Theoretical And Practical Study Of The Process Of Cotton Separation In Mobile Device

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Annotation

This article examines the issues of increasing the efficiency of the moving separator, which is the main working part of the device used in the transportation of cotton by air, in ginneries.

Keywords: cotton, pneumatic transport, separator, fan, pipe, cyclone, stone holder, auger, solenoid, vertical pipe, blade, drum, cleaner, mesh surface, shaft, vacuum valve, discharge-separator, volumetric.

1. INTRODUCTION

In order to improve product quality and increase fiber production in the ginning industry, it is necessary to improve the design of machines in the technological process of cotton processing. In solving this problem, the device of air transport of cotton is of great importance. In ginning enterprises, the raw material is cleaned from the bales and transported to the drying shops in the pipes of the air-descending device. Its simplicity and the ability to deliver the product to destinations in any complex direction without destroying it make the air-lifting device very common in the ginning industry. The distance between the gins and the main buildings located on the territory of ginneries is 200-250 meters and more. The area of influence of the pneumatic transport device is 100-110 meters. Therefore, in order to increase the impact zone of the pneumatic transport device in ginneries, a propulsion device consisting of a centrifugal fan VTs-12 and a separator SS-15A will be installed. Its main purpose is to improve the design of the propulsion device operating in the pneumatic transport in order to reduce fiber loss and electricity consumption while maintaining the natural properties of cotton. Therefore, the construction and operation processes of the moving devices available in the study were introduced.

In the territory of ginneries, it is not possible to transport cotton in bales located at a distance from the main building with a single air-transport device.

Therefore, in factories, an additional moving air-carrying device is installed in addition to the air-carrying device. An analysis of scientific research to improve the performance of mobile air-carrying devices has shown that its installation increases the amount of energy used to transport cotton and leads to a deterioration in the quality of cotton. To solve this problem, a mechanical conveyor has been used in some enterprises. But this has led to an increase in transportation costs. It also cannot deliver cotton in a rhythmic, guaranteed manner, like an air-carrying device. There are a number of problems with the conveyor belt when moving cotton from one bale to another bale when it is raining in the winter.

Therefore, after getting acquainted with the inventions and research work on improving the design of mobile airborne devices, the work process of devices with a conical mesh surface and separation zone was theoretically studied. During the separation of the cotton from the air, all the forces acting on the cotton fiber were taken into account.

At present, suction-drive air-operated pneumatic equipment is used to supply raw cotton from abroad to the production of bales (Fig. 1). In this installation, the function of the discharge-separator is performed by a volumetric pneumatic separator.

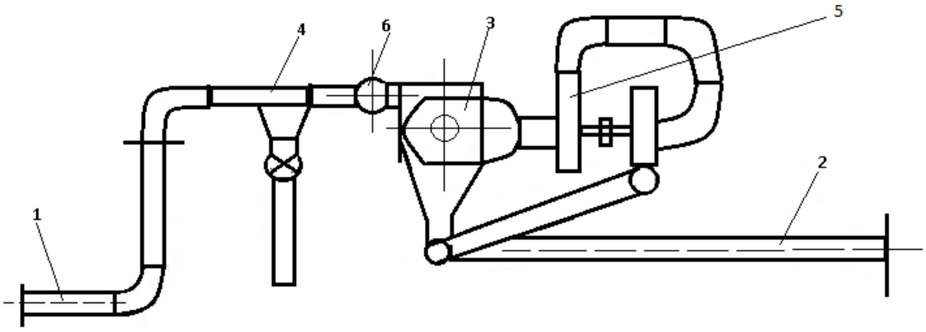


Figure 1. Pneumatic transport device of 'Hard Wick – Etter'
(1) and (2) suction and drive pipes, (3) separator, (4) stone holder, (5) fan, (6) electromagnet.

Separation of cotton from air was carried out by pneumatic method, which does not include cleaning of cotton impurities from mixtures. Unloading of raw cotton separated from the air is carried out by a vacuum valve. Productivity does not exceed 5-7 tons per hour. The main disadvantage is that the cotton separated from the air is likely to come into contact with the fan blades.

In some enterprises, an air blower has been introduced. (2) In this device it is also possible to dry the cotton during transportation by driving it with hot air in the pipe.

Scientists of the Institute of Mechanics of the Academy of Sciences of the Republic of Uzbekistan have created a pneumo-separator in order to reduce dust emissions into the atmosphere, improve the ecological condition of the region and preserve the natural properties of raw materials.

This pneumo separator operates under the influence of suction and blown air generated by the fan. A working pipe is connected to the suction part of the fan and when it reaches the ejection section, the cotton is released from the air under the influence of inertial forces.

The air-separated cotton is thrown to the next process under the influence of air blown from the ejection site. This pneumatic transport is equipped with a pocket designed to hold various heavy mixtures of cotton.

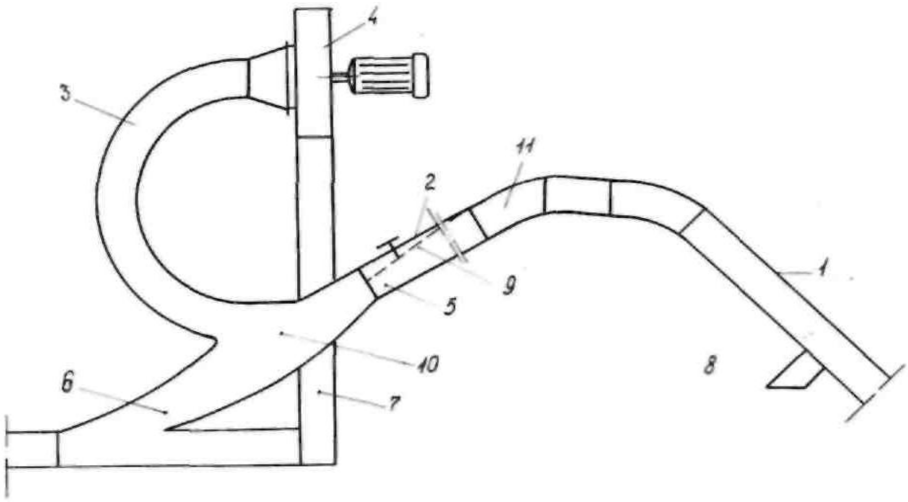


Figure 2. Pneumo separator

(1) top section, (2) bottom screw section, (3) benders, (4) fans, (5) producing pipes, (6) producing pipes, (7) vertical tubes, (8) stone handles, (9) adjusters, separation part (10), turning part (11).

In ginneries, a stationary pneumatic device is used to transport cotton from the bales to the production shops (Figure 3).

The pneumatic device consists of a separator SS15A, a fan VTs-12m and two cyclones TsL-3 and TsL-3.

This stationary pneumatic device works as follows. Suction through the suction air duct generated by the fan makes it possible to transport the cotton. Under the influence of suction air in the pipe, the moving cotton enters the working chamber of the SS-15A separator. The cotton separated from the air in the working chamber is discharged through a vacuum valve.

The air is sent to the cyclone through a fan, where the dust is removed from the air and released into the atmosphere. It is not widely used in cotton mills due to the complex design of this stationary device. Instead, a suction-blowing device with a simple design, without cyclones, which cleans the air, is used. (Figure 3)

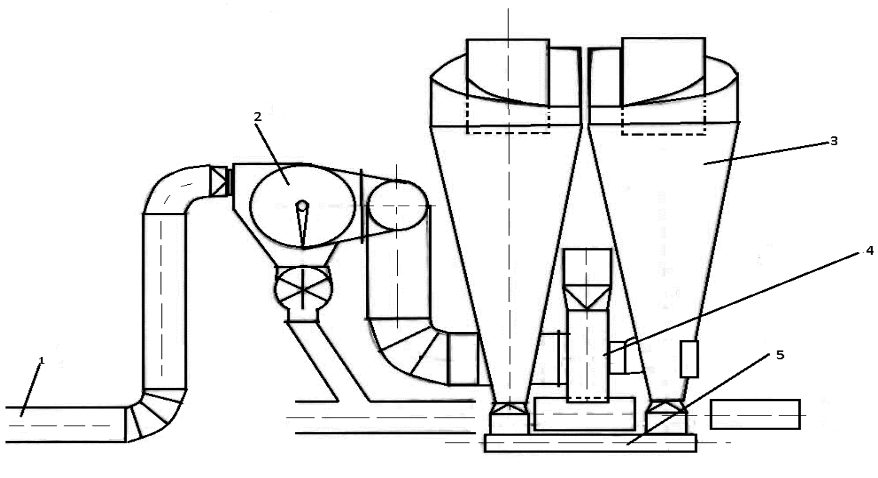


Figure 3 Fixed pneumatic device

(1) working pipe, (2) SS-15A brand separator, (3) cone cyclones, (4) fan, (5) screw.

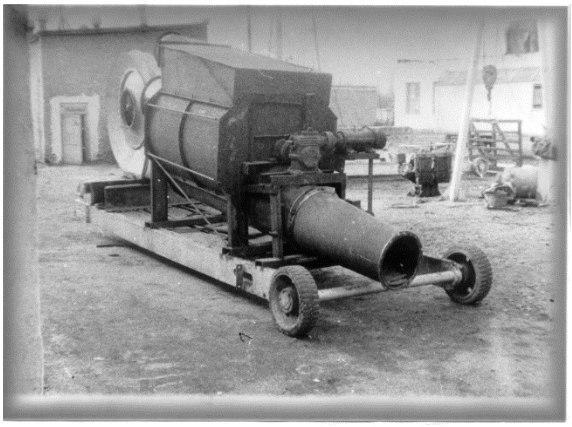
The performance of any machine is characterized by the improvement of its technical and economic performance. The main performance indicators of the moving device are: the effect of the air-carrying device on the quality of cotton fiber and seeds; the escape of the fiber from the mesh barrier holes to the fan; cleaning efficiency of the air-carrying device; aerodynamic characteristics.

It is known that it is necessary to constantly improve the technological equipment of primary processing of cotton. In the creation of new, high-efficiency designs of processing machines, it is very important to constantly improve the auxiliary equipment of ginneries, as well as the mobile air transport device, which is one of the key elements in the air transport system.

The study of air transport processes and cotton separation and a comprehensive analysis of the existing designs of moving air transport devices and separators have made it possible to develop an air separator design for cotton with a conical mesh shell cover drum.

The distinguishing feature of the new separator is the integration of the separation unit (mesh surface) and the discharge part (vacuum-valve) into a single unit, i.e in the form of a cylindrical mesh with a conical mesh cover.

The drum is mounted on a bevel extension shaft so that the suction air duct of the fan is not located in the upper section, the suction air duct and the cotton outlet pipe are not located in the lower section.



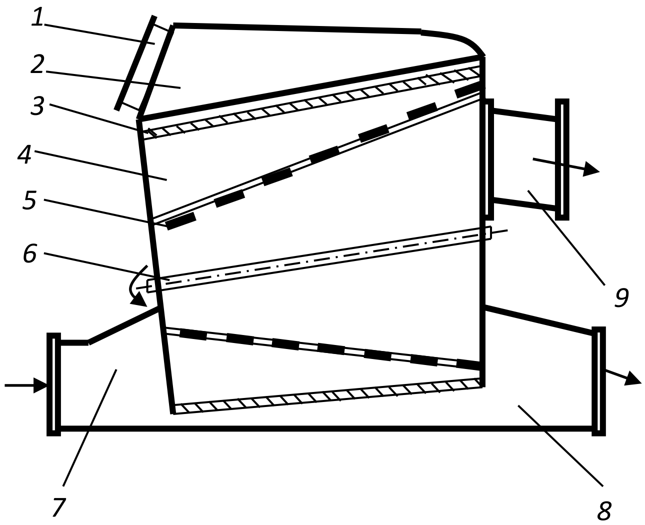


Figure 4. Separator with a conical mesh shell drum
(M.G.-1678923, Patent UZ-1573)

(1) inlet pipe, (2) separation chamber, (3) blades, (4) cell, (5) mesh surface, (6) rotating shaft, (7) blower pipe, (8) outlet pipe, (9) suction pipe.

When the moving separator is running, the cotton comes through the inlet pipe (1) to the separation chamber (2). Under the influence of air sucked from the mesh surface (5) through the suction pipe (9), the cotton falls into the cells located between the feathers (3). As the rotating shaft (6) moves the blade (3), the cotton located in the cell (4) passes into the lower chamber of the separator. There, under the influence of the air coming out of the blow pipe (7), it is separated from the mesh surface and passed to the next process through the outlet pipe (8).

In this device, the number of revolutions of the vane mesh drum, the consumption of suction and blown air in the inlet and outlet pipes, and the work efficiency were changed during the research in this device. The results show that the efficiency of the device is affected by the speed of the air entering the separation chamber and the speed of the air blown into the outlet pipe. The speed of rotation of the spinning drum was also important in ensuring that the cotton was separated from the mesh surface. The device was found to perform well when the blowing air velocity was 12.5 m / s and the rotation of the vane drum was 45 rpm.

Studies in this mobile device show that it is possible to reduce seed damage by 45%, fiber penetration into the fan by 30%, and pressure loss by 80%.

Improving the performance of the air-transporting device of cotton can be seen in the fact that in order to increase its radius of motion, the air-carrying devices can be installed in series. A carrier device using a moving air with a fan also requires the use of a separator.

As shown in the second chapter, the quality of cotton is significantly reduced due to the increase in the number of passes of the cotton through the moving device. Given that the deterioration of cotton quality occurs mainly in the separator, the previous chapter considered the possibility of separating cotton from the air in a mesh liner.

The main disadvantage of the air-carrying device is the increase in aerodynamic resistances in the radius of motion, which occurs in the joints of pipes that are not sufficiently sealed, as well as the loss of pressure in the constituent elements of the device.

Increasing the range of motion of the device is done by connecting a more powerful fan or several fans.

From practice and repeated experimental studies, it is advisable to: connect additional fans; connecting one or more additional fans; creating an interval not exceeding the range of motion of the fan.

Additional fans are equipped with special elements. They lose the constant contact of the transported material and the fan blades with the mesh surface, the exhaust body and the loading chamber, the vacuum valve.

The moving device is placed in series on the air-carrying device and consists of a fan with a separator and an air purifier.

The moving device is mounted on the cart due to the frequent change of air ducts.

The main function of a moving device is to increase the range of motion of the air-carrying device. However, it is also used in mechanical turning of cotton to prevent it from falling out during storage.

Existing air-carrying devices consume a lot of energy due to the emergence of high aerodynamic devices in addition to the deterioration of the initial conditions and natural properties of cotton. In addition, as the radius of motion increases, the increase in the number of crossbars significantly reduces the output of cotton fiber. Fiber loss occurs during the interaction of cotton with the mesh surface in the separator.

Fiber loss occurs through the passage of free fibers in the cotton through the separator mesh surface. In addition, with seeds, well-adhered fibers also break through the holes as the mesh surface is cleaned with a scraper. This is due to the fact that the cotton attached to the net is affected by many forces: frictional force, gravitational force, suction force, air forces pulling the cotton.

Under the influence of air force, the seed, which is larger than the diameter of the hole, sticks, and when the sucker is exposed, the fibers break and pass through the net.

When the suction current strength is higher than the fiber adhesion force to the seed, the fiber breaks and an event called “false madness” occurs. In this case, the fiber passes through the air and enters the dirt chamber.

The working efficiency of the separating elements can be achieved by using the process of inertial separation, in which case the contact of the cotton with the mesh surface would not be observed.

In order to maintain the range of motion of the air-carrying device and the quality of the cotton, a new design of the moving separator was also developed to prevent fiber loss.

Based on the results of theoretical research, a carrier device using inertial separator driven air was developed. This device (Fig. 2) is from the pipe (1), the separation chamber (2), the inclined pipe (3), the separator (4), the discharge pipe (5), the suction (6) and the outlet pipe (7) from the pipes and the fan (8). consists of.

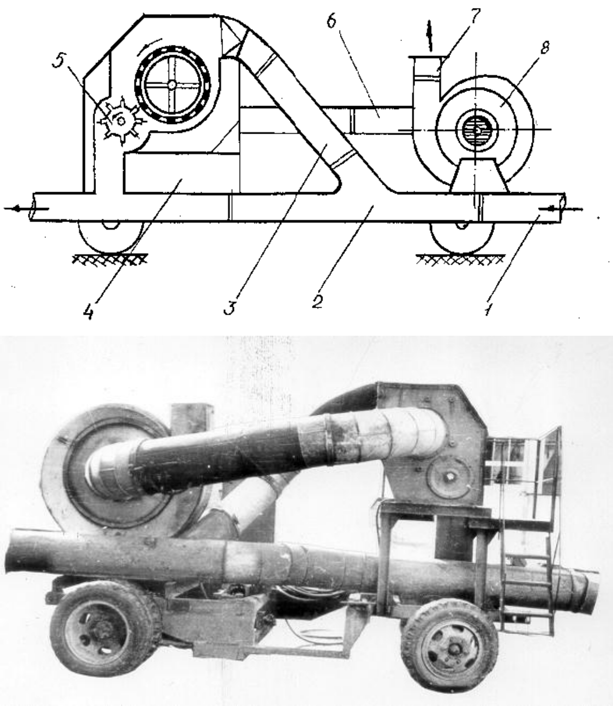


Figure 5. A moving device with a separation zone in a horizontal pipe

(1) pipe, (2) separation chambers, (3) inclined pipes, (4) separators, (5) discharge pipes, (6) suction pipes, (7) outlet pipes, (8) fans

The working process of this device is as follows. The cotton moving in the inlet pipe (1) comes to the inertial separation part (2) and is subjected to the suction air flow, continuing its linear motion. The main light part of the cotton comes to the separator through the inclined pipe (3) under the influence of air flow. There, cotton is separated from the air. The exhaust air exits the fan 8 through the outlet pipe (7) and the pieces coming out of the pipe (5) are joined with cotton wool separated from the previous air and transferred to the conveying device by means of the next air.

The use of an inertial separator allows the quality of the cotton to be maintained by separating it from the air without entering the separator. It also reduces the amount of cotton coming into the separator, making it easier to work with.

The used air separator passes through the mesh surface to the fan and is cleaned from there and released into the atmosphere. Examination of the new perevalka device showed that during separation, the main part of the cotton does not change its trajectory under the influence of large inertial forces and air flow, and passes to another process without any effect.

Only lightly fragmented cotton pieces (fine cotton pieces, dust and fine contaminants) enter the separator chamber with air. Pieces of cotton stuck to different surfaces of the separator are also removed by means of a squeegee, added to the main mass through a vacuum valve and transferred to the next process. By using a new device, the initial quality of cotton is fully preserved. Because the main part is not affected in any way. The production efficiency of the new device is high, and the addition of additional mobile carrying devices creates a normal transport process.

Comparing the two different moving devices, it was found expedient to apply it to the production of a conical mesh surface, given that a certain part of the cotton passes through the separator in the separation zone device. Therefore, it is proposed to install a cone-shaped drum-shaped moving device in the structure of the device, which carries out the transport process of cotton in the primary processing technology using air.

The results of theoretical research on solving the problem of transferring as little as possible of the cotton transferred from the bales to the processing process from the separator mounted on the moving device are presented.

According to this theory, it is proposed to pass through the separation zone when the cotton approaches the separator mounted on the moving device. It is based on the law of trying to maintain the linear direction of the cotton in a horizontally mounted pipe.

Therefore, the direction of the horizontal pipe in which the cotton was moving in the separation zone was maintained (Fig. 6).

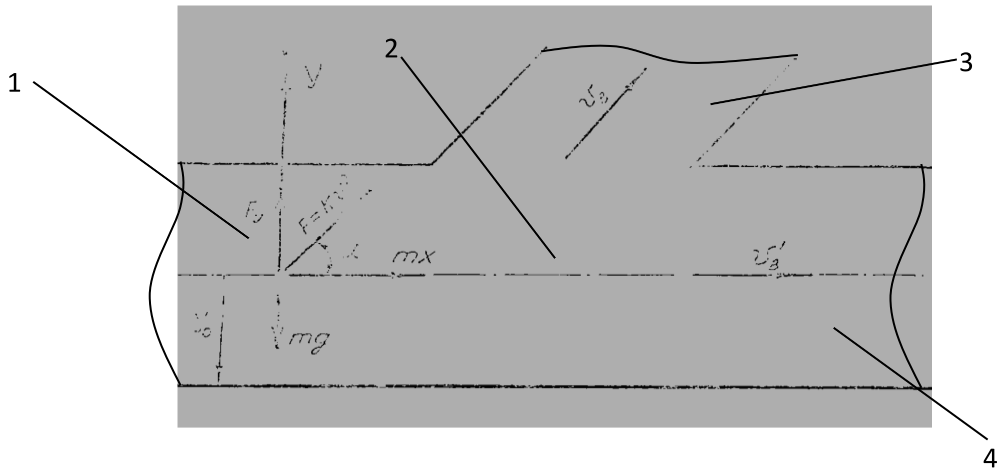


Figure 6. The movement of cotton in the separation zone of the horizontal pipe

(1) horizontal pipe to the separation zone; Separation zone (2); (3) oblique tubes; (4) horizontal pipe after separation zone.

The operation of the device shown in Figure 6 is as follows:

The cotton coming from the bales enters the separation zone 2 through the 1st horizontal pipe. Since the separation zone is divided into 3 tubes with a slope and 4 tubes with a horizontal position, the main part of the cotton moves correctly. A certain part goes to the separator through a sloping pipe. The separator separates the cotton from the air and throws it down through the mine.

The air sucked from the separator is blown into the horizontal pipe next to the separation chamber at high speed in the form of a nozzle. This allows the blown air to be transported a certain distance by combining the cotton entering the pipe and coming down from the mine.

Another advantage of such a system is that the small amount of cotton passing through the separator ensures that its mesh surface is always open. This allows the separator resistance to be reduced.

In this case, it is necessary to correctly choose the slope of the inclined pipe and find some dimensions of the separation zone, to determine the trajectories of the movement.

To solve the problem, an equilibrium equation is constructed for the position of the cotton in the separation zone.

$$\begin{aligned} m\ddot{x} &= C_x(V_b \cdot \cos\alpha + V_b' - \dot{x}) \\ m\ddot{y} &= C_y(V_b \cdot \sin\alpha - \dot{y}) - mg \end{aligned} \qquad (1)$$

with:

C_x - coefficient of resistance to air in front of the cotton;

C_y - three coefficients of cotton lifting;

V_b - air velocity in the inclined pipe;

V_b' - air velocity in the horizontal pipe;

V_x - horizontal speed of cotton;

V_y - the organizer of the speed of cotton in the vertical direction.

Integrating this differential equation, we obtain the following formula.

$$\begin{cases} x = (V_b \cos\alpha + V_b')t - \frac{m}{C_x}(V_b \cos\alpha + V_b' - V_b)\left(1 - e^{-\frac{C_e}{m}t}\right) \\ y = \left(V_b \sin\alpha - \frac{mg}{C_y}\right)\left[t - \frac{m}{C_y}\left(1 - e^{-\frac{C_e}{m}t}\right)\right] + y_0 \end{cases}$$

$$\left[t - \frac{m}{C_y}\left(1 - e^{\frac{C_y}{m}t}\right)\right] + y_0 \qquad (2)$$

Since the value of the second term of this system of equations is a small quantity, we do not take it into account. As a result, we can determine the trajectory of the movement of cotton in the separation zone using the remaining terms of the equation. Based on this, it was found that the condition of cotton in the separation zone is 3 different.

The first case:

$$F = V_b \sin\alpha - \frac{mg}{C_y} < 0 \quad \text{or} \quad V_b < \frac{mg}{C_y \sin\alpha} \qquad (3)$$

In this case, the value of the force driving the cotton in the separation zone cannot move the cotton. As a result, cotton accumulates in the lower part of the separation zone. This causes the cotton to become clogged and the air-carrying system to fail.

The second case:

$$F = V_b \sin\alpha - \frac{mg}{C_y} = 0 \quad \text{or} \quad V_b = \frac{mg}{C_y \sin\alpha} \qquad (4)$$

At the same time, the cotton is suspended in the separation zone, which allows it to move in a straight line. In this case, the cotton does not move towards the separator.

The third case:

$$F = V_b \sin\alpha - \frac{mg}{C_y} > 0 \quad \text{or} \quad V_b > \frac{mg}{C_y \sin\alpha} \qquad (5)$$

In this case, the cotton moves through the oblique tube to the separator. This prevents the cotton from moving horizontally along a straight line.

In order to carry out the separation of cotton from the air by the force of inertia, it is necessary to create condition 2. To do this, we will be able to determine the optimal values of the terms other than the equation, given that and and do not change.

$$\sin\alpha = \frac{mg}{C_y V_b} \qquad (6)$$

Using this equation, we complete Table 1 below.

Table 1. the velocity of the air in the inclined pipe.

V_b	20	24	28	32
$\sin\alpha$	25	30	35	40

Considering that more cotton moves at a speed of 24-28 m / s, it is advisable to prepare around the angle of inclination of $\alpha = 30 - 35^0$ the sloping pipe.

Thus, based on the results obtained, we were able to make some changes in the air carrier stroke, which in turn allows to reduce electricity consumption during the transportation of cotton and prevent deterioration of the quality of cotton.

2. CONCLUSION

1. Based on the analysis of research on the improvement of mobile devices, it was shown that cotton can be separated under the influence of inertial forces in the separation zone.
2. Theoretical research The equations representing the motion of cotton in the separation chamber of a moving device were constructed and the trajectories of motion were obtained by solving them.

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