Information systems in the technological processes automatic control development by technical condition criterion

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Abstract
The substantiation of the use of information systems for the rational management of the belt conveyor for transport rocks by the criterion of the technical condition of its equipment is considered.

Keywords: INFORMATION SYSTEM, AUTOMATIC CONTROL, DIAGNOSTIC SYSTEM, BELT CONVEYOR, DIAGNOSTIC SIGNS, DIAGNOSTIC MODELS.

The problem and its connection with science and practical tasks

Influence of an information system on the development of an automation systems and diagnostics consider on example of exploitation of belt conveyor in mining at transporting lumpy rocks.

New features in work and application systems of diagnosis and prognosis appear at exploitation of belt conveyor equipped with variable speed drive and automatic control system with different modes of transportation. The economic efficiency of use automated system diagnostics and resource prediction is achieved due to factors such as an increase in the mean time between repairs (productivity of maintenance object grows and the cost of maintenance reduces, the actual elimination of unexpected breakdowns) increase the reliability and productivity, elimination of secondary breakdowns, reducing repair time. This leads to increase in availability factor 0,015 ÷ 0,02 and utilization at 0,02 ÷ 0,03 [1]. Ability to control operating modes, namely, reduce the speed of the belt, tension and change the distribution of traction between the drums, to ensure a smooth start of loaded conveyor and thus reduce the load on the conveyor mechanisms, increase the service life of the belt, rollers, drums, increase the time between repair, further enhances the availability factor 0,01 ÷ 0,013 and utilization on 0,015 ÷ 0,02.

So, the creation of an automated diagnostics system and forecasting of technical condition of the conveyor mechanisms and coordination its work with the automatic control transportation system is an urgent task.

Analysis of research and publications

Problems of diagnosis mechanisms of general and special purpose engaged a number of authors [1 - 7], who developed the general situations and principles of technical diagnostics. Definition of the technical condition of the belt conveyor has its own specifics in mind a large length, the presence of complex assemblies and mechanisms, linked by a flexible traction body. So, it is important to continuously diagnose technical condition of these elements and predict the residual life, their influence on general resources of the conveyor system.

Development of functional circuits of conveyor and diagnostic research, associated with the identification information parameters [10, 11, 13] showed that, as the conveyor is a complex object consisting of a number of mechanisms and nodes, it makes sense to investigate these mechanisms separately.

The purpose of research

Creating a computer diagnostics and forecasting technical condition of the equipment requires solution of a number of theoretical and applied problems, including:

- the investigation of causal relationships between the main defects and the diagnostic parameters;

- the determination of characteristic changes of diagnostic features uniquely responsive to manifestation of a certain defect.

Therefore, the goal of this work is to find ways for problem solving using modern information systems.

Presentation of the material and results

Information systems are now an integral part of the automated control systems with modern technological processes. The operation of the equipment is fitted with an operating mode automatic control system and the computer system of information receiving and processing, presents new opportunities for the development of systems of diagnosing and forecasting technical condition of individual elements of mechanisms and systems in general. The control and corrective influence in the automatic control system of technological equipment operating modes is formed basing on the data diagnostics and forecasting systems.

Development of diagnostic models of the main mechanisms of the conveyor, such as the engine, reducer, belt, rollers, drums, allows more fully take into account cause-and-effect relationships between the main elements, their technical condition, characteristic diagnostic features corresponding to this type of defect. An important task is to develop the principles of operation of the automated system of diagnosis and prognosis with the priority mechanisms most frequently breaking down; establish dependencies of change the main diagnostic features of the mechanisms from operating modes. Development of functional circuits diagnosis and research related to the identification of informative parameters, have shown that it makes sense to explore these mechanisms separately. For this purpose have been developed and investigated diagnostic models of engine, belt, drums, support structures.

The diagnostic model building is produced in three stages: primary description of the object state, selection of diagnostic signs and exact match those to signs of malfunction, definition the relationship of revealed signs with the technical state of the object.

Consider a table that shows the reliability of the main units of 26 conveyors of "Krivbass Ruda" (analysis performed by the Rostov Institute of Civil Engineering) [1].

Table 1. Reliability of the main units of belt conveyors

Node of conveyor	The number of failures	Time to failure h.	Mean time between failures, h.	Number of replacements during scheduled maintenance	Average time per one replacementh.	Part of the time to eliminate failure in general downtime, %

Belt	106	2741	8.4	120	8.1	22.1
Electric equipment	44	6620	1.76	10	2.1	18
Rollers of upper branch	34	8550	1.3	481	2.5	14.9
Rollers of lower branch	64	4550	2.3	452	1.92	12.2
Reducer with clutches	53	5500	4.68	75	3.8	6.3
Drums	48	6070	4.2	68	4.5	6
Tension	12	22280	4.9	22	5.8	2.3
Brake	25	11620	3.1	10	2.1	1.2

Analyzing the data, we can conclude that more than 80% of the all downtime is falls on elimination the failures of the first five nodes. Less reliable conveyor elements such as conveyor belt, electrical equipment, rollers of upper and lower branches.

Great practical importance has research of the question of resources and deterioration of the conveyor belt, as it is the most expensive and wear out quickly conveyor element. Resource of conveyor belt from the time between the start of operation to level of the limit state of deterioration, which is determined by specific exploitation conditions.

Resource of conveyor belts depends on the nature of loads acting on it and the types of deterioration. Types of deterioration can be classified by the nature of the destruction of the structural elements of the belt. The main types of belts wearout are shown in Table 2.

Table 2. Types of belts wearout

Type of wearout	Reason of wearout
Abrasion of the middle part of the working lining with the further destruction of a framework	Slippage cargo ribbon in place of loading and on the roller carriages
Cuts, gusts working lining with the further destruction of a framework	Increased friction of belt on the elements of the supporting structures of the conveyor
Wearout of boards of a belt with further destruction of a framework	Interaction of belt with the support structures of the conveyor elements while de-centered movement
Percussion destruction of the working lining and the skeleton	Percussion interaction cargo pieces with ribbon in place of loading and roller carriages
Abrasion and destruction of non-working lining with the further destruction of the skeleton	Slippage of non-working lining on roller carriages and drums
General loss of strength of belt	Increasing the number of joints and repair sections on the belt, the poor quality of stacked pieces of belt
Emergency deterioration	Inappropriate use

Consider the main characteristic of the conveyor drive failure, for which we take the asynchronous motor with slip ring rotor (Table. 3).

Table 3. Typical fault of asynchronous motor with slip ring rotor

The main components and parts	Typical malfunctions
The stator winding	The deterioration of the winding,short circuit winding on shell, coiled-circuit in the winding
The rotor winding	Interruption in the winding, coil-circuit in the winding
Bearings	Changing the shape of rings, changing the shape of the rolling

	elements Increased clearance, pollution or lack of lubrication
Rotor	Unbalance, dynamic eccentricity, active iron crimping attenuation
Current collecting rings and brushes	Contamination of surface slip rings, the surface roughness of slip rings, high contact pressure

Developed diagnostic models of the main elements of the belt conveyor can be combined into an integrated information system for assessing the technical condition of the conveyor. The residual and overhaul period prediction principles for such system are formulated [8, 9, 11].

Structural parameters of the different elements of the conveyor are measured in different units and changed in different ranges. To compare them it is necessary to define a generic indicator of the technical condition of the equipment. Analysis methods to define generalized index is based on a combination of the geometric and arithmetic average of the numerical characteristics of a technical condition, showed their shortcomings. The advantage obtained by a method wherein the weights for each parameter value or the diagnostic characteristic value are referred to this characteristic or parameter and summing each element (node) of the conveyor.

Defining the health of the equipment it is possible to define the remaining residual life, i.e. forecast period of its failure. Analysis of existing methods and principles of forecasting showed that for most conveyors applicable principle, based on the use of extrapolation of retrospective data. For the most of the conveyor elements the exponential and power functions can be used as diagnostic feature changing approximating functions:

$$U_c(t) = b_c t^{a_c} + z; U_э(t) = a_э e^{b_э t} + z$$

where a, b - coefficients of the approximating functions; z - random variable, which characterizes the degree of influence of perturbation.

When forecasting technical condition of equipment of conveyor in particular solves two problems:

-does not exceed the value of the diagnostic parameter allowable value, if the node must running;

-determination of the residual node resource in the parameter at time.

According to these principles the identification algorithms of used and residual resources of the main elements are developed [11, 13, 14, 15]. This method is implemented by a computer information processing system.

On the basis of algorithms for determining the technical condition of the main equipment, used and residual resource and the principles of forecasting, developed a functional block diagram of the automated diagnostic systems. It differs from existing systems so that in addition to determines the current status, determines the most worn element of conveyor, which is important for the organization of preventive maintenance and ongoing operation of the mechanism. So, knowing the loads acting on this element, you can prolong the life and therefore the entire system. That is, based on the equipment condition generates control and corrective influence in the controls system of belt conveyor.

Thus, appears possibility of rational management of operation mode of the belt conveyor, depending on the technical condition of its components and mechanisms.

In this connection, proposed principles of building automated diagnostic systems of technical condition of the conveyor using computer processing of signals from sensors and devices, and software for its prediction, and conveyor drive control algorithms, taking into account both the current and projected state of the main constituent elements of the conveyor.

Implementation of the proposed control system is only possible with the use of a rather powerful means of local automatics, the so-called microprocessor means. The role of these highly integrated electronic devices in the operational processing of information flow for the diagnosis and management functions.

Necessary devices can be created or choosed from existing core microprocessor technology. This is facilitated by a wide range of automation produced from sensors to high-end programmable controllers, flexibility and variety of communication tools, and most importantly, their inherent design feature the ability to update certain parts of the system. The required solutions of automation tasks can be achieved by selecting a basic configuration of the local automation on mining machine via increasing or including any individual branch of it.

Conclusions

Considered principles of forecasting of technical condition of the conveyor and developed algorithms of identification of the used and residual life of its main elements can be applied to other types of equipment.

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