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On Determining The Conditions For Effective Operation Of The Vacuum Valve Of Cotton Separators

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Akramjanov Dilmurod Muxtor o'g'li,
Assistant,
Namangan Institute of Engineering and Technology,
Namangan, Uzbekistan

Boltabayev Bekzod Egamberdiyevich,
Assistant,
Namangan Institute of Engineering and Technology,
Namangan, Uzbekistan

Khusanov Sadi Makhamatjonovich,
Base doctoral student,
Namangan institute of engineering and technology,
Uzbekistan, Namangan

Muradov Rustam Muradovich
Doctor of Sciences,
Namangan institute of engineering and technology,
Uzbekistan, Namangan

Abstract

The article analyzes the efficiency results for the improvement and production of the separator device of the vacuum valve of the separator, the dependence of the number of revolutions of the network drum on changes in cotton pollution and the dependence of the

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number of revolutions of the vacuum valve and conductivity on the air outlet from the cotton fiber.

Keywords: nozzle, mesh surface, vacuum valve, mesh drum, inlet pipe. separation chamber.

Introduction

At present, pneumatic transport equipment is widely used in ginneries for the delivery of seed cotton to processing technologies. This system consists of several devices, the main element of which is the separator device. The main function of the separator device is to separate the seeded cotton from the air flow after delivery to the destination by air flow. Today, there are many types of separator device and their design has been improved for several years. The most common of these and currently widely used in all ginneries is the SS-15 brand cotton separator [1]. However, this separator device has its own drawbacks, and they play a role in the process of separating cotton from the air stream. The most important of these shortcomings is the damage to the seeds as a result of high-speed impact on the working chamber of the seed cotton separator. Also, during the stripping process with the help of a cotton scraper attached to the mesh surface of the SS-15 separator, the fibers are damaged by the seeds, and the process of artificial insemination occurs as a result of air absorption of the cotton fiber from the mesh surface. In this process, under the influence of free fibers and small forces contained in the cotton fiber, a certain part of the fibers cut from the seed passes through the surface of the net [2]. In addition, the passive compounds in the cotton move erratically in the working chamber, joining the raw cotton and becoming active. This, in turn, makes the process of cleaning cotton difficult. To solve the above problems, it is possible to separate the raw cotton from the air stream and clean them under the influence of centrifugal force [3].

The main results and findings

At ginneries for transportation of raw cotton from storage facilities to production, as well as from one to another, suction-type pneumatic units are provided. Due to the fact that

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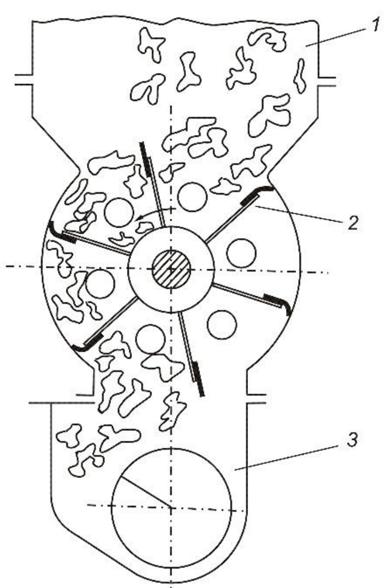
all elements of the pneumatic installation are under vacuum, outside air is sucked in through the slots and density. In places where the pressure difference outside and inside the installation is especially large, for example, in the network sections adjacent to the fan, it is most significant. As a result of air leaks, the power consumption of the installation increases and its reliability decreases due to the possibility of the separator bottom [4]. The reasons explaining the suction of a significant volume of air into the separator body can be identified by considering the principle and operating conditions of its vacuum valve [5].

The main purpose of the vacuum valve is to transfer material from places with lower pressure to places with higher pressure, and vice versa. The material coming from the separation chamber 1 (Fig. 1) sequentially fills the cells of the rotating paddle drum 2 and, moving downward with it under the action of its own mass and centrifugal force, is poured out of the cells onto the screw conveyor;



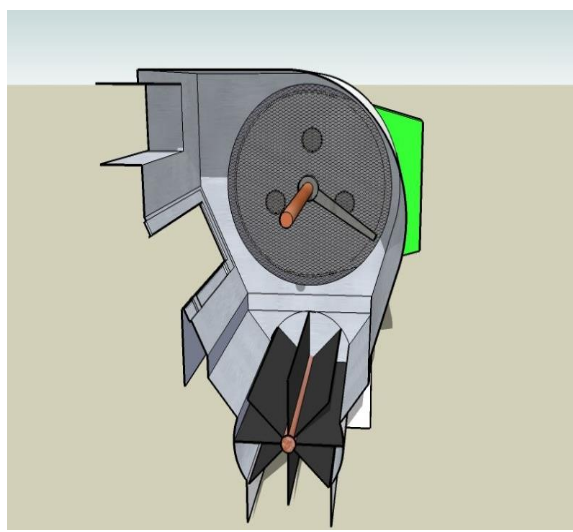


Fig. 1. Schematic diagram of the operation of the vacuum valve of the cotton separator

In the position shown in Fig. 1, cells-are under atmospheric pressure, cells v-vɪ are under

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vacuum equal to the vacuum in the separation chamber. Therefore, when cell III is suitable for loading, i.e. will move to position IV, the air in it enters the separation chamber and is directed to the fan. Consequently, even with ideal sealing of the vacuum valve, a significant pressure difference before and after it causes an inevitable overflow of air through it, the volume of which is proportional to the number of revolutions of the blade drum. As a result of this phenomenon, as well as due to wear of parts and often insufficient sealing of the end roof of the vacuum valve during manufacturing, the suction of air through it reaches 20-25% of the total volume moved by the fan. The increase in overhead power consumption is

$$\Delta N = \frac{(02 \div 0.25) * Q * Pv}{102 * \eta} \text{ кW} \qquad (1)$$

Where is the Q-fan performance, m/s;

Pv - total pressure, Pa.

The through put (performance) of the vacuum valves is determined by the formula

$$G\text{м} = q * \gamma\text{м} * \varphi * n \qquad (2)$$

Where is the q-volume of cells,;

γм- bulk weight (bulk density) of the material, kg /;

φ - cell filling factor

n-rotational speed of the paddle drum,

The filling factor of the cells depends on the type of bulk material and is inversely related to the rotational speed of the paddle drum. Therefore, the capacity of the vacuum valve increases with an increase in the frequency of rotation of the vane drum only up to a certain limit, and then falls due to a decrease in the filling factor. In addition, with an increase in the rotational speed, at which the maximum throughput of the vacuum valve is achieved, it is determined empirically for each specific type of material. According to the passport data, the rotational speed of the vane drum of the vacuum valve of the SS-15A

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separator is 92. We believe that it is unreasonably high and will detect this negatively affect the technical and economic performance of the pneumatic unit. Bottoms of the vacuum valve of the separator are most often the result of the negative effect of the outside air, which breaks into the chamber due to the indicated rotational speed of the blade drum and creates a counterflow that prevents the loss of individual raw cotton volatiles into the drum cells. The flywheels hover in the separation chamber before joining the separate lumps of raw cotton. For normal operation of the vacuum valve, the uniformity of the material supply is of great importance. When supplied in bulk, the material creates great resistance to the rotation of the vane drum, which leads to slaughter and sometimes to breakage of drive parts. It follows from the above that in order to increase the efficiency and economy of the separators, it is necessary to determine the optimal rotational speed of the vane drum of the vacuum valve. In order to reveal the effect of the rotational speed of the drum of the vacuum valve of the serial separator SS-15A on the air suction and the productivity of the material, we carried out research on an experimental pneumatic installation mounted in the laboratory of the building of the Kasansay Cotton Plant. The installation has an open circuit, in which the transporting air, passing through the working area, is emitted into the atmosphere, and the material is discharged by a vacuum valve into a special container. This scheme is convenient for measuring air and material flow rates. The tests were carried out at various operating modes installed with the help of throttle valves located at the inlet of the VTs-12M fan and at the site of the entrance to the working pipeline. The amount of air suction was determined as the difference between the air flow rates in front of the separator and behind it, measured simultaneously using a pneumometric tube and a micromanometer. The rotational speed of the vane drum was reduced from 92 to 60 min-1, replacing the electric motor of the vacuum valve drive with n = 1470 min-1 with an engine with n = 960 min-1 of the same power. To determine the amount of air suction through the vacuum valve, the amount of air entering through the separator body was determined. In this case, the paddle drum was not set in motion, and the outlet of the vacuum valve was tightly closed with sheet material using an elastic gasket. The absence of a noticeable increase in the air flow rate behind the separator testified to the good sealing of its body and seals in the hatches (inspection window); therefore, the values shown in Fig. 2 curves characterize

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the amount of air suction only through the vacuum valve. The results of the experiments showed that as the vacuum in front of the Pc separator increases, the suction of air through the vacuum valve increases. With a decrease in the rotational speed of the blade drum from 92 to 60 min-1, the volume of sucked in air decreased by an average of 30%. When operating under load, that is, when transporting raw cotton, the vacuum valve ensured reliable operation at a material capacity of up to 20 t / h more. In addition, noise and vibration were sharply reduced, and the power consumed by the vacuum valve decreased from 6.7 to 4.6 kW. The production check of the data obtained during the transportation of raw cotton of different moisture content was carried out on a mobile transshipment pneumatic installation to lengthen the radius of action of yard pneumatics at the Kasansay Cotton Plant. The separator was put into operation in December 2018. During this time the plant processed raw cotton of various grades and moisture content. In particular, the moisture content of grade IV raw processed in March 2019 was 28%.

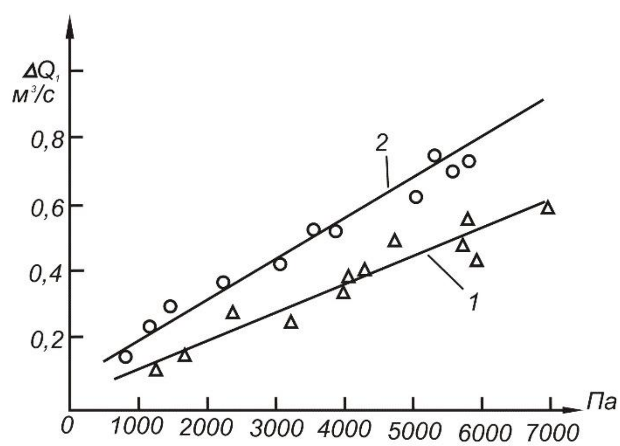

Fig. 2

Fig. 2. Curves of air suction through the vacuum valve depending on the vacuum in the separation chamber at the rotational speed of the vane drum 1-60 and 2-92.

However, during the operation of the transshipment plant, there were no violations in the operation of the peparator. Thus, tests in production conditions fully confirmed the results of theoretical and experimental studies. Reducing the rotational speed of the paddle drum

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of the cotton separator to 60 min-1 will reduce the amount of non-productive costs and reduce the unit costs of transporting raw cotton.

Conclusions

1. Differential equations of motion of cotton pieces along the vacuum valve were constructed.

2. A mathematical model was developed that represents the law of change of cotton pieces over time, moving in the working chamber of the separator and along the surface of the vacuum-valve blades. On the basis of the developed mathematical model, the optimal parameters were determined, which provide a reduction in the process of impact of cotton pieces on the mesh surface and a smooth discharge from the vacuum valve.

3. The law of change of dynamic compressive forces acting on the moving cotton pieces in the working chamber of the separator was determined, the optimal values of air mixtures and air velocity were found. The change in air velocities and air consumption entering and leaving the separating working chamber from the mesh surfaces was calculated by the cuts in the working chamber.

4. The author suggested increase in efficiency by moving cotton on the sloped net surface under the influence of its own weight. As a result, it will be possible to increase the time during which raw cotton stays on the net surface.

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