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Experimental studies of the cotton seed pubescence measuring transducer in the process control system

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ABSTRACT: This article deals with the technological process of linting when it is subjected to a series of sequential operations, which ultimately affect the indicators characterizing both the qualitative and quantitative yield of the finished product. The goal of the work is to increase the efficiency of the production process of linted cotton seeds, which consists in reducing the yield of substandard cotton seeds and reducing the consumption of energy and natural resources, by including a local automatic control system (ACS) for linting in the process control system of the gin-linter workshop .

I. INTRODUCTION

Experience has shown that the design features of existing technological machines, such as gins or linters, do not allow for precise adjustments that allow the battery of linters or linters to operate with a given amount of fiber or linter removal from seeds. Therefore, this leads to the production of substandard fiber, lint and seeds .

An analysis of existing methods for monitoring the main quality indicators directly in the technological process shows the need for their further improvement. Known control methods are either inaccurate or very time consuming. The main disadvantage of existing methods for controlling seed hairiness is the impossibility of using them in a continuous technological process, which leads to large losses of products.

II. METHOD OF RESEARCH

Obtaining a high-quality, complete product, which determines the choice of a rational operating mode for machines, is associated with maintaining a given value of seed hairiness after ginning or after linting . To take appropriate measures to control a technological machine, it is necessary to have a characteristic of the transient process of automation equipment. An analysis of technological process research shows that the gin or linter itself ensures the required quality of the resulting product, but when its operation deviates from the specified mode, the dynamic characteristics of transient processes must be taken into account.

Considering the pneumomechanical principle of operation of technological equipment, the last factor is very important. The study of the aerodynamic operating mode of the battery gin - fiber cleaner - fiber outlet - fiber condenser made it possible to establish the time of transient processes in the system: when starting the ginning process - 3 s, when stopping the ginning process - 1.6 s, Taking into account the pneumomechanical principle of operation of the technological equipment, the last factor and shaking of the working chambers - 1 s, between fiber cleaners - 0.2 s, between the condenser and the fiber cleaner closest to it - 0.33 s. Maintaining a certain value of aerodynamic parameters is important both in the shaft of fiber cleaners to stabilize the fiber cleaning process, and at the entrance to the condenser to ensure conditions for transporting fiber in the fiber outlet and the process of its separation in the condenser. The uninterrupted operation of the condenser depends on its aerodynamic mode, a significant deviation from which leads to the blockage of the installation

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by fiber and the transition of all electrical equipment to idling. Practice shows that 7% of process equipment downtime is associated with the operation of the pneumatic conveying system. The use of an effective express instrumental method for monitoring the quality indicators of seeds with further automation of the technological process is an urgent scientific and technical task for this industry [3].
Thus, the scientific research carried out covered the analysis of scientific works in the direction of improving technical means of automation and control to increase the efficiency of functioning of energy-saving electrical technological installations.

Previous research conducted to study the technological process of ginning and linting of cotton seeds, an assessment of their shortcomings and the possibility of using automation tools made it possible to specifically formulate the research problem and make assumptions about the possibility of solving it:
-research of technological processes for processing raw cotton in order to create a continuous automated production line;

-study of the dynamics of the transition process when establishing a rational mode in the control system for the technological process of seed processing at the linting stage ;

hairiness measuring transducer in the process flow control system;

- analysis of experimental results and selection of a rational operating mode for the linting technological process .
As is known , in addition to cotton fiber, valuable products of cotton production are linters and seeds, the quality of which mainly depends on the linting process . Currently, the linting process is partially automated and operating modes are set depending on the source material and the results of control of the finished product - linters and seeds. The main indicator of the quality of these products is linter removal, which is defined as the difference between the initial and final hairiness of cotton seeds during each linting . Therefore, the most important requirement for a regulated linting process is accurate and timely control of the hairiness of cotton seeds and appropriate regulation of the operating mode of the technological machine [1, 2]

III. ANALYSIS AND RESULTS

To solve the problems , theoretical and experimental studies of the technological processes of ginning and linting were carried out from the point of view of using a seed hairiness measuring transducer in a continuous technological process.

Scientific The novelty of this work is the development of a technological scheme and technical means of a continuous production line for automatic control of the quality indicators of cotton seeds and fiber to increase efficiency functioning of energy-saving electrical technological installations in the system of primary cotton processing.
The objects of study were technological machines of a continuous electrotechnological line such as a pneumatic conveying unit, a gin and a linter, as well as technical means of automatic control of cotton seeds. Theoretical and experimental studies were carried out on the basis of the theory of particle motion and the theory of automatic control . Experimental studies were carried out at the department " Automation and control of technological processes and production ", With using modern recording and measuring equipment, an information converter for seed pubescence , static processing methods, and computer technology.

Thus, attempts made by many researchers to establish the absolute value of seed pubescence in a continuous flow have not yet yielded positive results. However, the study of the question posed allowed us to conclude that in order to receive a signal about a change in pubescence, it is not necessary to have an absolute value, but rather it is enough to record deviations of the process from a given value in order to take appropriate measures to control the process, i.e. determine the relative magnitude of the deviation. They may concern changes in the conditions for changes in the position of the seed comb or the direction of movement of the seeds after leaving the linter. The latter is achieved by separating the flow of technical seeds from sowing ones.

Based on these conditions, a special device was proposed [4, 5 6], which provided a signal to control the linting process (Fig. 1.). The fundamental difference between this method of hairiness control and the currently used organoleptic one is that control is carried out not by one-time removal of a sample from the flow, but continuously in the flow by determining the relative weighted average signal value related to the reference value, i.e. the result of the comparison represents the degree of deviation of the pubescence of the controlled sample from that specified by the standard, its illumination with light from the visible spectrum, and the measurement of reflectivity by comparing the controlled

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samples with the standard. The sampling operation is carried out in a continuous technological process and at the same time the reflectivity is measured instrumentally and is combined with a standard, which has a known pubescence . As a result, a relative weighted average value is obtained .

Thus, the method used in the work provides for the organization of a new method of monitoring the operation of a technological machine according to the degree of pubescence of cotton seeds in a continuous process , which is sufficient to establish a regulated operating mode of the machine [6]. The new method is carried out as follows.

Information about the degree of furring is obtained from the result of the ratio of weighted average signals from photosensors, which is removed from the comparing device in the form of the voltage ratio E o /E 0 , which makes it possible to obtain a signal characterizing the occurrence of a deviation of the process from the established one in the form of voltage and use it for control over the process of linting and building a control system for mechanization tools that normalize the production of sowing seeds.

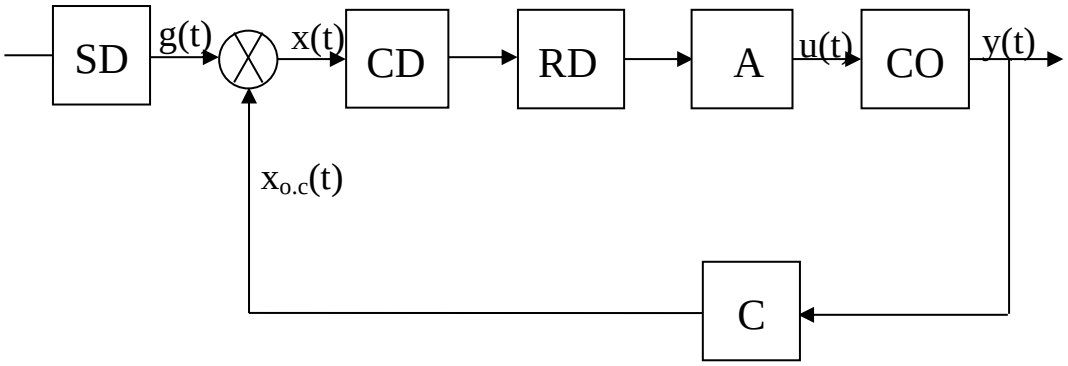

Figure 1. Functional block diagram of the automatic control system

SD – setting device, CD – converter device, RD – regulating device, A – actuator, CO – control object (linter), P – converter.

Thus, an analysis of methods for monitoring the degree of hairiness shows that for a qualitative assessment of the degree of hairiness in a continuous technological process, it is advisable to use the photometric method.

The developed and tested hairiness converter for cotton seeds makes it possible to build a closed-loop automatic control system of continuous operation from this parameter in the seed flow. Without touching on the internal structure of the feedback element, such an ACS can be represented as shown in (Fig. 1).

It should be noted that since we can specify the ratio both in the form Q_{to} / Q_e and the inverse ratio Q_e / Q_k, where Q_e – hairiness of the seeds of the reference sample; Q k is the hairiness of the seeds of the controlled sample, then the system can acquire different properties and belong to different types of automatic control systems. Then the block diagram shown in (Fig. 1) is converted to the block diagram presented in (Fig. 2).

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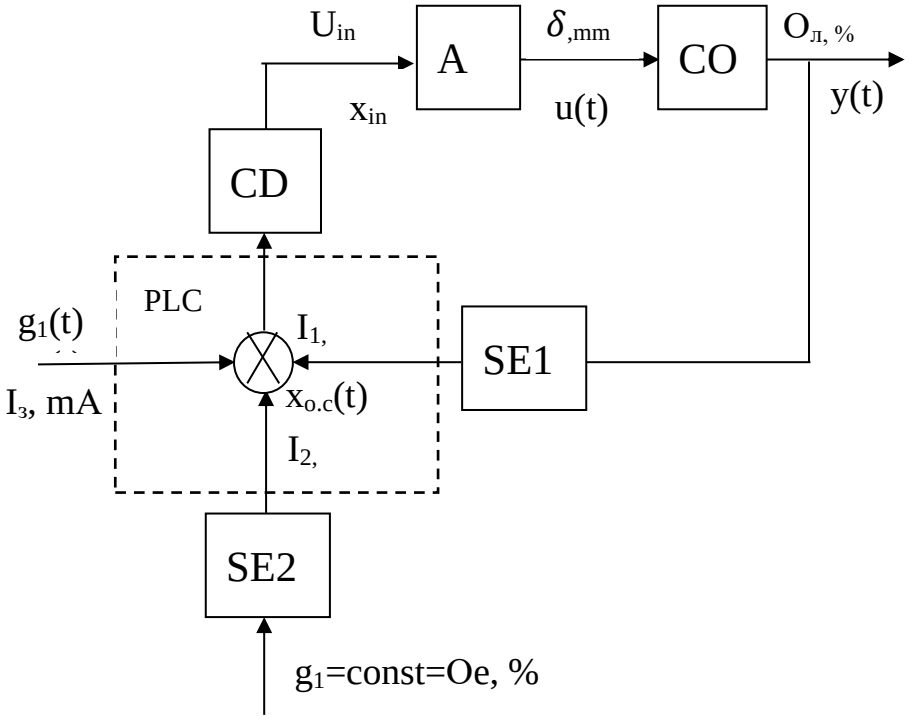

Figure 2. Converted functional block diagram

In the first case, the resulting system is an ordinary linear system, since the remaining links are also linear. In the second case, division is made by a variable value, and the system becomes nonlinear. In this case, it is necessary to decide whether the nonlinearity in the system is significant or insignificant.

This depends on whether the latter is used to impart special properties to the automatic control system (including for correction) or not, and the next task appears - research into controllability and observability.

From the point of view of quality management of the linting process , automation is one of the potentially possible actions to improve the quality of both technical and seed cotton seeds. Quality control - hairiness of treated seeds, as shown in [3], is most promising to be carried out using the optical method. Studies of the optical properties of cotton seeds have revealed many factors that influence the reflectivity of bare cotton seeds when monitored photometrically. On this basis, studies were carried out using a photometric sensor, which makes it possible to determine the hairiness of cotton seeds in a continuous technological process. But for this it is necessary to classify the linter as a control object according to the principle of distribution of output coordinate parameters, i.e. pubescence . Or you can pose the problem of how to form a controlled sample of seeds in a technological flow and solve it in terms of whether it is possible to use the representation of a linter as an object with distributed or lumped parameters.

During a given time interval, the mass of seeds passing through the linter has the most significant influence on the process. But the hairiness of the emerging seeds is a variable value, since due to the dullness of the saw blades of the saw cylinder, their gripping and scraping abilities are reduced. However, discrete changes in the amount of pubescence do not give the required result, since it allows one to judge only the quality of already processed seeds.

Measurements of a continuously changing quantity require continuous automatic monitoring, which can indicate the nature of the change in the hairiness of the treated seeds directly on the stream.

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To determine the class of the control object and, as a consequence, the installation location for hairiness control , directly in the process flow, a series of experiments were carried out on the distribution of the mass of incoming seeds along the length of the linter tray.

Experiments were carried out in the gin and linter workshop of the Jizzakh cotton plant. To obtain reliable information, the first three linters were selected, differing from the rest in the most stable nutrition.
The length of each linter was divided into five equal sections of 330 mm each. Sampling was carried out within 10 seconds with a specially made tray, the length of which corresponded to the length of the linter, and the size of the cells corresponded to the length of the linter sections, which made it possible to simultaneously monitor the seeds along the entire length of the linter.

The sample weight was monitored in six repetitions with an interval of 30 minutes. Weighing of samples was carried out on scales with an accuracy of 1 kg.
Based on the data obtained, diagrams were constructed for measuring the mass of incoming seeds in different areas of the linter (Fig. 3) .

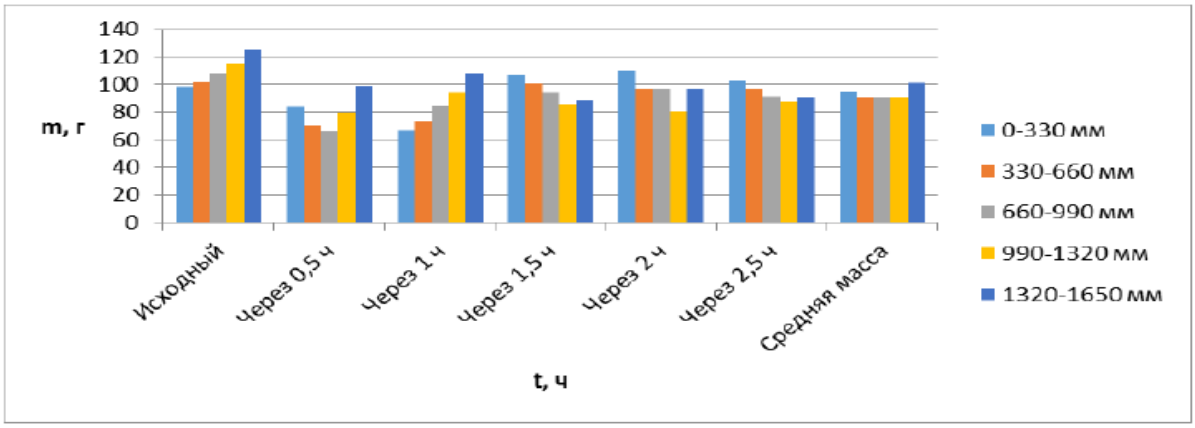

Figure 3. Diagram of changes in seed yield in different areas of the 1st linter

IV. CONCLUSION

From the results obtained it follows that the mass and pubescence of seeds falling out of the linters are randomly distributed along its length and control can be carried out using an average sample of seeds with the installation of a sensor at any site .
The proposed method and information converter for determining the degree of hairiness of cottonseed seeds makes it possible to develop a technological scheme and technical means for a continuous production line for automatic control of the quality indicators of cotton seeds and fiber.
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