



THE USE OF INTELLIGENT ALGORITHMS TO IMPROVE THE ENERGY EFFICIENCY OF ELECTRIC LOCOMOTIVES

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Annotation: *In such a complex structure as a traction power supply system (STE) interacting with an electric rolling stock (EPS), and even more so taking into account the use of EPS regenerative braking, energy efficiency analysis and planning should be accompanied by a comprehensive assessment of the effectiveness of the measures proposed for implementation. Technical and organizational measures implemented for this purpose must meet the following requirements: - to ensure a reduction in the energy intensity of the transportation process; - be economically feasible; - contribute to ensuring the transportation process in the required current and prospective volumes.*

Keywords: *heuristic solution, optimal solution, machine learning*

Currently, there are no methods or software tools to evaluate and predict changes in the energy efficiency indicators of train traction relative to current values when changing the technical characteristics of the PE and the operational parameters of railway sections. In this regard, it is interesting to create an intelligent system (IP) for monitoring and planning energy efficiency indicators of train traction (hereinafter referred to as IPET), based on knowledge about the degree of influence on the main energy efficiency indicators of factors that can be conditionally classified into three groups:

- operational factors and characteristics determined by the train management system;

- operational factors and characteristics determined by the traction resource management system;

- parameters and characteristics of the STE.

A distinctive feature of IP from analytical and statistical systems is the ability to

- to process dynamic data that changes during processing;

- to change the data processing methods themselves as data becomes available and updated;

- self-learning, i.e. the ability to gain knowledge from already accumulated experience and data.

In the case of software implementation of IP, instead of exact algorithms, as a rule, the method of heuristic solution search is used, which, unlike the algorithms of complete search, allows ranking the states of the research object based on their "prospects". The main class of heuristic search algorithms is the search from the optimal state.

implementation of the proposed IPET IP. To do this, consider the functional scheme of this system (Figure). The IPET IP system should implement three main groups of intellectual tasks:

- 1) formation of a database of initial accounting and settlement information;

- 2) Data mining (IAD) and obtaining calculated expressions;

- 3) expert decision support. The first task can be solved by using intelligent interface systems as intelligent databases, which will allow for the selection of the information necessary for the operation of the system, derived from the totality of accounting data stored in the IVC of

JSC Russian Railways. As an iAd tool (the second task), Data Mining technology can be used, which is capable of providing constant updating of functional and logical patterns in samples of accumulated information on the state of energy efficiency of train traction, taking into account the values of influencing factors, parameters and characteristics, as well as predicting the development of the studied energy consumption processes in the STE. It is assumed that the process of intellectual activity of Data Mining in the proposed IPET IP system will include several stages: - identification of trends, i.e. stable patterns, associations and sequences; - predictive modeling, i.e. predicting unknown values and predicting the development of processes; - exception analysis, identifying deviations and explaining them.

For example, all values of operational factors and site characteristics with a certain discreteness can be represented as vertices of a set of graphs, the edges of each of which form links between factors and characteristics implemented for specified design conditions, and the graphs themselves show all possible combinations of factors and characteristics in the design area. Their number corresponds to the number of possible combinations of operational factors and characteristics. In this case, the task of finding the optimal solution will be reduced to a heuristic search for the possible best values of energy efficiency indicators based on the software implementation of the ES inside the IPET IC. Summing up what is described in the article, it is worth noting that the implementation of the proposed IPET will certainly require a large number of complex and high-tech work. However, as a result of these works aimed at solving the tasks outlined in the article, it will be possible to obtain the necessary knowledge to create the core of a

complex information and analytical intelligent system that, in the course of its operation, will be able to solve the most complex tasks of improving the energy efficiency of train traction and, as a result, to increase the economic efficiency of Russian Railways.

Artificial intelligence is a phenomenon of recent years, exciting the minds of scientists, entrepreneurs and ordinary users. Today, this technology is no longer the plot of a fantasy novel, but a reality that is rapidly changing the face of our familiar spheres of life. From medicine and finance to transportation and entertainment, AI is permeating everywhere, becoming the main driver of progress in the 21st century.

Energy systems are one of the most complex engineering systems of our time. With the development of renewable sources and increasing workloads, their management is becoming more and more time-consuming. Traditional calculation and planning methods are beginning to give way to intelligent algorithms. Artificial intelligence (AI) and advanced algorithms make it possible to analyze huge amounts of data and make decisions faster and more accurately than was previously possible. Today, researchers and engineers are already using machine learning, neural networks, and optimization methods to predict consumption, plan network infrastructure, and automate power system management. For example, the transition to carbon-neutral energy and distributed generation leads to a complexity of network operation modes that traditional methods cannot cope with.

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