AMERICAN Journal of Engineering, Mechanics and Architecture
Volume 2, Issue 2, 2024 ISSN (E): 2993-2637

Diagnostics Provides Determination of the Technical Condition and Mechanisms of the Rolling Stock

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Abstract: The trouble-free operation of all objects of locomotive mechanisms and electric motors can ensure a safe transportation process on railway transport. Diagnostic tools form the basis of train safety. Diagnostics ensures the determination of the technical condition of all devices and mechanisms of the rolling stock. With the help of diagnostics, the tasks of not only managing the transportation process are solved, but also the physical condition of the object is determined, as well as their malfunction.

Keywords: automation, traction, electric motors, controls, transistors, quality, safety.

In the world, a special place in the field of scientific research is occupied by diagnostics and control of ensuring the safety of rolling stock and ensuring the reliability of all elements and control systems of railway transport based on modern microprocessor systems and new technologies. The main consumer in the composition of the railway electric drive are asynchronous traction motors, whose share in the structure of electricity consumption is 70%. The reliability of the traction motor automation devices depends on the monitoring and diagnostics of the elements. Basically, monitoring and diagnostics are carried out for symmetrical control systems. Therefore, it is necessary to monitor and diagnose the operation of elements of traction motors and circuit control systems in asymmetric modes. In this regard, research work is relevant.

Control systems and converters based on IGBT transistors are being created in the world, which affect the quality of safe operation of all elements of locomotives. In different countries of the world, such as the USA, England, France, Spain, Germany, Japan, China, optimized design parameters of electric drives and modern diagnostic measures for the safe movement of railway transport are being created. At the same time, special attention is paid to stability, reliability and the development of complex systems for management teams. These works do not consider the phenomena of pulsation, the occurrence of higher and lower harmonics in control systems, which occur in non-standard situations. The service life of traction motors with long-term operation depends on the development of new modern control and diagnostic systems in non-standard situations.

Large-scale research work aimed at developing devices and diagnostic systems for elements of locomotives and electric locomotives to eliminate failures in automation and telemechanics systems is carried out in leading scientific centers and higher educational institutions of the world, including General Electric Transportation (USA), Institute of Communications Technology Hannover, Siemens, AEG, SEL, in Technical University in Braunschweig (Germany), St. Petersburg State University of Railway Engineering, Russian Transport

University, Moscow Institute of Transport Engineers, Samara University of Railway Engineering (Russia), Tashkent State Transport University (Uzbekistan).

As a result of worldwide research on improving methods and methods for diagnosing electric locomotive components, mathematical models and software materials have been developed to prevent failures in systems and controls during starting and braking of locomotives.

As a result of practical research, an improved system of functional diagnostics of the control circuit in non-standard situations in the traction mode of electric locomotives “O'zbekiston yo'lovchi” was obtained based on the expansion of control functions using modern microprocessor systems. A microprocessor control scheme for the traction electric drive of an electric locomotive was also developed in non-standard situations, taking into account the peculiarities of frequency control of the asynchronous motor speed. The monograph provides recommendations for calculating the optimal parameters of electric drive elements based on the algorithm and software material.

The reliability of the research results was achieved by applying theoretically sound concepts of automated control, as well as by matching the results obtained using a functional system on a mathematical model and on experimental devices.

The scientific significance of the research is explained by the development of a method for measuring diagnostic parameters, the validity of diagnostic concepts and methods, mathematical modeling by a control algorithm in non-standard situations, taking into account the parameters of functional diagnostic elements and computer calculation to increase the reliability of the control system without distortion and failures.

The practical significance of the results of the work lies in the development of a microprocessor control scheme for a traction electric drive in non-standard situations, taking into account the peculiarities of frequency control of the asynchronous motor speed, as well as the improvement of the functional diagnostics system based on the expansion of the control function and the developed recommendations for calculating the optimal parameters of the electric drive elements.

Based on the improvement of the system of functional diagnostics of the control scheme in non-standard situations of electric locomotives

The trouble-free operation of all objects of locomotive mechanisms and electric motors can ensure a safe transportation process on railway transport. Diagnostic tools form the basis of train safety.

Diagnostics ensures the determination of the technical condition of all devices and mechanisms of the rolling stock. With the help of diagnostics, the tasks of not only managing the transportation process are solved, but also the physical condition of the object is determined, as well as their malfunction. With the help of diagnostics, mathematical models and fault models are developed, diagnostic algorithms are built.

Technical diagnostics are presented in the form of: test diagnostics; functional diagnostics; combined diagnostics.

The fundamental factor of test diagnostics is that the responses of the diagnostic results are considered to be working effects on the inputs of diagnostic tools and can be removed from both the main outputs and additional ones. Absolutely all outputs are control points where the obtained diagnostic results are compared with reference values. The test diagnosis can be presented in the form of a block diagram.

To develop an algorithm for test diagnostics, it is necessary to have an impact source; a measuring device; a communication device for the object of diagnosis and an information processing device. This is done using automated schemes. A block diagram of functional diagnostics is presented.

Functional diagnostics is called, in which working influences (algorithms of functioning) are received at the base of the input and the results are recorded using control points.

For complex objects, both test and functional diagnostics (combined) are used. All diagnostic systems use sensors that make it possible to obtain primary data on the condition of the object of study.

Combined diagnostics is used to diagnose electric and diesel locomotives.

Qualitative determination of the technical condition of an object is the task of technical diagnostics. The technical condition of the facilities is determined by the established regulatory documents and are subject to changes during operation. Control of the parameters of a complex multicomponent object such as an electric locomotive, a diesel locomotive with a certain accuracy is called technical diagnostics. The serviceable condition of objects can be for certain operating conditions, for other conditions – a faulty condition.

By the nature of the interaction, the object is a means of diagnosis, functional diagnosis and test diagnosis are distinguished. Test diagnostics is determined by applying test signals to the object under study.

Information about the condition of the object is received directly in the normal operation of the object, such a diagnosis is called functional. The chosen diagnostic method allows you to identify malfunctions in the object, determined by the characteristic completeness of technical diagnostics. The classification of technical diagnostic tools is shown.

With an increase in the controlled parameters of the object, diagnostic tools become more complicated. The procedure and composition of monitoring the parameters of the diagnostic object are established by the algorithm of technical diagnostics. Elementary verification is carried out for diagnostic parameters using sensors, functional or test exposure. Algorithms can be conditional and unconditional. Conditional algorithms are called those that are defined after elementary checks, and unconditional ones are checks of parameters that are defined in advance. To build algorithms, it is necessary to know the descriptions of objects, the conditions of their functioning and behavior in a faulty and serviceable condition.

The description of these processes can be set in analytical form, in the form of tabular data, in the form of vectors, graphical forms, or a mathematical model in explicit or implicit form.

An explicit mathematical model defines a description of the serviceable and faulty states. The implicit model consists of a description of the proper operation of the object. According to the serviceable condition of the object, you can create any faulty modifications. Any object that is serviceable or defective is represented by a dynamic system, determined at any given time by the parameters of the input, internal parameters that are found in dynamic mode.

The expert method. This method is used at the first stage of commissioning of locomotives. A special expert technical commission checks all the operating parameters of locomotives with its instruments, analyzes the measurement results obtained and establishes a diagnosis. At the same time, modern microprocessor technology is used. However, this assessment is subjective, since a person is not always able, by virtue of his abilities, to process correctly incoming information and subjective errors may occur.

Mathematical methods. Mathematical methods can be divided into two large groups: modeling of diagnostic processes and theories. Theory can include pattern recognition, set theory, and so on.

Mathematical modeling is mainly used to determine in electronic circuits. To diagnose the dynamic modes of complex devices, such as a locomotive, the use of this method, due to obtaining complex analytical expressions, is difficult.

Mathematical modeling allows you to associate analytical expressions with malfunctions in the details of an object. In mathematical modeling, tabular algorithms or analytical models are used.

In addition to these algorithms, probabilistic algorithms are also used. Defects are determined according to the Bayes formula:

$$P\left(\frac{A}{B}\right) = \frac{P(A)P(B/A)}{P(C)P(B/C)}, \quad (1.11)$$

where P(A/B) – determines the probability of the sum of parameters B and defect A; P(A) – determines the probability of a defect of a random choice of diagnostic parameters; P(B/A) – the probability obtained experimentally In the occurrence of a defect; P(C) P(B/C) – the sum of the products of probabilities if there are any signs of a defect.

The spectral analysis method is used to diagnose parts of an electric locomotive subjected to friction. Usually these parts are lubricated with various oils. The wear of these parts is determined by the amount of accumulated wear particles in the lubricant, the amount of which is determined by spectral analysis. The number of wear particles is determined by various methods: calorimetric, magnetoinductive, radiographic, radiometric and others.

Non-destructive testing methods. This type of control can identify both obvious and non-obvious defects for which there is no documentation of rules, methods and measuring instruments. Non-destructive testing includes optical, capillary, acoustic, magnetic, radiation, and electrical types.

Magnetic and ultrasonic flaw detection are usually used for locomotives. This method allows you to detect cracks ranging in size from one to three microns.

The thermal method. The thermal method allows you to analyze the thermal radiation of the details of the object under consideration. The power of thermal radiation depends on the parameters of electrical objects, on the defect of parts and their coupling. The intensity of warm radiation also depends on changes in the operating mode of engines, motors and other electrical devices, as well as on overheating of their elements. The thermal method can be divided into contact with measuring the parameters of thermocouples, temperature paints, as well as measuring liquid crystal displays. This method allows you to register temperatures from +100C to +1000C.

The non-contact method is based on measuring thermal radiation by bodies and converting it into an electrical signal. The parameters of the receiving devices usually include: sensitivity threshold, output signal value, time constant. Radiometric converters and photovoltaic systems can be used as a receiving device.

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The untested states make up the first part of the new matrix. According to the compiled matrix, you can select the preferred function before the untested parameter. At each selection step, parameters are selected that should reduce the residual uncertainty. The matrix is constructed until the residual entropy is zero.

This method is applicable at the initial stage of determining the diagnostic parameters of locomotive systems when there is no statistical data on failures of its elements.

The boundary points of the state change are indicated by the letters A, B, C in the range of diagnostic frequency. The normalized parameters are determined by both established standards and technological tolerances during operation.

Normative diagnostic parameters use deterministic and statistical approaches. In the first case, the description is used by analytical differential equations, since the change in the output signal occurs due to structural changes in the parameters and characteristics of the input signal. The second method uses a criterion for optimizing the normative values of the diagnosed parameters, i.e. it uses the probabilistic characteristics of the output of the Z parameters beyond the acceptable values. The second criterion for this method is the total cost of diagnostic errors.

When diagnosing, an important circumstance is to identify the technical condition of the object by determining the incipient defect. In this case, we select the locomotive elements only those that tend to change the technical condition of the object, such as, for example, bearing wear, insulation failure, changes in the electrical and electronic properties of the locomotive equipment. When diagnosing, we use probability theory and methods of mathematical statistics.

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