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Improvement of The Design and Substantiation of The Parameters of The Working Bodies and Drive Mechanisms of The Bitter Separator Machine

Djuraev Anvar Djuraevich, Ashurov Khisrav Khurshid o'g'li, O'rozov Akobir Abdunazar o'g'li, Abdiyev Bobur Kamol o'g'li, Nuriddinov Sur'at Zavqiddin o'g'li

Professor, Tashkent Institute of Textile and Light Industry, Uzbekistan
Assistant teacher of the department Mechanical engineering, Navoi state mining institute, Uzbekistan
Student of the department Mechanical engineering, Navoi state mining institute, Uzbekistan
Student of the department Mechanical engineering, Navoi state mining institute, Uzbekistan
Student of the department Mechanical engineering, Navoi state mining institute, Uzbekistan

ABSTRACT: The development of agriculture depends on the conditions for ensuring the quality and safety of the grown and manufactured products. To solve these problems, grain processing enterprises in particular, must have a well-equipped technical base, capable of ensuring high-quality separation of incoming cotton seeds without losses within a short period of time. The separation of cotton seeds has a key place not only in the processing process, but is also one of the main ways to increase the yield of grain crops, since the separation process contributes to the selection of the highest quality (physiologically ripe) seed. Working with cotton seeds is based on basic principles, which include progressive technology, continuous processing methods and automation of the production process. Post-harvest processing of cotton seeds should ensure the timely organization and timely implementation of all its stages while ensuring the minimum possible values of the energy and labor intensity of the process. The overwhelming number of separating machines used today in agriculture have a rather low productivity, since most of them use gravitational forces to clean cotton seeds. Every year, production requirements increase and require new, most energetically and technologically efficient separation methods, as well as the creation or modernization of existing separation machines with higher performance, quality and efficiency of separation of grain mixtures.

KEYWORDS: mathematical model, machine, knot, vibration, bitter separator, chain lengthening, motor, rotary motion.

I. INTRODUCTION

As you know, the process of separating cotton seeds, i.e. their separation into fractions, differing in the properties of particles, is one of the key technological operations in the processes of acceptance, storage and processing of cotton seeds.

At the enterprises of storage and processing of cotton seeds, flat-screen separation is most widely used. In flat sieve separation, along with the main features of separation, such as the size and shape of particles, the process is influenced (favored or hindered) by density, coefficient of friction and surface, etc. gravity when separating cotton seeds.

The most promising against the background of flat sieve machines are Bitter separators, which use the forces of inertia of rotation and vibration for intensive separation of the processed cotton seeds.

Thus, the use of vibration in the separation of cotton seeds is of considerable interest. For further, wider use of vibration-based cotton separators in agricultural enterprises, further research is needed on the vibration preparation technology, the design of the Bitter separator and their electric drive, which will significantly improve the quality of the technological process, increase the efficiency of separating cotton seeds and the service life of machines. For a complete understanding

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of the state of the issue, consider the design of grain cleaning separators, the most common at agricultural enterprises in our country.

II. METHODOLOGY

The bitter separator is designed to extract oil-bearing impurities from sunflower husks. The bitter separator consists of the following main units: frame, sieve drum, shaft with beaters, drum drive, shaft drive, side (inspection) covers, input husk gravity, output husk gravity. The frame is a welded channel structure. The sieve drum is mounted on rollers in the frame. The shaft with beaters (disintegrants in the form of blades) is fixed in bearings located on the end walls of the separator and placed inside the drum. The beaters on the shaft are installed at an angle to the shaft axis along a helical line, which ensures the advancement of sunflower husks along the sieve drums. Cleaning brushes are located on the sides of the sieve drum. The receiving device is a gravity flow. The productivity of the BS-500 bitter separator is up to 150 t / day for cotton seeds.

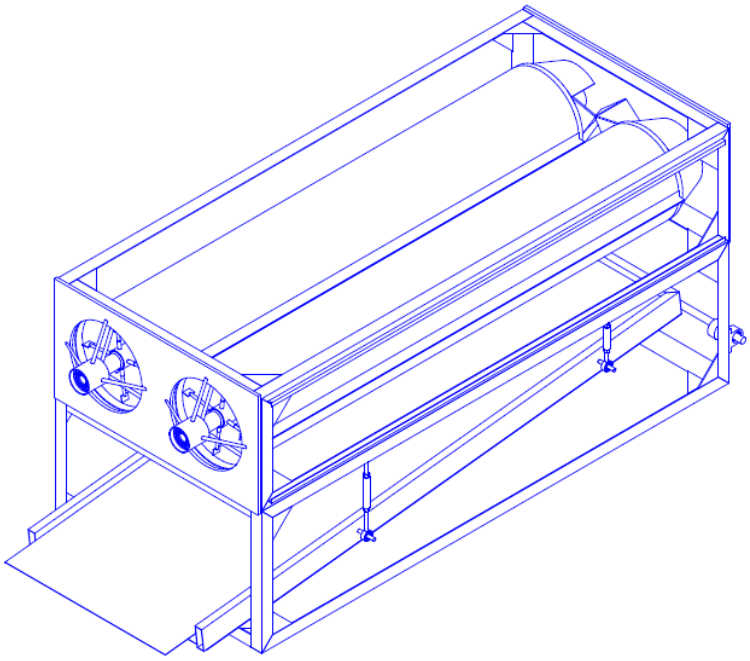

Fig. 1. General view of the bitter separator.

The kinematic characteristic makes it possible to trace the sequence of transmission of motion from the engine to the working bodies of the machine. Usually the kinematic characteristic is shown as a kinematic diagram.

Increasing the speed of rotation of the sieve drum increases the centrifugal forces, which press the cotton mass against the surface of the drum. Consequently, the friction force of the layers of the seed mixture against the surface of the sieves and with each other increases, which sharply reduces the speed of layer-by-layer movement of seeds and productivity, increases the trauma of the particles of cotton seeds, but at the same time the separation efficiency increases. Thus, an increase in the rotation speed of the sieve drum increases the screening rate, however, the particles of cotton seeds also need to surpass the resulting frictional forces. For this, various methods are used, for example, additional blowing is used with the help of an air flow, axial or rotational vibrations are imparted to the sieve drum. It is possible to use these methods together.

These methods are used in grain bitters separators. Compared to the separation of cotton seeds using gravitational forces (in flat sieve machines), the communication to the separator's working bodies of oscillatory movements along the axis of rotation made it possible to significantly increase the productivity and efficiency of the separation process.

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III. SYSTEM ANALYSIS

Bitter separators, in comparison with flat-sash separators, have significant advantages in view of the fact that:
- vibration of the working bodies allows to reduce the forces of friction and adhesion between the particles of the seeds. This increases their mobility (cotton seeds begin to behave like a liquid) and makes it possible to increase the degree of sifting of cotton seeds through the openings of the sieve. For example, the sowing rate of some leguminous crops increases up to six times;
- vibration contributes to a better process of redistribution of cotton seeds in the layer and over the sieve surface, which significantly increases the separation efficiency;
- vibrations of the working body with certain values of the amplitude and frequency, together with the rotational movement, contributes to an increase in the separation efficiency, which is relevant for the separation of difficult-to-separate mixtures;
- at high productivity, they have a small sieve area, less metal and energy-intensive. For example, a vibrating separator, in comparison with a flat sieve machine, has a metal consumption of up to 7, energy consumption - up to 13, and operating costs - 3 times.

Modern designs of Bitter separators differ from each other in the location of the working body, the direction of its vibrations, as well as in the design of the vibration exciter. In Bitter separators, the oscillatory movement of the working body is communicated in most cases from an eccentric or crank mechanism.

The separator is loaded using a hopper. The working body (drum) is rigidly fixed on the separator, which has triple perforation of sieves, scrapers and mounted on two bearings in the housing, which is connected with the sliders sliding along the guide rollers by means of brackets. The rolling bearings are joined with a nut. Spacer rings are located inside the conical working body. The guide vanes are mounted on the rod. With the help of a belt transmission, the conical drum and pulley are given a rotational movement around their generatrix, and the oscillatory movement is realized using a connecting rod of the crank mechanism (not shown in the diagram), which is installed and fixed on the housing cover.

The parts of the Bitter Separator machine in its previous state consisted only of engines. Based on the calculations, the machine parts were replaced with chain drives and made to be driven by a single motor and a single reducer. The modified parameter machine was vibrodiagnostics it using VibXpert II device from different parts. The obtained results were studied and the following results were obtained.

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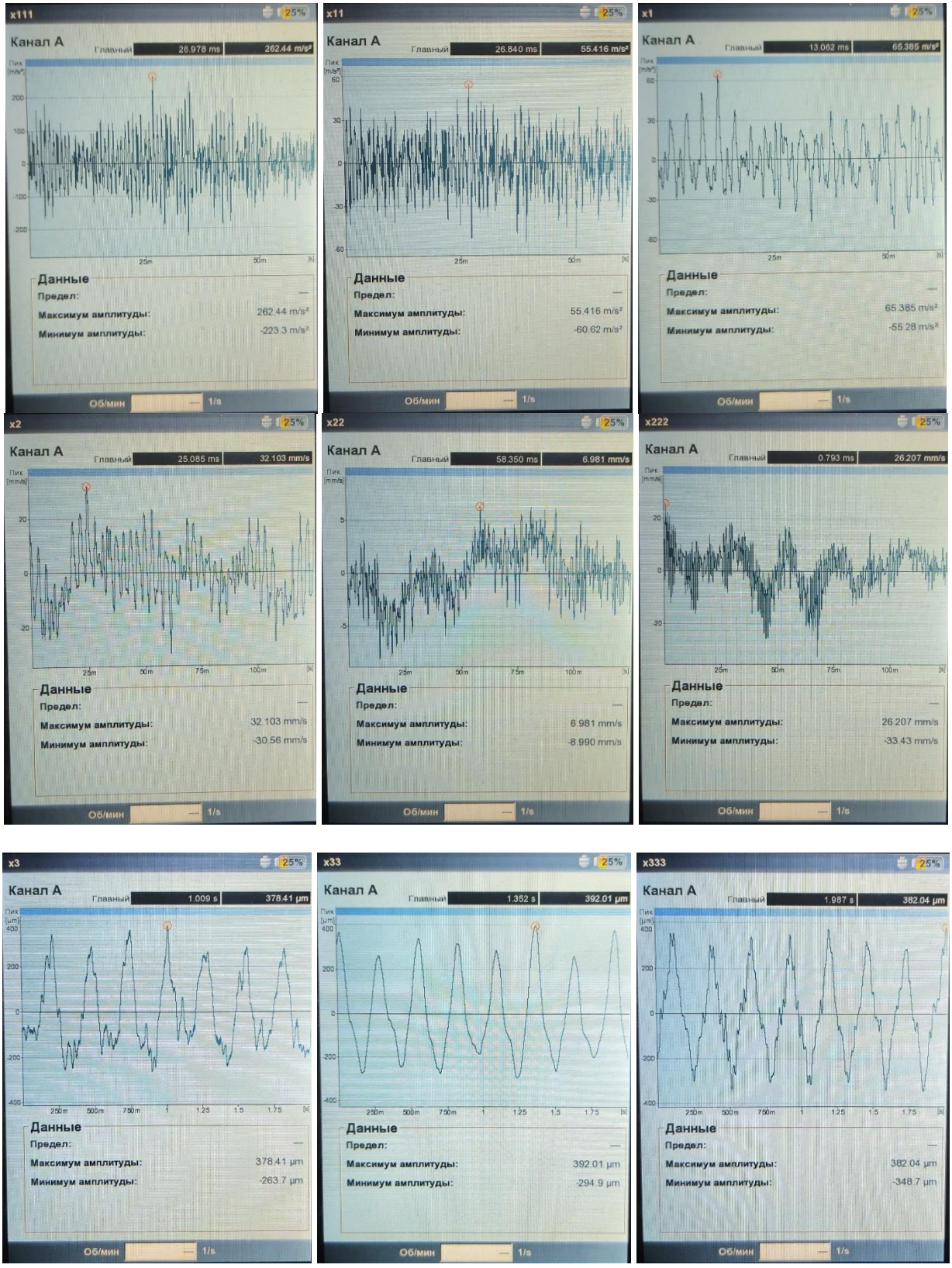

Fig. 2. Results obtained on VibXpert II.

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In experimental studies, the values of the average speeds of movement of cotton seeds along the generating surface of the sieves were obtained. As a result of research, a law has been obtained that makes it possible to clarify the construction of a generator, which differs significantly from a parabola. From the obtained conditions for the intensity of sifting cotton seeds through the sieve holes, the relationship between the geometric parameters of the working body and the kinematic parameters is shown.

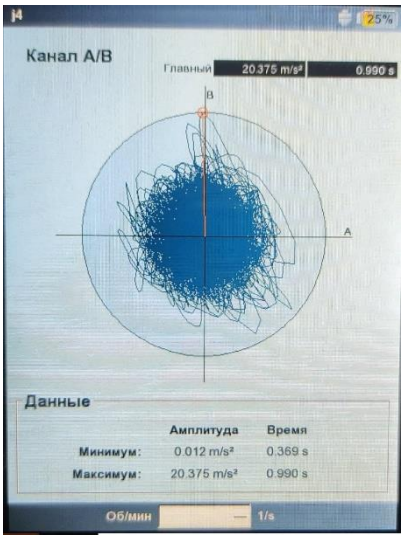

Fig. 3. Orbital analysis using VibXpert II.

The tests of the Bitter separator were carried out, the working body of which performs transverse and longitudinal vibrations. It was found that the communication to the sieve of longitudinal vibrations to a greater extent affects the increase in the separation efficiency than the communication of transverse ones, and further studies were carried out on a setup with vibrations of the working body along its generatrix. In the course of the research, it was found that giving the sieve vibration motion significantly reduces the separation time, but the vibration amplitude cannot be less than a certain value, and compensation by the vibration frequency is possible only within the optimal process speed.

With a constant range (amplitude) of the oscillatory movement, it significantly affects the efficiency of separating cotton seeds. As can be seen from the analysis, Bitter separators are the most productive, technologically and energy efficient and the most promising for further use at agricultural enterprises that handle and store seeds.

Further improvement of the technology for preparing seed material based on vibration, the design of Bitter separators and their electric drive, which will significantly increase the efficiency of the technological process and increase the durability of the machines.

In the cases discussed above, eccentric, crank and crank and crank mechanisms are used. It is also possible to use pneumatic and hydraulic vibrators. However, they have certain disadvantages that limit their use. The use of a hydraulic drive to obtain the oscillatory movement of the working body of the separator is limited by the following main disadvantages:

- the high dependence of the viscosity of the fluids used in the hydraulic drive on temperature, leads to a change in its performance and creates additional difficulties in operation;
- leakage of the working fluid from the system, reduces the efficiency of the drive, causes non-uniformity of movement and complicates the achievement of a stable speed of movement of the working body at low speeds.
- since oil is mainly used as a working fluid, which is an aggressive medium, its contact with agricultural products is unacceptable, which significantly limits its use.
- also the hydraulic drive has a rather complex design, consisting of a large number of parts, made according to a high class of accuracy, which entails its high cost.
- high degree of fire and explosion hazard of hydraulic oils;
- the energy of the hydraulic drive cannot be transmitted over long distances, this is due to the large hydraulic resistance of the system. This factor is due to the low efficiency. A pneumatic drive, in comparison with a hydraulic drive, looks more preferable, however, it also has the following disadvantages:
- heating and cooling of the working gas in the process of compression and expansion leads to the possibility of freezing of pneumatic systems;
- high cost of energy in comparison with electricity;

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- low efficiency than a hydraulic drive;
- low accuracy of operation and smooth running. Seed bitter separators are characterized by the absence of an elastic connection between the working body and the base, the presence of a rigid connection between the support of the foundation frame and the working body. Therefore, it is advisable to use eccentric or crank vibrators.

In such drives for oscillatory motion, the working body is pivotally connected to the connecting rod without elastic connection. Thus, the oscillating system of these separators is quite simple.

In this case, the vibration amplitude of the working body remains constant over the entire operating frequency range, therefore, such a drive requires special expensive measures to ensure start-up. The existing design schemes of oscillatory drives with kinematic excitation of oscillations of the working body have the following disadvantages:

- the presence of rigid kinematic connections in the drive, due to the need to use converters of the rotary motion of the drive motor shaft into the oscillatory motion of the working body;
- transfer of significant dynamic loads to the cage body and frame, which affects the fatigue strength and reduces the service life of the machine;
- the presence of a large number of rubbing and wearing surfaces (operating time between service intervals is 180 hours);
- impossibility of smooth regulation of the vibration amplitude of the working body. In existing designs of Bitter separators, the vibration amplitude of the sieves is regulated stepwise, for example, by changing the rollers of the eccentric mechanism (copier), or by changing the length of the connecting rod during the machine stops. This process has a high labor intensity, requires stopping the technological process, disassembling the vibration drive and leads to additional equipment downtime. In this case, electromagnetic vibrators look most preferable. In them, the oscillatory movement is carried out without the use of converters of the type of movement. However, oscillatory motion drives based on electromagnets have some disadvantages:
- make a lot of noise during operation;
- require very careful adjustment, since during operation they are prone to longitudinal and lateral rolling, which requires additional time and leads to equipment downtime;
- when the load on the working body changes, the oscillation amplitude deviates from the set value, which leads to disruption of the technological process;
- they do not have the ability to provide an amplitude of oscillation of more than 0.01 m, which significantly limits the performance of installations based on them;
- the performance of grain cleaning machines with electromagnetic vibrators depends significantly on the supply voltage.

IV. RESULTS

The use of linear induction motors in the oscillatory motion drive makes it possible to create technological machines that will have a completely different design layout, have high reliability, while having low operating costs.

1. The analysis of the main cleaning machines for cotton seeds used at enterprises engaged in the processing of cotton seeds (Bitter-separator) has been carried out. It was revealed that the Bitter-separator, according to its technological parameters, is the most effective for cleaning cotton seeds.
2. The analysis of possible drives of oscillatory motion of cleaning plants for cotton seeds is carried out, from which it can be seen that a promising direction in the development of electric drive of oscillatory motion is the creation of electromechanical systems based on linear asynchronous motors, a distinctive feature of which is the use of the working body of the machine as a rotor. In this case, the efficiency is the engine is equal to the efficiency drive, which is not done in other drives.

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