it. In this regard, the role of product-carrying transport vehicles in achieving high production capacity is incomparable.

Below, we will examine several types of stone traps used in cotton ginning enterprises.

1. To this day, a number of cylindrical stone traps are still being used in cotton ginning enterprises. Their difference from other types of cleaning devices lies in the simplicity of the cylindrical stone trap's design and ease of installation. Damage to cotton seeds also occurs in the stone trap, which is one of the main elements of the pneumatic cotton conveying device and is used to clean cotton from heavy impurities. This process occurs under the influence of the impact force generated when the cotton strikes the wall of the working chamber of the cylindrical stone trap.

In this research study, in order to reduce the impact force, a plate with a spring is placed on the part of the working chamber of the stone trap where the cotton strikes (Figure 1). This, in turn, creates the possibility of increasing the speed of cotton particles in the air flow.

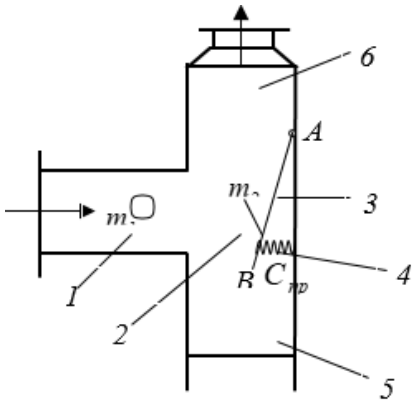

Figure 1. Cylindrical stone trap with a spring-based plate installed in the working chamber (M.G.-1454882)

1 - inlet pipe; 2 - working chamber; 3 - plate; 4 - spring; 5 - pocket; 6 - outlet pipe.

The stone trap operates as follows. Cotton transported by the pneumatic conveying device, together with air, enters the working chamber (2) through the inlet pipe (1) of the stone trap. In this process, the cotton strikes the plate (3) mounted on a spring (4) in the working chamber. With its speed slightly reduced, the cotton is directed vertically upward through the outlet pipe (6) to the next machine. Impurities heavier than cotton cannot rise upward, separate from the cotton, and fall down into the pocket (5).

When a cotton particle of mass m_1 entering the working chamber of the stone trap strikes the middle of plate AB at a speed v_1, a dynamic force P_{din} is generated, which we determine using the following formula:

$$P_{дин} = kP_{CT} \qquad (3.1)$$

Where: k - dynamic coefficient; P_{CT} - static force.

The dynamic coefficient is calculated according to the law of conservation of energy using the following formula:

$$k = 1 + \sqrt{1 + \frac{v_n^2}{g\Delta_{CT}(1 + \frac{m_2}{m_1})}} \qquad (3.2)$$

The static force is determined using the following formula:

$$P_{CT} = m_1 g + m_2 g \qquad (3.6)$$

Where: $m1$ - mass of the cotton particle; $m2$ - reduced mass of the plate; g - acceleration due to gravity, m/s².

As a result of the conducted studies, it was observed that by changing the small and large diameters of the spring, the spring deformation and the resulting dynamic force values do not change significantly.

2. Among stone trap devices, the efficiency of the cylindrical stone trap in capturing heavy impurities is relatively low, i.e., equal to 60%, and during their operation, cotton seeds are broken due to the impact of cotton against the walls of the working chamber. In order to prevent seed damage and increase the capture efficiency, the cylindrical stone trap was modernized by increasing the degree of cotton loosening in its working chamber (Figure 2). [5].

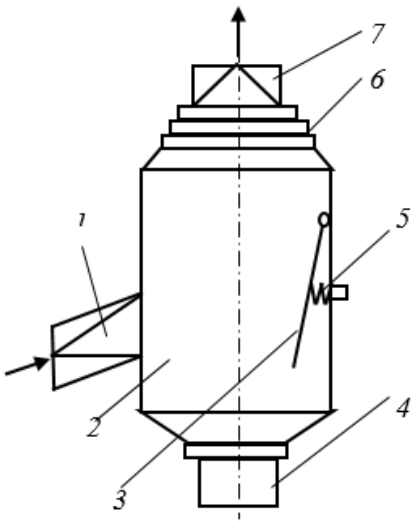

Figure 2. Cylindrical stone trap
1-inlet pipe; 2-seperation chamber; 3- plate; 4-stone collector; 5-spring; 6-conical ring; 7- outlet pipe.

The technological operation process of the cylindrical stone trap is as follows. Cotton moving through the pneumatic pipe by air enters the separation chamber (2) of the stone trap device through the inlet pipe (1) and strikes the surface of the deflector plate (3), which is mounted on the side wall of the chamber by means of hinges. As a result of the impact against the plate, the cotton is loosened, and the heavy impurities contained in it fall into the stone collector (4) at the bottom of the separation chamber. The cotton, separated from the heavy impurities, strikes the surface of conical rings (6) arranged in a stepped manner, is additionally loosened, and rises upward through the outlet pipe (7). A spring (5) is installed between the plate and the side wall of the stone trap's separation chamber to reduce the impact force generated when the cotton strikes the plate mounted on the side wall.

The main reason for installing the inlet pipe of the cylindrical stone trap at an inclination of 60-65° relative to the axis is to prevent damage to the fiber and seeds by avoiding direct impact of the cotton moving at high speed against the walls of the device. As a result of scientific and practical research, researchers have placed a plate with a spring on the part of the separation chamber where the cotton strikes, in order

to reduce the impact force acting on the cotton. The spring-mounted plate reduces the degree of damage to the fiber and seeds of the cotton upon impact, and due to plate deformation, the loosening of cotton particles increases. The increased loosening of cotton particles creates the possibility of increasing their speed in the air flow. The loosening of cotton particles in the cylindrical stone trap allows for maximum capture of heavy impurities contained in the cotton [4, 5].

Analysis of research results

This article analyzes the main disadvantages in the operation of stone traps (devices for separating heavy impurities) used in cotton ginning enterprises. In particular, the problem of cotton particles falling into the pockets of stone traps, their contamination, and consequently being discarded as waste is highlighted. The main theoretical aspects are as follows:

1. Spring-loaded plate (Figure 1) - installed to reduce the impact force and increase the speed of cotton. The static deformations of the spring and the plate are taken into account.

2. Stone trap with conical rings (Figure 2) - it was achieved to increase the degree of cotton loosening and improve the efficiency of capturing heavy impurities (above 60%). The installation of the inlet pipe at an inclination of 60-65° relative to the axis prevents damage to fiber and seeds. It was determined that changing the small and large diameters of the spring does not significantly affect the dynamic force.

In this research study, theoretically based design solutions are proposed to increase the efficiency of separating heavy impurities during the cotton cleaning process and to reduce damage to cotton and seeds. The proposed CD plate, spring-loaded plate, and conical ring system make it possible to control the movement of cotton particles in the air flow, increase their degree of loosening, and reduce impact forces. At the same time, it was also determined that the effect of design parameters on the dynamic force is small in some cases.

Suggestions and Conclusions

Based on the theoretical analysis presented in the article and the existing disadvantages, the following suggestions are made to further increase the efficiency of the process of separating cotton particles from heavy impurities:

1. Introduction of a two-stage stone trap system, i.e., in the first stage - preliminary separation of heavy impurities (stones, metal, etc.), in the second stage - installation of a separate chamber for separating fine heavy impurities and processing cotton that has fallen into the pocket. With this method, the current efficiency of 60% can be increased to 80-85%.

2. Optimization of the plate material and surface - replacement with coatings that reduce the coefficient of friction (for example, Teflon or polymer-coated metal). This

ensures uniform movement of cotton particles. As a result, the coefficient of friction decreases, and speed and separation efficiency increase.

As a final conclusion, it can be stated that the analysis of research conducted by scientific researchers from the republic and foreign countries to improve the device for cleaning raw cotton from heavy and other types of impurities has shown the need to identify a number of disadvantages of existing stone traps, to effectively separate cotton particles that have fallen into the pocket part, to additionally clean cotton in an aerodynamic cleaning device, and to prevent mechanical damage to cotton to the maximum extent possible.

References

1. Jabborov G.J. va boshqalar. Paxtani dastlabki ishlash texnologiyasi. // T.: O‘qituvchi, 1987.

2. F.Rahimov, N. Gadaev, Kh. Kosimov, R. Muradov Theoretical Studies on the Impact of Cotton and Heavy Mixtures on the Walls of the Working Chamber of the Stone Crusher // Web of Semantic Universial Journal on innovative Education, Volume 2 Issue 3, Year 2023 ISSN: 2835-3048 https://univerpubl.com/index.php/semantic.

3. A.Sidikov,. E.Qambarov,. O.Sarimsakov. // Toshtutgich kamerasida paxta bo‘lakchalarning harakatini o‘rganish. Farg‘ona politexnika instituti. Ilmiy-texnik jurnali, 2020-y, Tom 24, № 6, 70-75 b.

4. Мурадов Р., Марданов Б., Саримсаков О. // Исследование движения и ударного взаимодействия частиц хлопка с отражателем в камере цилиндрического камнеуловителя. Деп в УзНИИНТИ, 1992 № 1747-Уз.

5. X.Qosimov. Yangi toshtutgich qurilmasi konstruksiyasini yaratish va ishlab chiqarishga joriy qilish. // fal..fan. PhD diss. ... Namangan, 2022y.