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STAGES OF AUTOMATION OF GRAIN PROCESSING

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Abstract

"The article is the result of a logical continuation of a previously conducted study dedicated to the automation system of grain processing and the practical applicability of statistical methods for assessing the conformity of the produced products. The options for applying the stages of automation of grain processing in technological process management are analyzed. The article discusses problems associated with the application of the automation system for grain processing, which demonstrate significant improvement in the production process and productivity, and conclusions are drawn that automation of grain processing is a necessary step to improve productivity, quality, and production efficiency."

Keywords: automation, grain products, management, technological process, production process control, stages of automation of grain processing.

Grain processing is one of the most important branches of the food industry. Modern technologies and automation methods allow for a significant increase in the efficiency and quality of the production process.

The introduction of automation in the production processes of grain processing is a complex of measures aimed at automating and optimizing various stages of production. This can include automatic control and regulation of production parameters, the use of modern equipment, and the application of software and technologies.

By its nature, an automated control system at a grain storage and processing enterprise is a technical basis. It is used to account for the quantity of raw materials and to control the precise execution of the specified regulations for the use of raw materials to create the final product. Such strict control leads to a reduction in possible errors in the management of the production process, which can result in emergency situations, downtime due to a lack or untimely supply of raw materials to the production line, and so on. Also, by strictly following regulations, 100% coincidence of the production of mixtures according to the prescribed recipe is achieved. This improves the quality of the final product and reduces costs [1-4].

The goal of introducing automation is to improve the quality of the product, improve control over the production process, reduce energy costs, and reduce the amount of necessary labor [5-8].

This article examines the main stages of automation in grain processing, as well as the advantages and disadvantages of using automation in this industry.

Materials and Methods

The final products of grain processing include various products such as flour, groats, animal feed, alcohol, beer, and others. The process of grain processing can be quite laborious and time-consuming. The choice of method and management of the technological process of raw material processing is one of the main problems faced by grain processing companies.

A significant amount of primary sources of information are used in automatic and automated measurement of technological parameters of the process of heat and moisture treatment of bulk grain materials. However, often the results of such measurements cannot be applied in the management of the technological process due to unresolved errors, which are the cause of unreliable information. This necessitates the correction of such errors by eliminating the random and systematic components of the errors. The elimination of random error in the measurement results of technological parameters is successfully achieved through the use of various types of threshold, permissible algorithms and statistical methods [9-10].

The research material consisted of the results of scientific and practical achievements in the field of statistical quality control and the implementation of statistical methods, which can be presented in the format where high-level complex methods were applied, including cluster analysis methods, multifactor (dispersion) analysis, operations research methods, as well as special methods used in the development of technical control operations and experiment planning.

Stages of automation in the processing of grain products

Let's consider options for using automation in managing the technological stages of processing grain products [11-13]. The hierarchical structure of the system under consideration is presented in Fig. 1.

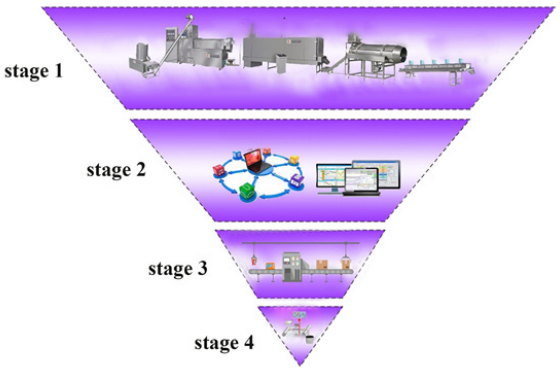

Figure 1. Stages of automation of production processes.

The first stage of automation is partial automation using various mechanization mechanisms. Mechanization includes the use of various mechanisms such as conveyors, separators, cleaners, and other mechanisms that allow the grain processing process to be automated. This significantly reduces processing time, reduces labor costs, and increases productivity.

The second stage is the automation of the management process. With the help of automation of the management process, it is possible to manage the entire process of processing grain products. This includes automation of temperature management, humidity, and other parameters of the grain processing process. This allows achieving high product quality and increasing efficiency.

The third stage of automation is the automation of the packaging and storage process. Automation of the packaging and storage process allows reducing the time for packaging and storing products, as well as increasing productivity. Automatic packaging, transportation, and storage systems are used for this purpose.

The fourth stage is the automation of the monitoring and quality control process. Automation of the monitoring and

quality control process allows automatically controlling the quality of the product and quickly responding to any deviations from established standards. Special sensors and monitoring systems are used for this purpose.

Based on the above, it can be stated that the automation of grain processing is a necessary step to improve the efficiency and quality of the processing process. Automation methods allow accurately controlling and regulating all stages of grain processing, which leads to improved product quality and a reduced likelihood of errors in the production process [14-15].

However, it should be noted that the automation of the production process requires significant investment in equipment, software, and staff training. In addition, the implementation of automation may require a restructuring of production processes, which may also require additional costs.

Overall, grain processing automation methods represent an important step in the development of production and its efficiency improvement. They allow reducing costs for personnel and energy, improving product quality and level of control, and reducing production time [16].

Research results and their discussion

In most cases, several indicators are controlled simultaneously in the production process, and changes in one indicator lead to changes in others. When such dependencies exist, means of multidimensional statistical control are used, but the lack of a mechanism for extracting the maximum amount of data on production processes through a logically constructed algorithm deprives them of practical applicability.

To solve this problem and apply a grain processing automation system, a series of studies were conducted, demonstrating significant improvements in the production process and increased productivity.

One of the research results was the optimization of the grain drying process, which was achieved through automation and control of the humidity and temperature of the air in the drying chamber. This made it possible to reduce drying time, lower energy costs, and increase the quality of dry grain. In our research, grain dryers were designed for drying a wide range of products: wheat, barley, rye, rapeseed, corn, sunflower seeds, legume seeds, and bulk materials.

Hence, the highly relevant task is to create modern grain drying automation systems with the maximum possible use of existing system elements. This allowed us to automate the technological process of grain drying on a modern component basis, with significant cost savings.

For the implementation of modern grain drying automation systems on previously constructed facilities, it was advisable to use the cable lines of existing systems. However, the use of relay elements from existing systems seemed questionable, as many of them became unusable during operation [17]. Based on this, we came to the conclusion that the system could be centralized based on one microcontroller (MC) (Figure 2) or distributed using several combined MCs.

The choice of one or another equipment is determined by the topology of the arrangement of actuators, sensors, which allows for maximum use of existing cable routes, avoiding additional costs. In this case, both domestic and imported equipment can be used. In each case, the choice of equipment is determined by coordination with the developers and does not have a fundamental purpose [18].

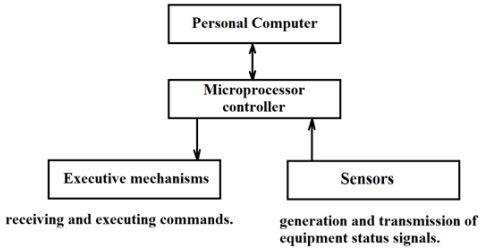

Figure 2. Process control system for grain drying.

The software of the system consists of two components:

Software of the lower level;

Software of the upper level.

The software of the lower level controls the operation of the equipment and performs the following:

Reception and execution of commands;

Reception and processing of settings;

Polling of sensors;

Emergency shutdown of equipment.

The software of the upper level controls the operation of the PC and performs the following:

Maintenance of the grain drying process ASU model;

Formation of settings;

Pre-emergency and emergency indication of the equipment status;

Interaction with the integrated enterprise ASU.

The task of fully automating the grain drying process is very complex. Therefore, the following stages are possible when solving it:

Introduction of remote control of the main parameters of the drying process (for example, the temperature of the drying agent, the moisture and temperature of the grain) and automatic blocking during the operation of the drying equipment and mechanisms (fans, exhaust mechanisms, nozzles).

Automatic regulation of the main parameters of the drying process (temperature of the drying agent, drying time).

Creation of an automatic grain dryer with a programming device that allows for choosing the optimal modes of grain drying depending on its initial qualities (moisture and temperature) without human intervention.

In addition, research has been conducted related to automating the process of grain cleaning. As a result of automatic grain cleaning, the amount of grain that enters the sorting table is reduced, which reduces the amount of processed grain and saves energy costs.

Moreover, automation of grain packaging allows for reducing the amount of required labor and decreasing packaging costs, while automatic quality control of the product helps avoid low-quality products and reduce waste [19].

Overall, the research demonstrates that automation of production processes in grain processing allows for improving product quality, reducing energy costs, and decreasing the amount of required labor [20].

Conclusion: As a result of automating the processing of grain products, there has been a significant increase in productivity and the quality of the products produced. Automation allows for the automatic control and regulation of production process parameters, reducing the likelihood of errors and minimizing risks to production.

Furthermore, the automation of the grain processing process reduces the amount of required labor, allowing for a reduction in personnel expenses. Additionally, automation

allows for a reduction in production time and energy costs.

The main task facing the implementation of a modern automated control system is to create a grain storage and processing production that minimizes raw material losses at the enterprise due to improper storage and untimely delivery for processing, while also operating with minimal energy consumption and producing high-quality products at minimal cost. A very important goal of the automated control system in grain processing enterprises is to reduce accidents, emergencies, and production downtime due to line malfunctions. Modern automated control systems allow for the automatic regulation, control, and management of incoming data from different areas of the production process, including the flow of wet and dry grain, drying processes, and more.

Automating the processing of grain products is a necessary step for improving productivity, quality, and production efficiency. It allows for a reduction in personnel, energy, and time costs, as well as increasing the level of control and quality of the products produced.

Thus, it is important to emphasize the feasibility of continuing research into the development and application of automated systems using statistical methods for controlling, regulating, and predicting the output parameters of products, enabling their widespread use in the grain processing industry.

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