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Analysis of Research on Improvement of Elements of Pneumatic Installations in Order to Reduce Damage to Cotton Seeds

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Abstract *— This article presents an analysis of a number of scientific studies on improving the process of transporting cotton in a pneumatic conveying device. Scientific research was mainly focused on maintaining the quality of transported cotton, reducing damage to seeds, energy consumption and dusty air emissions. When studying the stone trap process, it was found that since the stone trap separation chamber was installed opposite the descent chamber, the cotton quickly moved and hit the walls. As a result, the seeds were found to be damaged. Damage to the seeds was carried out by installing elastic elements in the working chambers of the stone trap and separators, which are the elements of the device after the pipe.*

Keywords — Pneumatic conveying device, seed damage, impact force, separator, separation chamber, working chamber, small contaminants, technological chain, pipe, mesh drum.

The first transportation device using pneumatic transport was used in 1893 by Dorfman to unload grain from ships. The efficiency of the device was small and consumed a lot of energy.

Despite this, it was widely used in Europe for unloading grain. Pneumatic conveying device for transportation has several advantages over mechanical conveyors. Advances in research have improved the transportation process using pneumatic conveying. As a result of the application of many technical solutions developed by scientists today, the technical and technological indicators of the pneumatic conveying device of raw cotton have improved significantly.

A number of scientific studies have been carried out to improve the process of transporting raw cotton by a pneumatic conveying device. Their main direction mainly consists in maintaining the quality of the transported raw cotton, reducing damage to seeds, energy consumption and the emission of dusty air into the atmosphere.

When transporting raw cotton in a suspended position in straight sections of the pipe, the seeds and fibers are not damaged and the surface wear process slows down. However, when transported at this speed, the inertia forces in the pipe shells increase sharply. Raw cotton hits the inner surface of the casing harder. As a result, speed is lost, and the stress at the point of impact increases. This leads to increased damage to the seeds and accelerate the destruction of the shell.

It was found that seed damage during stress decreases relatively with increasing angle of incidence.

These studies show that studying the stress process plays an important role in studying the damage to raw cotton in a pneumatic conveying device, and a number of studies have been conducted on this issue.

In these studies, the movement of raw cotton was considered in connection with the work processes of machinery and equipment for processing raw cotton. In the work, studies were conducted on the process of stress on pipes during transportation of seeds. A. Burkhanov [1] accepted the seed of raw cotton as a spherical body with a radius of 0.3 cm. Impact force, calculation of impact time, was demonstrated to scientists both theoretically and practically.

H. Akhmadhodzhaev, in order to reduce the damage to the seeds of raw cotton caused by the uneven movement of raw cotton in metal pipes, suggests replacing metal pipes with polymer pipes.

When raw cotton is transported in polymer pipes, its friction with work surfaces is reduced. And this reduces the damage to the raw cotton. That is, seed damage is reduced by 15-25%, the formation of technological defects in the fiber is reduced by 10-20% [2]. In this work, the effect of the geometric dimensions of the pipe on seed damage under various modes of transportation was studied. It was determined that the degree of damage to the seeds is affected by the radius of curvature of the pipe and the speed of transportation of cotton [3].

The authors believe that in order to reduce damage to the seeds, it is necessary to reduce the amount of the normal component of the impact force on the bent part of its pipe. The installation of a rubber coating on the work surface, where cotton can hit in the bent part of the pipe, reduces seed damage by 2-3 times [4].

Now we will get acquainted with the work on improving the elements of the pneumatic conveying device in order to reduce the damage to seeds.

The results of monitoring the process of transporting cotton using air showed that the raw materials are unevenly transmitted through pneumatic conveying pipes. As a result of this, cotton moves inside the pipe, accumulating in some places, and in some places it is rarely divided into certain pieces [5].

Failure to uniformly transfer the raw cotton to the pipe will lead to a deterioration in the operation of the elements of the pneumatic conveying device. As a result, the efficiency of the device for holding heavy cotton mixtures will decrease, damage to fiber and seeds will increase, clogging of separators on mesh surfaces will occur, the likelihood of fiber with heavy mixtures in stone traps will increase, and in the separator, the likelihood of fiber going to waste together with the exhaust air will increase. In addition, due to poor grinding of the raw cotton, the efficiency of the drying drums and cleaning machines is sharply reduced.

Today, suppliers in ginneries are not able to freely supply raw cotton. The main reason for the lack of high-performance machines that evenly deliver cotton to the pipes of the pneumatic conveying device is the lack of a scientific and theoretical framework that would fully characterize the interaction and movement of the cotton-air mixture during pneumatic conveying.

Accordingly, it is possible to choose the optimal mode of pneumatic transportation by studying the movement in the horizontal and vertical sections of the pipeline, taking into account the forces affecting the raw cotton during pneumatic transportation. Here, the opportunity arises to maintain the quality indicators of raw cotton, reducing the stress of raw cotton on the pipe wall.

The quality of products depends not only on the machinery and processing technologies, but also on the process of preparing raw cotton. During the collection and storage of raw cotton, various foreign bodies can be added to it. Studies show that they can make up 0.2-0.3 percent of the mass of raw cotton. This requires the introduction of devices that separate raw cotton from heavy mixtures during processing. Otherwise, stones and metal fragments fall into the working chambers of the gin, linter and cleaning machines, which negatively affects their uniform operation and design features of the working bodies, which as a result leads to a decrease in the efficiency of the equipment [6-8].

Despite the fact that the problem of improving the process of separating heavy mixtures from raw cotton is very important, until now there has not been developed equipment for collecting stones, which would be quite effective, making it possible to reduce damage to the seeds in the working chamber. Therefore, in the processing chain for processing raw cotton, several ineffective devices were installed that capture heavy mixtures, they cause loss of additional pressure, reduce production efficiency and the radius of the pneumatic conveying device.

The main disadvantages in the design of stone traps, its geometric and technological dimensions do not allow to completely retain heavy mixtures from the composition of raw materials.

When improving the pneumatic transportation process, first of all, it is necessary to take into account the preservation of the former natural properties of raw cotton. Indeed, deterioration in the quality of the raw cotton can also occur in the ventilated part of the device during transport. Therefore, a separator is installed - a device that separates raw cotton as part of a pneumatic conveying device. In the separator, the raw cotton is separated from the air by gravity and centrifugal force. In this regard, the separators are divided into volumetric, inertial and centrifugal types.

The design of existing separators is not sufficiently improved. They create high aerodynamic drag, which causes a loss of air pressure created by the fan. In addition, when separating raw cotton from air, this creates technological defects in the fiber, which leads to a deterioration in the quality of cotton. And through the openings of the mesh surface, the release of fibers with air is observed.

Despite the fact that a lot of research has been conducted to study the separation process, the processes of separating the raw cotton from the mesh surface and releasing it into the vacuum valve have not been fully studied.

For this reason, scientists and experts in the field of raw cotton cleaning have conducted research on the development of methods to reduce seed damage, improve the degree of cleaning of raw cotton without installing additional energy-intensive equipment in the current technological processes of raw cotton processing enterprises. In this case, first of all, the capabilities of the elements of the pneumatic conveying device for transporting raw cotton were effectively used. Examples of these elements are stone traps and separator devices.

The stone trap is designed to capture heavy mixtures in raw cotton. The raw cotton is transported by air in the horizontal part of the pipe and enters the separation chamber of the stone trap, which is installed at the transition point to the pipe in a vertical position.

Since the volume of the separation chamber is slightly larger, the speed of the raw cotton decreases and begins to rise toward the vertical pipe. The gravitational air force of the vertical part of the separation chamber is intended only for lifting the raw

cotton. For this reason, compositions that are relatively heavier than the raw cotton cannot rise up due to air, and fall under their own weight into the pocket of the stone trap.

When the working process of the stone trap is studied in detail, since its separation chamber is installed in front of the discharge pipe, the raw cotton moves by its inertia and strikes its wall with great force. As a result, the seeds are damaged, and this is further observed in the process of ginning, i.e., in the separation of fiber from the seeds of raw cotton. Since these defects are so tightly attached to the fiber, it cannot be separated from the fiber cleaner [9].

As a result, the spinning property of the fiber decreases, which leads to the formation of various nodes in the spun yarn, and the quality of the material obtained is reduced due to the formation of spots. In order to eliminate this drawback of the stone trap, it was proposed to install an elastic element in a place where raw cotton can be hit with a blow. This element is made in the form of a mesh drum and is mounted on an elastic base (Fig. 1).

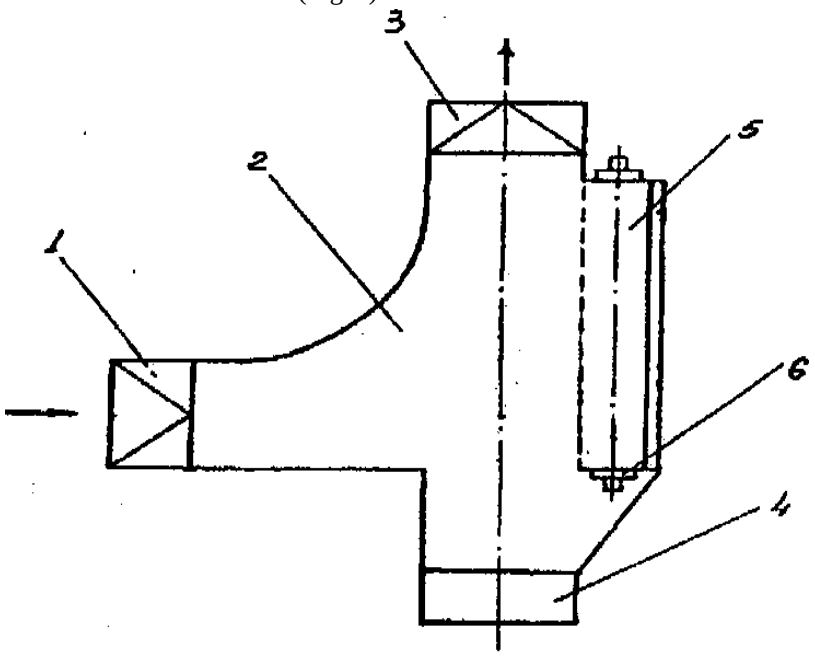

Figure 1. An advanced device for catching heavy premieres. APIAP02993
1 - premium pipe; 2 - a working chamber; 3 - outlet pipe;
4 - pocket; 5 - mesh drum; 6 - elastic base.

The place where raw cotton can be hit is made in the form of a mesh drum, which not only reduces damage to the seeds of raw cotton, but also separates small weed premieres from raw cotton.

Since the mesh drum is installed vertically, small weed premieres, separated from the raw cotton, fall into the pocket of the stone trap under the influence of its own gravity.

Such a change makes it possible to separate fine impurities from cotton without making small changes to the design of the stone trap. Along with this, the elastic installation of the mesh drum allows you to reduce damage to the seeds of the raw hopk.

The last element of the pneumatic conveying device is a separator. Its main function is to separate the raw cotton from the transporting air. This process is as follows. The raw cotton enters the separation chamber of the separator through the inlet pipe. Since the volume of the separation chamber is much larger, the speed of the raw cotton is reduced several times. Air is drawn in through the mesh surfaces mounted on the side of the separation chamber.

For this reason, 30% of the raw cotton entering the separation chamber moves toward this mesh surface. As a result, the raw cotton adheres to the mesh surface. Raw cotton cannot pass through holes in the mesh surface since the holes have a diameter of 6 mm. Air and small weeds are separated from the raw cotton and sent to the cyclone through the fan suction pipe. The cyclone cleans the air of small particles of dust and releases it into the atmosphere.

In the working chamber of the separator, the remaining mass of cotton, which does not adhere to the mesh surface, is its inertia and hits the wall in front of the inlet pipe. It is this stress, as well as the stone trap, that causes damage to the seeds. To

eliminate this drawback, both in the separator and in the stone trap, it was proposed to push through a certain distance on the wall of the separation chamber theoretically. As a result, this led to a reduction in impact force.

In addition, in order to increase the ability to separate small contaminants in the working chamber of the separator, it was proposed to establish a vibrating mesh surface. In addition to this change, a study was conducted to increase the number of holes in the circular mesh surface to separate more raw cotton from fine dirt in the separator.

As a result of this, if the mesh surface is installed in a conical shape, its usable surface may double in size, that is, the usable area may double. Such a change provides the greatest release of small contaminants from raw cotton. This change does not cause any changes in the design of the separator and does not lead to additional energy consumption. This only slightly changes the shape of the mesh surface. As a result of such changes, it becomes possible to isolate the largest amount of fine impurities from raw cotton, while reducing damage to the seeds during pneumatic transport of raw cotton.

The stationary transmission equipment available at the enterprises consists of SS-15A separator and centrifugal fans.

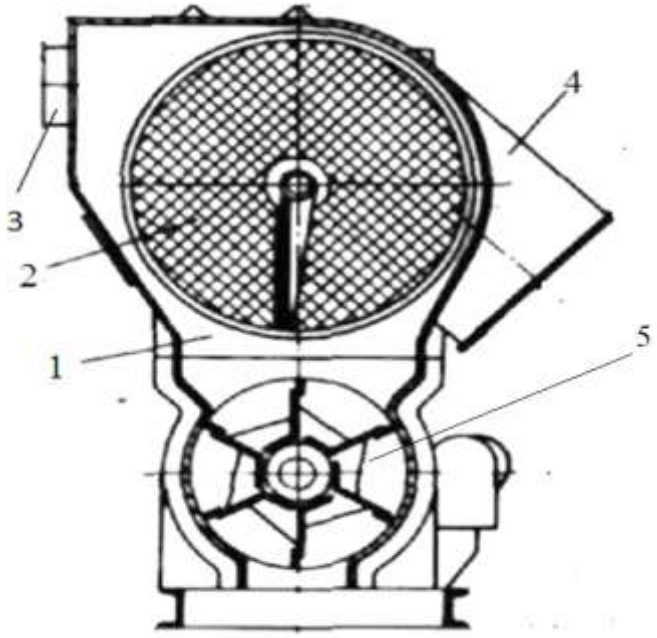

Figure 2. The SS-15A separator consists of the following parts.

1- chamber, 2- mesh surface, 3- inlet pipe, 4- outlet pipe, 5- vacuum-valve.

2-

The device for separating seed cotton from the air, invented by H.T.Akhmedkhodjaev, R.Murodov and S.D.Baltabaev, is shown in Figure 3.

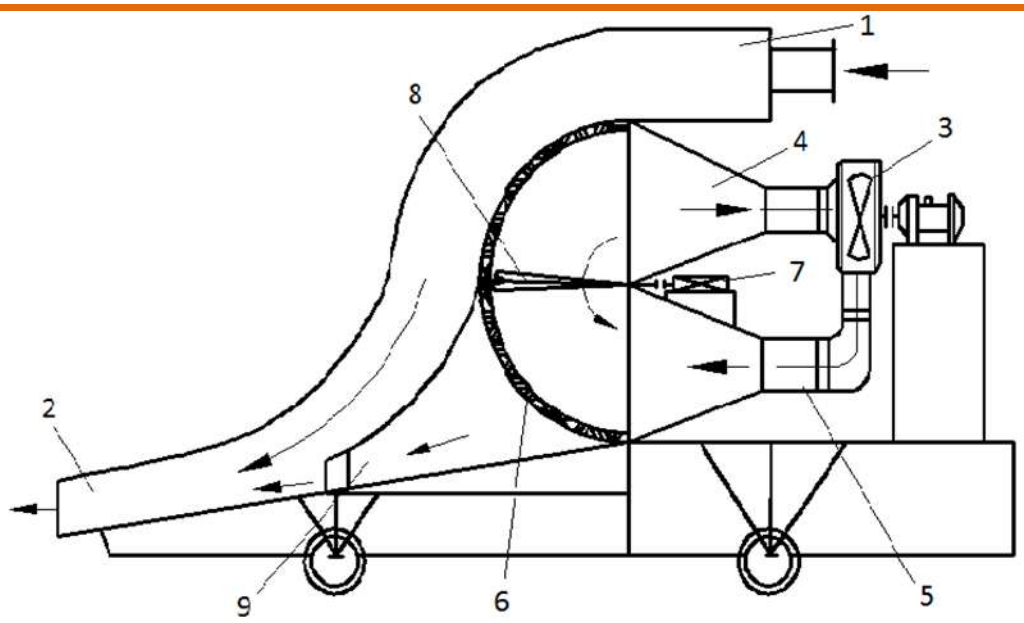

Figure 2 Construction of a stationary transmission device.

1- drive air and cotton inlet pipe; 2 - blower air and cotton outlet pipe; 3 - fan; 4 - inlet chamber of the sucked technical air to the fan; 5 - exit flow of technical air with pushing force from fan; 6 - spherical mesh surface; 7 - engine; 8 - barrier of incoming and outgoing bunkers; 9 - blower air flow outlet pipe.

The operation of this equipment is as follows:

The cotton coming in with the suction air flow enters through the inlet pipe 1 and as a result of the weight of the downward pushing air flow passing through the outlet, the pushing force is reached and exits the stationary transmission device through the outlet pipe 2.

The used air is sucked from the suction chamber 4 through the fan 3 and the blower air flow is prevented from entering the air through the spherical mesh surface 6 installed at the inlet and outlet of the technical air through the outlet pipe 5. The blower airflow is added to the outlet pipe 9 cotton stream to create a pushing force. The set is adjusted by 8.

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