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R. RADEV

ADVANCED ROBOTIC APPLICATION

INTELLIGENT COMMUNICATION

ADVANCED PROCESS CONTROL

Technological Machines Diagnostics of Grain Processing Enterprises as the Object of Automation

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Abstract – **The article gives the basic concepts of reliability, performance, durability, considers the issues of changing the technical state of the machine during operation. The models under consideration have the ability to introduce various perturbations in order to simulate physical defects, and numerical simulation on a computer made it possible to obtain solutions in the form of temporary realizations of oscillations for different states of the simulation object. The cooperative use of the full-scale method and mathematical modeling made it possible to reduce the volume of full-scale experiments and apply statistical methods of analysis in the problem of classifying the technical condition by constructing mathematical models of the probability of failure and uptime during their operating time. The content of the main types of machine states is revealed, considerable attention is paid to the issues of identifying and influencing failures and the causes of failures in the machine, the reasons for the loss of performance during operation.**

Keywords – grain, grain processing, equipment and machines, failures, deterioration, mathematical modeling, diagnostics, breakdowns, technical monitoring, reliability.

I. Introduction

In grain processing facilities, events associated with a sudden breakdown of equipment during operation can lead to an accident and the appearance of a source combustion, and, as a result, a fire or explosion. To reduce the likelihood of sudden breakdowns and accidents, measures are taken for technical monitoring and equipment diagnostics.

Modern detection of deviations in the operation of machines and equipment helps to maintain the required quality indicators of the technological process. Non-destructive testing and technical means find their place in the application of diagnostic methods, especially in the field of maintenance of equipment of grain processing enterprises, and also allow them to obtain objective information about the current technical state of technological machines and plan the type and time of rational repair maintenance based on the results of diagnostics. An analysis of the dynamics changes in diagnostic features (trend classification) makes it possible to identify the origin of defects and predict the occurrence of fatal changes in the technical condition caused by the development of irreversible degradation processes in equipment nodes, which leads to a decrease in the likelihood of accidents at the enterprise. However, due to the lack of available technical means and specialists in the field of technical diagnostics at grain processing enterprises, technical diagnostic methods have not yet fully found their place. Based on the foregoing, we chose the grain processing enterprise JSC "Galla-Alteg" located in the city of Tashkent, the Republic of Uzbekistan, as the object of research. The aim of the study is to ensure the safety of production, through the reliability and efficiency of the operation of technological equipment and the development of an automated system for monitoring and diagnosing equipment.

II. Material and Methods

Grain processing technological process has a certain direction, is characterized by a continuous flow, a large length of the technological line, requires a huge amount of energy and differs from other objects, and is also an object that belongs to the category of explosive. When solving the above problems, it will be difficult to ensure the efficient operation of production and equipment and their safety without the introduction of an automated process control system. Theoretical and empirical research methods were used to solve this goal in the process equipment diagnostics. Theoretical methods are based on the principles of system analysis and mathematical modeling, automatic control laws, machine learning methods are based on the methods of mathematical statistics. Diagnostic equipment models are based on the laws of classical mechanics.

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III. DIAGNOSTIC ALGORITHM

Reliability learning is based on the systematic acquisition of knowledge, and in order to ensure the reliability of both process learning itself and industrial equipment, the practical application of knowledge and its assimilation can be carried out through a system of knowledge and skills, built according to the flowchart shown in Figure 1.

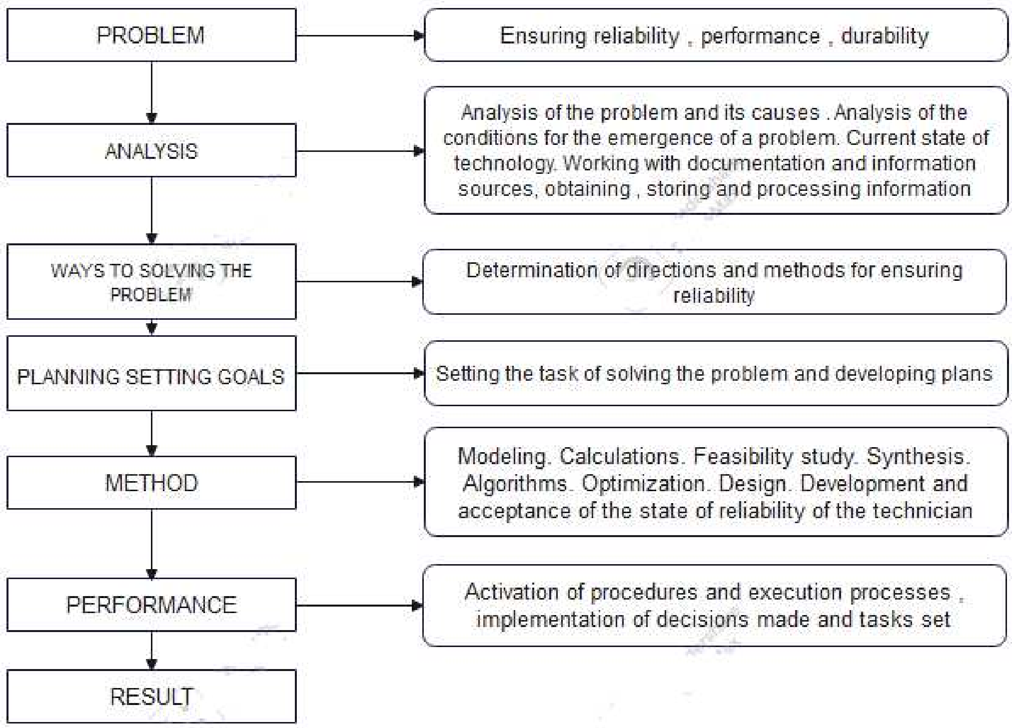

Fig. 1. Block diagram of a knowledge acquisition system for solution tasks for ensuring the reliability of equipment.

The results of our research [1-5], as well as the analysis of a number of scientific sources [6-16], confirm that to ensure a high level of reliability and durability of equipment and machines, it is necessary to plan work in this direction and carry out the development of technical and organizational methods according to the presented algorithm.

At the same time, at the stage of developing methods for ensuring reliability, the main attention should be paid to modeling, calculation, implementation of technical and economic fundamentals, as well as the development of other documents. As a result, the decisions made and the tasks set lead to ensuring and increasing the reliability of process equipment.

By substantiating the reliability management system by the method of immutable computer simulation, it is possible to improve the organization of maintenance of grain processing equipment and increase its efficiency. In particular, maintaining the indicated reliability requirements should be based on cost and reduced in terms of costs [17].

$$F = F_1 + F_2 \to min. \;\; S = S_1 + S_2 \to min. \qquad (1)$$

Where: F is a criterion for minimizing losses and costs for technical service (objective function); S is the cost criterion (objective function); F_1 is the cost of performing technical service operations to maintain the level of reliability; F_2 - damage from downtime of grain processing equipment and a decrease in output; S_1 - the cost of grain processing; S_2 - costs for the technical service subsystem.

According to [18], a system of differential equations is known that describes the operation of a closed queuing system and its solution. Probability of absence of requirements p_0:

$$p_0 = [\sum_{k=0}^{n} \frac{m!}{k!(m-k)!} \cdot a^k + \sum_{k=n+1}^{m} \frac{m!\boldsymbol{n}^k}{\boldsymbol{n}^{k-1} \cdot n!(m-k)1}]^{-1} \qquad (2)$$

where:

- m is the current number of posts;
- n is the maximum number of posts;
- α is the system parameter;
- k is the number of serviced requests.

Analysis of the results of researches of resource tests was determined by more than 20 thousand hours of equipment of its experimental link. The time between failures of a roller mill type A1-BZN is on average 250 hours, and also vertical scouring machines type RZ-BMO -12 is determined at about 900 hours - 1000 hours at standard rates. Statistical processing of experimental data was carried out by developing a mathematical model of the probability of failure Q(t) and the probability of failure t, taking into account the working time.

The exponential dependencies of the model expression are described as follows

$$Q(t) = 1 - \exp(-\omega t), \;\; P(t) = \exp(-\omega t), \qquad (3)$$

where ω is the failure rate parameter (hour -1).

As a result of the research, it was found that the value of the failure flow parameter for centrifugal fans was 0.0030, roller machines - 0.00321, whip machines - 0.0009, scourers - 0.00101, entoleitors - 0.00098. It is known that the probability of failure due to random incidents is subject to the dependence:

$$Q(t) = 1 - e^{\omega t}. \quad (4)$$

Where ω is the parameter of the flow of failures caused by incidents in production, h. The distribution of the time between failures of technological machines corresponds to the normal distribution law:

$$Q(t) = \int_o^t f(t)dt. \quad (5)$$

Where f (t) is the distribution density of uptime, described by the formula:

$$f(t) = \frac{1}{S\sqrt{2n}} e^{\frac{(t-m)^2}{2S^2}}, \quad (6)$$

where:

- m_i is the mathematical expectation of equipment operation time to failure;
- S is the standard deviation.

The probability of an emergency situation under the simultaneous impact of random events and gradual failures due to wear and tear of equipment for new machines is described by the following relationship:

$$Q(t) = 1 - \{e^{\omega t}[1 - \int_o^t f(t)dt]\} \quad (7)$$

If the equipment is in operation during the time T, the dependence takes the form

$$Q(T + t) = 1 - \{e^{-\omega t} e^{\omega T}[1 - \int_o^t f(t)dt]\}. \quad (8)$$

Thus, it is impossible to work safely, increasing the reliability and efficiency of machines and mechanisms without extensive use of technical diagnostics. The introduction of diagnostic tools, the development of new and effective methods for monitoring system diagnostics is an urgent task that allows you to abandon maintenance and repair in accordance with the rules and switch to a progressive principle of maintenance and repair in accordance with the real situation. This gives a significant economic effect.

IV. Results and discussion

When dealing with the problems, we proceed primarily from the analysis and application of a systematic approach. In our case, a systematic approach is a method of scientific knowledge based on the study of a technical object as a system, that is, its systematic approach is considered as a methodology of scientific knowledge based on the study of technical objects as a complex system. This approach means the analysis of the system in the interrelation "Man - technical object - environment".

In the case under consideration, technological equipment is perceived as complex mechanical systems; for this purpose, we consider grain processing systems to be technical objects [19] . The main principles that define an object as a complex system, which can be: hierarchy, sets of object elements and interelement relationships, structure, unity and integrity, mathematical models and building modeling systems.

For these purposes, consider a number of features of technological systems as complex technical systems. However, it is necessary to identify a number of features associated with complex systems:

1. Complex systems are characterized by self-organization, self-control, self-adaptation;
2. The ability to restore performance in parts, without interrupting or disrupting the entire system;
3. Hierarchy.

It is known [20] that the analysis of the reliability of complex systems has its own specific features, where the assessment of the reliability of a complex system and the connections between its elements play a special and important role, where the construction of a reliable model of the system is carried out taking into account the features, parameters and classifications. This takes into account the state of technological equipment: the state of operation in the standby mode; functions, in the process of operation, the state of the ability to work in the mode of performing certain tasks; non-working state, recovery period [21].

When calculating reliability, we use block diagrams with the possibility of dividing a complex system into separate elements, for each of which it is possible to determine the probability of failure ($P_i(t)$- the probability of failure of the i-th element for a given period). Then we can determine the probability that ($P_i(t)$) the entire system will fail. Usually such calculations are called system reliability calculations. Taking into account the above parameters of mechanisms and nodes, we can conclude that in the simplest cases, the failure of one node mechanism can lead to the failure of the entire system.

For example, most drives of machines and mechanisms are subject to these conditions. If the gear, bearing, clutch, control lever, electric motor, lubrication pump, do not work with any drive, the operation of the machine will stop, which will lead to the stop of the entire operation of the machine. Then the probability of failure of such a system will be equal to the product of the probability of failure of its mechanisms and units as a whole.

$$P(t) = P_1(t)P_2(t)P_3(t) \dots P_n(t) = \prod_{i=1}^{n} P_i(t).$$

Let's give an example: if the node consists of 50 parts, and the probability of failure of each part during the considered time is $P_i(t)$= 0.99, then the probability of failure of the node will be equal to $P_i(t)$= $(0.99)^{50}$ = 0.55. If the node consists of 400 parts with the same probability, then $P_i(t)$= $(0.99)^{400}$ = 0.018, indicating that the node is down. The problems of ensuring the reliability of equipment are solved by complex and systematic approaches to solving problems in the organizational, methodological and personnel areas.

The study of physical processes that lead to a change in the reliability of an object and its mechanisms can be fully carried out in the context of a system analysis of the state as *"a changing environment - a working technical object - human activity."*

The results and studies presented in this article are focused on the operation of products - grain processing equipment, reliability management systems. To this end, we consider and analyze the grain processing enterprise as an object of diagnostics and automation of technological equipment [22].

When processing grain and obtaining grain products, this technological process is a flow and high-energy activity, which has its own characteristics. The large length of the technological line and the explosiveness of such enterprises require the use of automated process control systems at mills to ensure the efficiency and safety of work [2, 3].

As a result of the introduction of an automation system, an automated process control system [24-25] exercises full control over the technological process and all technological units:

- visualization of the technological process in real time;
- automatic selection of optimal options for managing product lines;
- prevention and prevention of industrial accidents;
- reduction of interruptions in the operation of equipment;
- exclusion of the human factor.

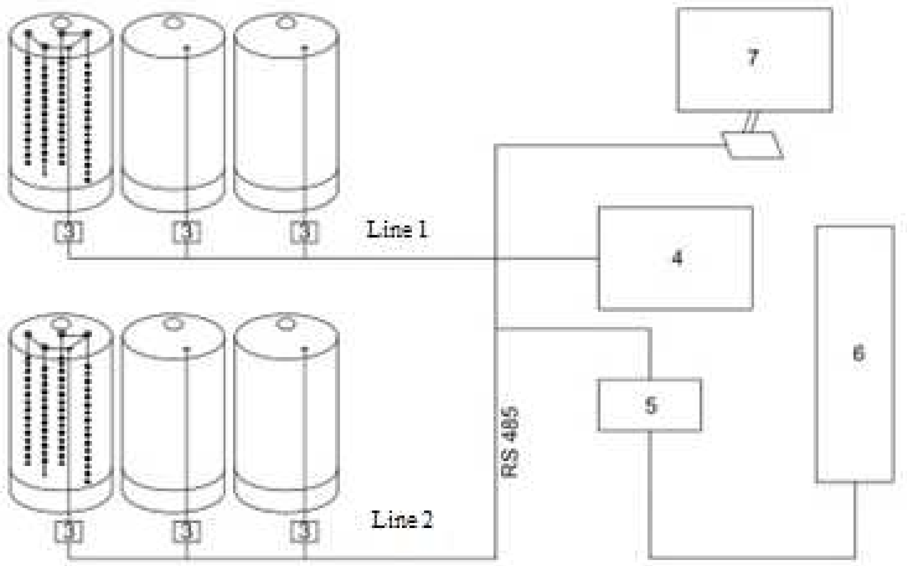

Fig. 2. Automated grain temperature and moisture control system for elevators and granaries

What is shown in Fig.2 has the following meaning: 1-elevator, 2-suspensions for connecting temperature and humidity sensors to the control controller, 3-elevator suspension interrogation unit, 4-control controller, 5-analog suspension interrogation unit, 6-analog silo suspensions, 7-system software.

For these purposes, in order to implement an automated mill control system, it will be necessary to focus on solving the following technical problems:

- start/stop of transport equipment in accordance with the developed routes using overload protection with increased line noise immunity;
- introduction of an automatic grain moistening system in the shop for hydrothermal processing of grain;
- control of the flow of grain for the preparation of the mixture of grain crushing;
- control and controllability of roller machines in the grain crushing shop;
- provision of soft start systems for powerful asynchronous electric motors;
- visualization of the state of modes, capabilities and equipment, signaling, information support of the text, writing a log and archiving the process control;
- data transfer to an automated control system for accounting and further processing of consumed electricity in existing directions after a certain time interval.

Based on the results obtained, it should be noted that grain processing, which currently has a continuous production cycle, is a source of increasing the reliability of enterprises through the operation associated with the construction cycle of technological equipment, it will be necessary to focus on determining costs and losses, accidents and production downtime. [26-27].

V. Conclusions

As a conclusion, we can say that on the basis of a systematic approach to ensuring the performance and reliability of technological equipment used in the grain processing process, it will be necessary to focus on the application of the scientific method of knowledge based on the study of a technical object as an integral system in connection with working conditions, which leads to the formation of a structure in which the basic principles for the creation and application of complex systems are determined by the multitude of elements and interelement relationships, hierarchy, unity and integrity of the system.

When considering similar problems of grain and grain processing and ensuring the reliability of the machines and devices used, it is necessary to use computer modeling in accordance with the criterion of the efficiency of technological equipment in terms of parameters and maintenance modes when determining the patterns of influence on the reliability and efficiency of grain, which allows to accurately determine its readiness.

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