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ANALYSIS OF RESEARCH ON IMPROVING THE SEPARATOR AS A COMPONENT OF THE COTTON AIR-ASSISTED TRANSPORTATION DEVICE

Abstract. The article presents an analysis of scientific research conducted on improving the separator, which is the main element of the air-drying device for cotton ginning. It is known that the separator is used to separate the cotton seeds from the air stream. In addition, it has been studied that during the separation of cotton raw materials, as a result of hitting the upper shell, high forces are exerted during separation from the mesh surfaces and during the passage of cotton raw materials through the vacuum valve , which in turn causes damage to the seeds and fibers. The scientific research shows the need to improve the design of the main elements of air-transporting devices in order to avoid damage to the seeded cotton and its products in order to obtain high-quality fibers.

Keywords: pneumatic transport system, transport process, separator, raw material, air-assisted transport device, efficiency, separation, pressure, pneumatic separator, vacuum valve, separation process.

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Introduction. The high quality of cotton fiber and its products produced by cotton ginning, textile and light industry enterprises, meeting the requirements of world standards, is the main factor in their demand in the world market. In recent years, as a result of the implementation of comprehensive measures to develop the textile and garment and knitting industry in our country, and to support the investment and export activities of enterprises in the sector, 45 percent of the cotton fiber and yarn produced in the republic are being processed, and the annual export potential of the sector has exceeded $ 3.2 billion. In the world, cotton fiber is one of the main raw materials for the textile industry. According to the International Consultative Committee (ICAC), the top five exporters of cotton fiber include the USA, India, Australia, Brazil and Uzbekistan, and the importers are Bangladesh, Vietnam, China, Turkey and Indonesia. Special attention is paid to the sustainable development of cotton ginning enterprises, the development of technical means and technologies at the enterprises of the sector, increasing the level of efficient use of production capacities, and the production of high-quality

competitive products in the world cotton market. In this regard, special attention is paid to the improvement of highly efficient cotton ginning machinery and the creation of resource-saving technologies at world cotton ginning enterprises [1-4].

In cotton ginning enterprises, pneumatic transportation of cotton is very common, mainly by air, and is used to transport cotton with a grain between departments and within departments. The main reason for the widespread use of pneumatic transportation is that it does not destroy the grain cotton, in addition, this device is compact, and its pipes can be installed in any direction at the enterprise and cotton preparation points [5].

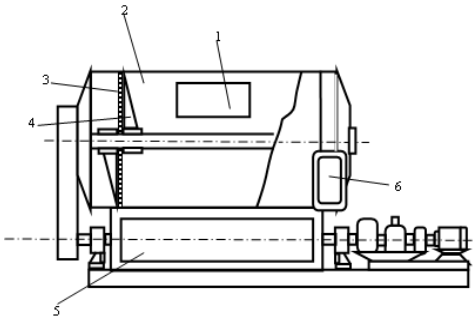
Also, the main reason for the widespread use of the air-transporting device is its reliable operation, minimal material loss during cotton transportation, the compactness of the device, the possibility of its use in places that are inconvenient and narrow for mechanical transport vehicles, and its ease of maintenance and repair. In addition, transporting cotton with an air stream contributes to the fluffing of cotton and the loss of a certain amount of moisture. Also, in the process of separating cotton from air, the preliminary cleaning of cotton from small impurities and dust is ensured [6].

Literature Review. Pneumatic transport is connected to a continuous technological process in all departments of the enterprise, and its normal operation greatly affects the productivity of the departments of the enterprise. During the transportation of cotton seeds in a pneumatic transport device, cotton mixed with air is separated using a separator, that is, the main task of the separator is to separate cotton seeds from the air while preserving the natural properties of cotton.

Many scientists have conducted research on the separator equipment, which is one of the main elements of the device for transporting cotton seeds using an air stream. As mentioned above, the separator is used to separate cotton seeds coming from the air stream [7].

Pneumatic transport devices are equipped with separators that serve to separate the transported cotton raw material from the air. The cotton separation part is performed on a mesh surface made of steel material. A certain part of the cotton raw material sticks to the mesh surface under the influence of the air flow, and the elastic material-coated rollers are separated from the mesh surface and the separated cotton raw material is discharged into the vacuum valve. In the separator, in addition to the impact on the front wall of the cotton raw material, it also rubs against the mesh surface, where damage to the seeds and fibers occurs [8].

Many scientists have conducted research on the process of separating cotton from the air flow carrying it, using a separator machine, which is one of the main elements of the device for transporting raw materials using an air flow. The separator separates cotton from dusty air and partially cleans it of fine impurities. The SS-15A separator is widely used in the technological process of cotton ginning enterprises. A number of scientific studies have been conducted by scientists and specialists in the field to improve the design of separators [9]. Figure 1 shows a diagram of the SS-15A separator.



1 – inlet pipe; 2 – separation chamber; 3 – grid surface; 4 – strainer; 5 – vacuum valve; 6 – air suction pipe.

Fig. 1. SS-15A brand separator

The separator consists of an inlet short pipe (1), a separation chamber (2), a mesh surface (3), a damper (4), a vacuum valve (5) and an air suction pipe (6). When the separator is operating, the cotton is transported to the separation chamber (2) through the short pipe (1). The speed of the cotton in the chamber decreases significantly and the main part of the cotton moves straight under the influence of inertial force, hits its wall and falls to the vacuum valve under the influence of its own weight. A smaller part, under the influence of the air flow, moves to the mesh surface (3) and closes. The cotton stuck to the mesh surface is separated by the damper (4) and transferred to the vacuum valve. With the help of the air flow, small impurities are sucked through the mesh surface using the pipe (6). The efficient operation of the separator also depends on the process between the damper and the mesh surface. If the separator cleans the mesh surface in a timely manner, the air flow will accelerate. In studies [10], it was observed that cotton bundles formed around the separator shaft during the separation of cotton stuck to the mesh surface. The separator is able to clean the stuck part of the cotton on the mesh surface within a radius of 200 mm by rotating it two or three times. Considering that the separation process is continuous, it can be seen that cotton always sticks to a larger part of the mesh surface. This leads to an increase in the hydraulic resistance of the separator and a reduction in the radius of action of the air-driven conveying device.

Shamsutdinov T.O. [11], based on the results of the conducted research, scientifically substantiated the fact that cotton separation occurs at an angle of rotation of 135º, while the flow velocity is 16 m/s.

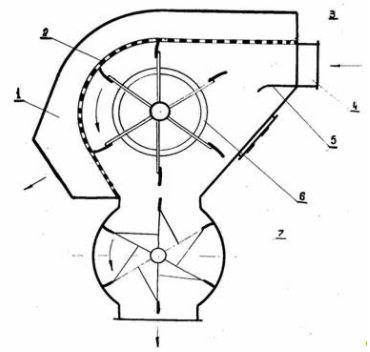
Artikov N. [12] studied the dependence of the speed of movement of cotton raw materials at the entrance to the separation area of the pneumatic separator on the length of the inclined pipe. According to the author, if the length of the inclined pipe is l = 1.9 m, the separation process will be more effective. At this length, the air flow velocity should be V = 26.1 m/sec. He proposed the relationship between the coefficients indicating the resistance to the movement of the mixture and the coefficients depending on the concentration of the mixture for pipes of different diameters. This helped to determine the hydraulic resistances of the pneumatic transport device with high accuracy.

Amirov R. [13] proposed to create an area with zero pressure when separating cotton from a mesh surface. This is at the point where the separator meets the mesh surface. It is located behind the separator, covering the mesh surface and rotating with it. As a result, the air velocity sucked through the holes of

the mesh surface becomes zero. This allows easy separation of cotton stuck to the mesh. In this case, there is no accumulation of cotton between the mesh surface and the separator, no breakage of the seed, damage to the fiber, and no escape of the fiber separated from the seed with air. However, since the sectoral integral surface is 0.0045 m^2, this leads to a decrease in the useful surface of the mesh. This, in turn, increases the aerodynamic resistance of the separator.

During operation, when the cotton raw material falls unevenly onto the separator, some cotton pieces fall onto the mesh surface and clog it. If there is no device to remove it from the surface, the surface will become clogged. Figure 2 shows a separator created by Uzbek scientists under the brand name "KhSCh". In this case, the transported cotton raw material enters the separator's separation chamber through a pipe along with air. The volume of the separation chamber is larger than that of a short pipe. Therefore, the air velocity in it decreases from 20-25 m/s to 7-8 m/s.

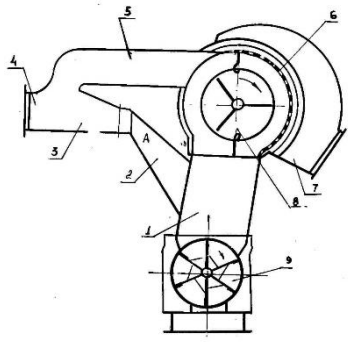
At this speed, the cotton raw material continues to move by inertia and clogs the mesh. The cotton is separated from the mesh surface by a rubber-bladed drum, and then falls under the influence of its own weight into a vacuum valve.



1 – air flow; 2 – grid; 3 – separation chamber; 4 – inlet pipe; 5 – guide; 6 – rubber winged drum; 7 – vacuum-valve.

Fig. 2. "KhSCh" brand separator

Kadirkhozhaev S.M. [14] created a new "SH" brand separator, which is a further improvement of the pneumatic separator shown in Figure 3.



1 – working chamber; 2 – cotton bottom access road; 3 – line is the bifurcation point; 4 – inlet pipe; 5 – cotton upper access road; 6 – mesh surface; 7 – suction short pipe; 8 – elastic layer drum; 9 – vacuum valve.

Fig. 3. SS-15A "SX" separator

In addition, during the cotton gin process, high forces are exerted during separation from the full surfaces as a result of impact on the upper shell and during the passage of the cotton gin through the vacuum valve, which causes damage to the seeds and fibers that cotton is torn in a separator with a scraper . This occurs as a result of the free fibers and pieces of cotton stuck to the mesh vibrating around the core when being cleaned with scrapers. Therefore, a cotton roller is formed in front of the scraper along the entire length. The speed of movement of this roller at the farthest point from the scraper shaft is 4 times higher than at the closest point. Therefore, bundles of fibers and tearing of cotton raw material are formed. In order to reduce the formation of defects in cotton raw material, the author proposed to make a scraper-cleaner in the form of a box with a length of 450 mm, a width of 100 mm and a depth of 50 mm, having a rubber edge along all its parameters [15]. Based on this design of such a scraper, at the moment of scraping with the main scraper, the force of tension of cotton on the mesh is zero, and the scraper separates cotton without forming a cotton roller.

Such a solution to the problem was also proposed by the authors of [16]. They proposed to make the separator mesh with a closed section, in which the adhesion force of the cotton raw material to the mesh surfaces would be zero. However, this solution was not widely used due to the increase in the aerodynamic resistance of the separator and its negative impact on its performance. At the same time, in the studies devoted to improving the design of separators used for cotton raw material, we can see research works aimed at determining the size of the mesh surfaces and their effect on damage to the transported material.

Mamatkulov O. conducted research on increasing the efficiency of the mesh surface [17]. The study investigated the effects of grain defects on the number of passes through the separator. It also investigated the effect of increasing the number of passes through the separator on fiber loss in the device. The researcher proposed a design change for the separator to reduce fiber loss and grain damage in the CC-15 A cotton separator. The author also studied the effect of increasing the number of passes through the CC-15A separator on grain damage and fiber loss and analyzed the results (Fig. 4).

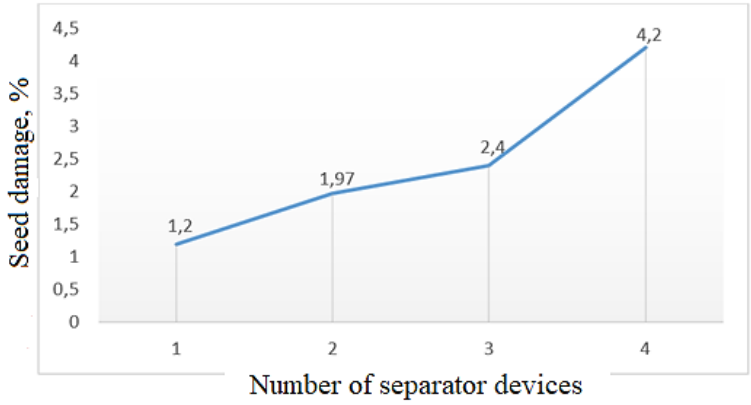


Fig. 4. Effect of the number of separators on seed damage

From this graph, it can be concluded that increasing the number of passes in the separator has a negative effect on cotton seed damage. In this process, cotton damage mainly occurs on the separator front and mesh surface.

Eshmurodov D. [18] developed a separator design with a flat-shaped deflector with a 20-degree slope, which reduces damage to the grain and prevents the formation of free fiber in the impurities. The impact of the cotton flow on the rear wall of the existing CC-15A separator at a speed of 12-15 m/s at the inlet leads to mechanical damage to the grain, rapid wear of the rear wall of the separator, and a decrease in the life of the separator. The main goal of the research is to create a separator that ensures the long-term operation of the pneumatic transport by reducing the speed of the cotton flow to 3-4 m/s, thereby preventing the failure of the inner wall of the separator and the vacuum valve, as well as mechanical damage to the grain. According to the results of the research, a special guide device was developed to guide the cotton at the entrance to the chamber in order to reduce the impact force on the rear wall of the separator. As a result, mechanical damage to the seed was reduced by 16.5%.

Conclusion. Currently, scientific research is being conducted to create new designs of the separator. The effective operation of the separator, along with the mesh surface, is also affected by the vacuum valve, which is one of its main elements. The results of the conducted scientific research show that all the shortcomings of the separator have not been completely eliminated. The analysis shows that it is necessary to conduct in-depth research to improve the separator and its main working parts.

Studies have shown that the main reason for the decrease in the efficiency of the cotton separator is the contact of the main part of the cotton being separated from the air with the mesh surface. The contact of cotton with the mesh surface leads to a deterioration in its quality indicators and an increase in the aerodynamic resistance of the separator. Since the mesh surface is almost completely covered with cotton, air is sucked in only from a small part of it, which is cleaned by a sieve.

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МАҚТА ТАСЫМАЛДАУҒА АРНАЛҒАН ПНЕВМАТИКАЛЫҚ ТАСЫМАЛДАУ ҚҰРЫЛҒЫСЫНЫҢ ҚҰРАМДАС БӨЛІГІ РЕТІНДЕ СЕПАРАТОРДЫ ЖЕТІЛДІРУ БОЙЫНША ЗЕРТТЕУЛЕРДІ ТАЛДАУ

Аңдатпа. Мақалада мақтаны өңдеуге арналған пневматикалық көлік құрылғысының негізгі элементі болып табылатын сепараторды жетілдіру бойынша жүргізілген ғылыми зерттеулерге талдау ұсынылған. Сепаратор мақта тұқымын ауа

ағынынан бөлу үшін қолданылатыны белгілі. Сондай-ақ, мақта шикізатын бөлу процесінде жоғарғы қабыққа соғу нәтижесінде, торлы беттер мен вакуумдық клапан арқылы өту кезінде тұқымдар мен талшықтарға зақым келтіретін жоғары күштер пайда болатыны зерттелді. Зерттеулер тұқымдық мақтаның зақымдануын болдырмау және жоғары сапалы талшықтар алу үшін пневматикалық көлік құрылғыларының негізгі элементтерінің дизайнын жетілдіру қажеттілігін көрсетеді.

Тірек сөздер: пневматикалық көлік жүйесі, тасымалдау процесі, сепаратор, шикізат, пневматикалық көлік құралы, тиімділік, бөлу, қысым, пневматикалық сепаратор, вакуумдық клапан, бөлу процесі.

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АНАЛИЗ ИССЛЕДОВАНИЙ ПО СОВЕРШЕНСТВОВАНИЮ СЕПАРАТОРА КАК КОМПОНЕНТА ПНЕВМОТРАНСПОРТНОГО УСТРОЙСТВА ДЛЯ ПЕРЕНОСКИ ХЛОПКА

Аннотация. В статье представлен анализ научных исследований, проведённых по совершенствованию сепаратора, который является основным элементом пневмотранспортного устройства для переработки хлопка. Известно, что сепаратор используется для отделения семян хлопка от воздушного потока. Также изучено, что в процессе отделения хлопкового сырья в результате ударов о верхнюю оболочку, при прохождении через сетчатые поверхности и вакуумный клапан, возникают высокие силы, которые вызывают повреждение семян и волокон. Исследования показывают необходимость совершенствования конструкции основных элементов пневмотранспортных устройств для предотвращения повреждений семенного хлопка и получения волокон высокого качества.

Ключевые слова: пневмотранспортная система, процесс транспортировки, сепаратор, сырьё, пневмотранспортное устройство, эффективность, разделение, давление, пневматический сепаратор, вакуумный клапан, процесс разделения.