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Проаналізовано витрати дизельного палива маневровими тепловозами за видами руху. Досліджено час роботи дизель-генераторних установок тепловозів ЧМЕ3, що працюють за системою двох одиниць в різних режимах. Виконано аналіз відомих технічних рішень з підвищення ступеня використання локомотивних енергетичних установок

Ключові слова: маневровий тепловоз, система двох одиниць, дизель-генераторна установка, витрата палива

Проанализированы расходы дизельного топлива маневровыми тепловозами по видам движения. Исследовано время работы дизель-генераторных установок тепловозов ЧМЭ3, работающих по системе двух единиц в различных режимах. Выполнен анализ известных технических решений по повышению степени использования локомотивных энергетических установок

Ключевые слова: маневровый тепловоз, система двух единиц, дизель-генераторная установка, расход топлива

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INVESTIGATION OF EFFECTIVENESS OF CHME3 DIESEL LOCOMOTIVES, WORKS ON TWO-UNIT SYSTEM

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1. Introduction

The use of the locomotive sector of railway transport of Ukraine shunting locomotives operating on multiple-unit, to ensure the required power, has long been a concern of specialists, but it is necessary to consider their modes of operation and the need to save diesel fuel when operating at low loads. This issue is the main topic when considering the efficient use of fuel - in the management of energy resources and the formation of trains at railway stations, taking into account the introduction of the program by resursozberezheniyu in rail transport [1].

2. Statement of the problem

Saving diesel fuel during the operation of diesel vehicles is one of the most important issues of the railway transport of Ukraine. The reduction of costs for diesel fuel, used for diesel locomotive engines, maintaining the engine power is the primary task, requiring constant search for new opportunities, which makes it possible to reduce fuel consumption [1 – 4].

At the present time the diesel fuel cost is one of the principal expenses for locomotive facilities of Ukrainian railways.

Aim of the article is to analyze fuel consumption by diesel-locomotives on Donetsk Railways according to the kinds of motion; study the annual fuel consumption by diesel-locomotives with a two-unit set; explore the operation time of diesel generating sets of ChME3 diesel-locomotive shunters with a two-unit set in various modes while performing shunting operations; analyze existing engineering solutions for longer usage of locomotive power plants of diesel-locomotives.

3. Literature review

In the literature, many devices start stalled diesel generators diesel locomotives. This is the introduction of diesel locomotives of various energy storage systems, hot start and heating, condensing system start-up. The proposed system to run diesel locomotives with energy-capacitors are too expensive and require many technical improvements and upgrades.

In the analysis of options to improve the efficiency of shunting locomotives of CME3 working on a system of two units, namely, their power plants were set directions for the implementation of the task. In the proposed options is offered with two diesel locomotives use diesel generator sets, storage devices, as well as to optimize the processes of diesel engines in order to smooth the transition process [1 – 24].

4. Investigation modes of operation power units diesel locomotives when operating "dual cockpit"

Having analysed the diesel fuel consumption by Donetsk Railways for recent 10 years from 2002 to 2011 it has been found that diesel fuel consumption on the railroad, on average, makes up 100.2 thousand tons of reference fuel, including annual 39.9 thousand tons of reference fuel, spent on shunting which makes up 40.0 % of all diesel fuel consumption by the Railway. The share of diesel fuel consumption by traffics on Donetsk Railways for 10 years is presented in Fig. 1.

On Donetsk Railways for shunting ChME3 diesel-locomotives with a two-unit set are used . Fuel consumption by one "dual cockpit" of ChME3 diesel-locomotive shunters with a two-unit set, is on average about 200 tons per year. Thus, annual fuel consumption by diesel-locomotive shunters with a two-unit set amounts 1000 tons of diesel fuel [7, 16 – 18].

Therefore, the search for solutions aimed at reducing the fuel consumption by diesel-locomotive with a two-unit set appears to be rather relevant [3, 5, 7, 16, 19 –21].

Fig. 1. Share of diesel fuel consumption on Donetsk Railways for 10 years by different traffics

The choice of ways of fuel consumption reduction by diesel-locomotives needs to be based on the nature and peculiarities of their operation.

ChME3 diesel-locomotive shunters with a two-unit set perform different shunting elements: pulling-out trains to the departure yard, switching, idle hours, reserve overtaking, coach shift because of difference in automatic coupler height, etc. For each of these elements the diesel generating set works in a certain mode.

The distribution of operating hours of diesel generating sets of diesel locomotives in different modes working on a two-unit set is shown in Fig. 2.

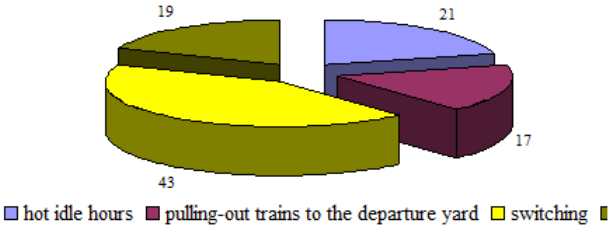

Fig. 2. Distribution of operating hours of diesel generating sets of diesel locomotives in different modes while working on a two-unit set

From Fig. 2 it is evident that diesel locomotives operate in traction mode 43 % of time per shift. The existing scheme of operation of ChME3 diesel locomotive shunters with a two-unit set can be as follows: either both diesel locomotives operate simultaneously in traction mode or one diesel locomotive can be plugged up.

The operation of both diesel locomotives in traction mode while switching is not always appropriate because of light weight of the trains, additionally while both diesel locomotives operate in traction mode, frequent changes of principal controller position will be observed, because tractive force will be great and it will necessitate continual adjusting of diesel generating set capacity, which can cause transit mode work and excessive fuel consumption [19 – 21].

One diesel locomotive stopping in wintertime is not possible due to low temperature of outer air, which can cause diesel freezing. In summer frequent diesel stopping's are impossible due to poor state of accumulator batteries.

When pulling-out trains to the departure yard 17% of time diesel-locomotive shutters work in traction mode.

Moreover, 21 % of time per shift make up hot idle hours, that is operating in idle mode, which can cause increased fuel consumption and a great deal of harmful emissions into the atmosphere.

Thus, analyzing the modes of ChME3 diesel locomotive shunters with a two-unit set, we can make a conclusion that in most cases diesel generating sets operate in non-economical modes.

Principal directions of longer use of diesel-locomotive shunter power plants are shortening operating time in idle mode and cutting time of transition processes (Fig. 3). A lot of studies carried out by national and foreign researchers are devoted to these questions [2, 5, 6, 8, 15, 18 – 24].

On the basis of this literature we can conclude that it is possible to cut time of transition processes by improving the controlling system of diesel generating sets of diesel locomotive. It is suggested to make engineering changes in the design of mechanically operated controller of the diesel rotational speed. In addition it is suggested that one should change mechanically operated controller of the diesel into automatically operated one. The implementation of such engineering solutions needs great capital investments, which is not reasonable.

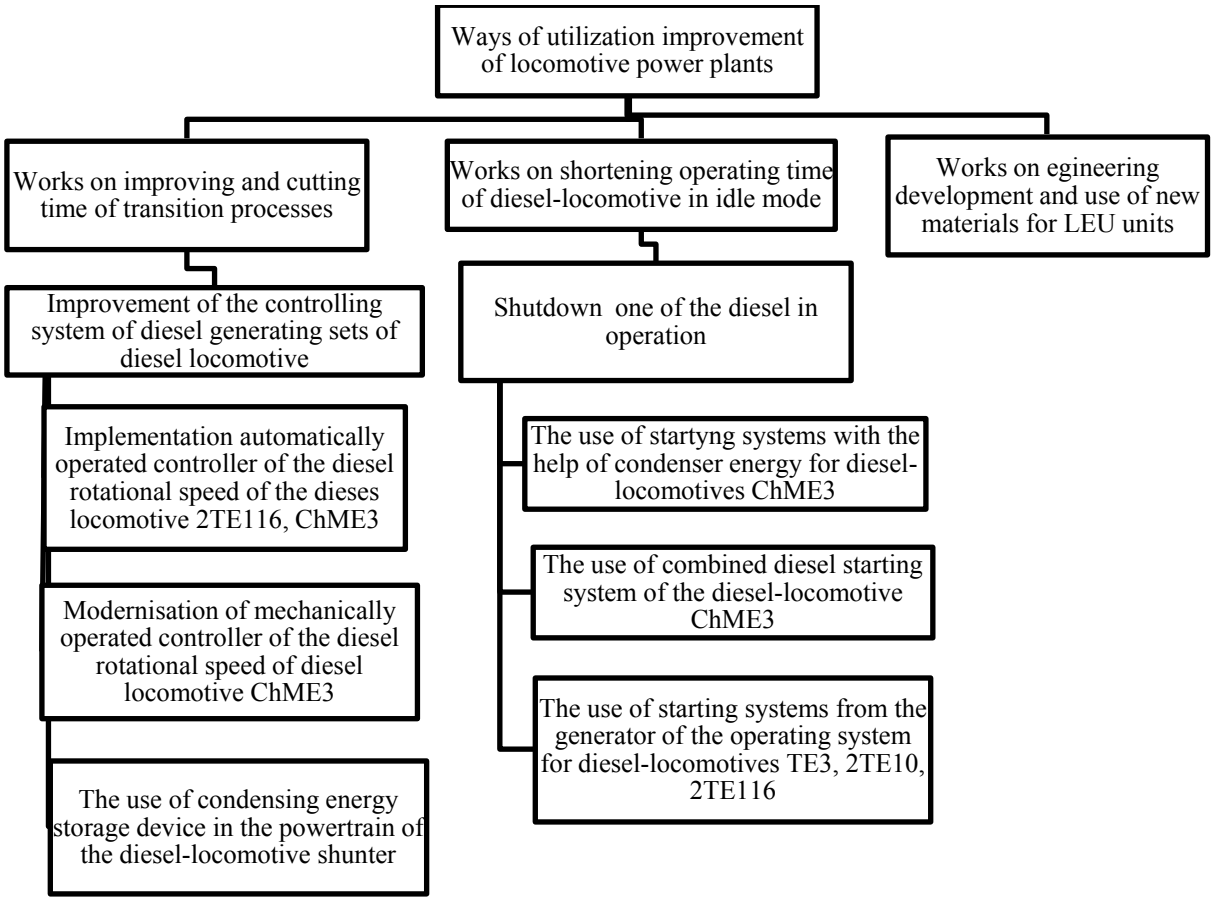

Fig. 3. Ways to make longer the use of locomotive power plants

Cutting time of transition processes of the diesel-locomotive shunters with a two-units set is possible by choosing optimal operation of diesel-generating sets of diesel locomotives during certain shunting operations without extra investments.

A lot of papers and engineering solutions are devoted to the problem of shortening operating time in idle mode. Basic solution of shortening operating time of the diesel-generating sets in idle mode is the shutdown of one of the diesels.

The shutdown of the diesel generating set, working with two units is possible during switching and idle hours. But it is necessary to develop new starting system by frequent shutdown of the diesels, while current system cannot allow frequent starts because of lack of time for recharging accumulator batteries. In addition, frequent use of accumulator batteries will raise demands for their technical state, which causes increase in expenses for their maintenance, replacement and repair.

A lot of starting systems of the stopped diesel generating locomotives are described in the literature. There are implementation of different energy storage systems, systems of warm start and heating, condensing starting systems. Suggested diesel starting systems of the diesel locomotives with energy consuming condensers are too expensive and need engineering changes and modernizations.

There are generator starting systems, suggested for diesel locomotives series TE3, 2TE116. Such systems can become analogs for starting systems developing from the generator of the operating diesel locomotive for diesel locomotive shunters ChME3 with a two-unit set. They do not need heavy capital investments and can save diesel fuel.

5. Testing results of research

Operation "two-unit" CME3 shunting diesel locomotives for shunting are the formation of cargo trainsand also on the gravity humps widely used on railroad of Donetsk railway. To improve the efficiency of their work has been taken a number of works for the optimum mode of operation of diesel generator sets, this will reduce the capital investment that a sufficient effect on fuel economy - energy and financial resources.

6. Conclusions

1. The article analizes fuel consumption by diesel-locomotives on Donetsk Railway for 10 years by types of traffic. The analysis has showed that 39.9 thousand tons of reference fuel are spent annually for shunting, making up 40.0 % of all diesel fuel consumption by the railroad.
2. The annual fuel consumption by diesel-locomotives with a two-unit set has been analyzed; makes up over 200 thousand tones in one dual cockpit.
3. The operation time of diesel generating sets of ChME3 diesel-locomotive shunters with a two- unit set in

various modes while performing shunting operations during the shift has been explored. Time analysis has showed that in most cased diesel generating sets work in uneconomic modes and the problem of choosing optimum operation is very urgent.

4. The article has studied the existing engineering solutions of growth of utilization rate of locomotive power plants of diesel-locomotives and has found out that there is no optimization of the operating mode of the diesel-locomotive shunters with a two-unit set. The above mentioned situations demonstrate the importance of carrying out scientific research, aimed at increasing the effectiveness of the use of diesel-locomotive ChME3 with a two-unit system, by choosing optimum operation of the diesel-locomotive engine.

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