$$\Delta Y_n = t_p \sigma^*_{Y_n}, \tag{8}$$

где t_p – коэффициент Стьюдента для заданной надежности и числа степеней свободы $k = L - 1$. В рассматриваемом случае надежность принималась $p = 0{,}05$. Здесь $\sigma^*_{Y_n}$ – остаточное среднеквадратичное отклонение, вычисляемое по формуле:

$$\sigma^*_{Y_n} = \sqrt{\sum_1^L \left(Y_n - Y_n^*\right)^2 / (L-1)}. \tag{9}$$

Среднеквадратическая относительная ошибка прогноза определялась следующим образом:

$$\delta_{Y_n} = \left|\Delta Y_n\right| / Y_{n\,max} 100\%, \tag{10}$$

где $Y_{n\,max}$ – наибольшее значение прогнозируемой величины.

Полученные в результате значения: $\sigma_{Yд} = 21{,}2$°C, $\sigma_{Yп} = 20.9$ °C, $r_{YдYп} = 0.99$, $\sigma^*_{Yп} = 2.34$ °C, $\Delta Y_п = 0.28$ °C, $\delta_{Yп} = 3.2\%$.

Выводы

Полученные результаты свидетельствуют об адекватности предложенной тепловой модели АД, работающего в сетях с некачественной электрической энергией. Учитывая, что для многих типов двигателей в справочной литературе отсутствуют сведения о коэффициентах теплоотдачи и теплоемкости, а по отдельным приводятся только тепловые постоянные времени, значения указанных параметров модели могут быть получены по использованной в статье методике.

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JUSTIFICATION FOR THE REQUESTED OF A PARAMETERS MONITORING SYSTEM FOR TRACTION ELECTRIC DRIVE OF MINE ELECTRIC LOCOMOTIVES

As experience in the operation of the traction rolling stock of domestic iron ore mines, transients (about 60 %) occupied most of the time functioning, which is connected with the peculiarities of doing work on the extraction of iron ore and adversely affects the reliability of the constituent elements, and especially on traction motors (TM). Emergencies often take place during operation of the traction unit in underground mines it can occur in the circuit, switching equipment, converter, traction engines (fig. 1). Emergency situation can be caused

by various factors in these devices. Basically, it is a short circuit of the electric circuit, breakage of the electric circuit, the deviation of the drive parameters are valid, the failure of the constituent elements and blocks of the actuator, the violation of the algorithm and others.

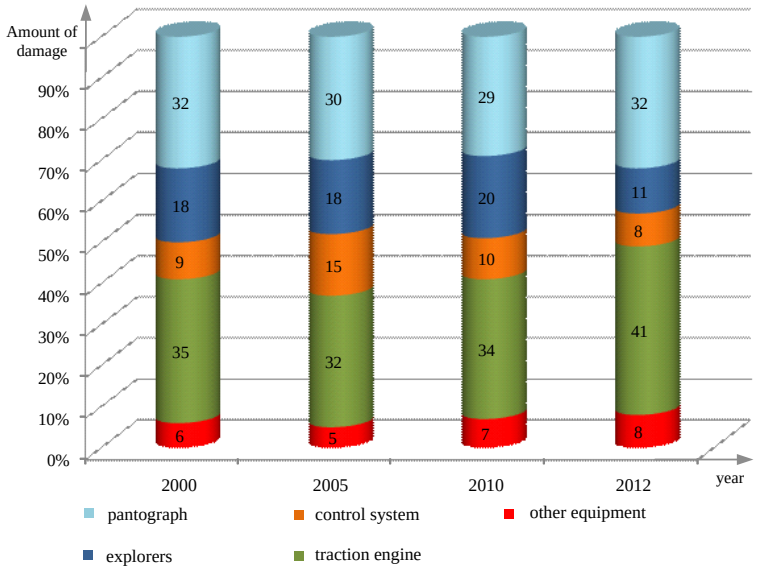

Figure 1 – Dynamics of changes in consolidated figures amounts of damage to the main elements of the traction electric mine locomotives K14 when operating in iron ore mines Kryvyi Rig iron ore basin

It should be noted that the dynamics of damage to rolling stock are changing over the years. However, traction electric motors take a significant proportion of material costs for the repair. As can be seen from fig. 2, a large part of the material costs at the mine Kryvyi Rig accounted for engine repair.

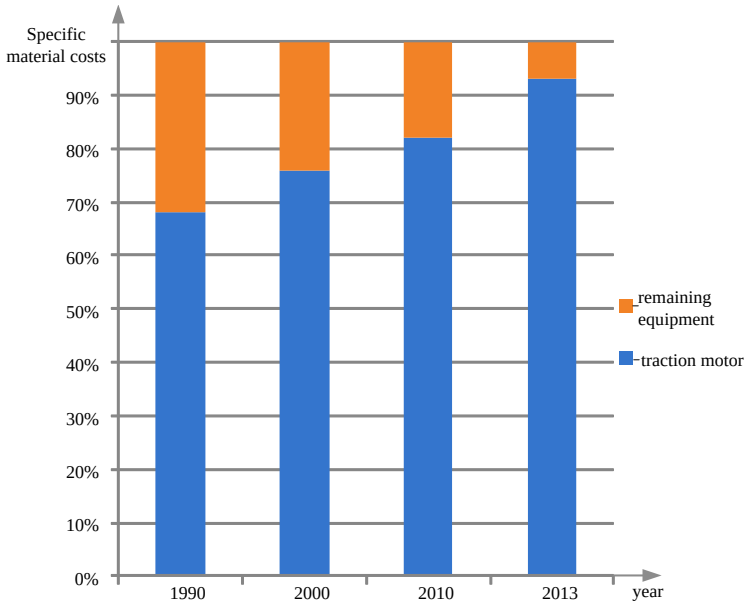

Figure 2 – The dynamics of change in unit material costs for repair of traction electric mine locomotives K14 at the mine Kryvyi Rig iron ore basin

In this regard, the increase of reliability of work of mine electric locomotive transport, is a very important issue through the development and implementation of systems for monitoring the condition of the basic functional nodes.

At present, the development of the measures, aimed at improving the reliability and reducing the costs associated with the operation of a mine locomotive is necessary. With the aim of improving the reliability of mine electric locomotives his necessary to have reliable information about the technical condition of the equipment [1]. Therefore, special attention should focus on those elements that limit the mileage of locomotives between overhauls, followed by recommendations for their technical content. This category of items is traction motor.

The traction direct current motors series-wound are used on the locomotives, compared to the engines of parallel excitation have several advantages: a large overload capacity and starting torque, less sensitive to voltage fluctuations and other.

The monitoring system of the rolling stock is a set of objects, methods and tools, as well as performers, allowing you to control the rules set by the relevant normative-technical documentation. It should be a mandatory part of the system of preventive maintenance of railway rolling stock.

Installs the following applications monitoring systems of electric locomotives:

– when testing and commissioning of electric locomotives in the production process;

– during maintenance during operation;

– repair of electric locomotives.

The structure of the monitoring system should allow to increase functionality by adding transducers and refine the software system. In other words, the system must be scalable and configurable.

When establishing a monitoring system in mine locomotive needs to address the issue of improving the reliability and optimization of their work. The objects of monitoring have the weak and are nodes need to upgrade or replace, as the objects that are in an unstable range. It is necessary to evaluate the technical level of new facilities prior to their commissioning and in their manufacture or repair of controlling the stability of quality.

The parameters measurement is one of the main functions of the monitoring system. The monitoring is carried out based on observations of the behavior of the managed system to ensure the optimal functioning of the latter (measurement of the achieved results and their correlation with the expected-mi results) [2]. The system adaptation makes on the basic on the monitoring data, i.e. the adoption of optimizing management decisions.

In mine trolley locomotives are controlled main parameters of the traction electrical systems mine electric locomotives: power, voltage traction motor, the voltage in the contact network, the current traction motors, the speed of movement of the mine locomotive. Also important is the monitoring of the following parameters: temperature of the traction motors, energy, energy losses. All these parameters must be controlled in order to avoid or prevent accidents.

The monitoring system implementation will allow to control the technical condition of TM in operating conditions, to choose the driving mode of the locomotive based on the status of the nodes that will increase their switching stability, reducing the number of faults, reducing the number of unscheduled repairs, the effective planning of repairs on-condition and an overall increase of service life [3].

System for monitoring the technical condition of electric rolling stock must meet the following requirements:

– to provide for monitoring the status of the controlled nodes;

– to form conclusions about the suitability of the equipment for further use and to predict its service life.

Using the monitoring system can be:

– increase the duration of the operation (by improving the quality of repair);

– reducing execution costs of unscheduled repairs;

– the reduction of the volume of repair works;

– reduced maintenance costs;

– the actual removal of unexpected failures (reliability and performance);

– elimination of secondary damage (broken gearbox faulty bearing);

– lower costs of labor and material resources;

– reducing the cost of maintaining the mine vehicles.

The conclusions. The monitoring system of the rolling stock is a set of objects, methods and tools, as well as performers, allowing you to control the parameters of the traction rolling stock. The monitoring system implementation will allow to control the technical condition of the traction motor in operation, to select the driving mode of the locomotive based on the status of the nodes that will increase their switching stability, reducing the number of faults, reducing the number of unscheduled repairs, the effective planning of repairs for technical costanding and an overall increase service life.

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