ANALYSIS OF THE EFFICIENCY OF LOCOMOTIVES THE BY THE METHOD OF AVERAGING CALCULATED VALUES

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ABSTRACT

The results of the substantiation of the parameters of the main indicators of transportation work and fuel and energy efficiency of the use of mainline (train) freight locomotives of diesel traction during the movement of freight trains without stops and with stops on intermediate separate points on a virtual, hilly section of the railway. The average values of the kinematic parameters of the movement of freight trains and the energy indicators of the transportation work of diesel locomotives of the 3TE10M, UzTE16M3 series in quantitative and monetary terms were obtained by averaging the calculated values. It has been proven that UzTE16M3 diesel locomotives, in comparison with 3TE10M diesel locomotives, save diesel fuel and money for train traction by approximately 11.99 percent.

Keywords: study, freight train, diesel locomotive, railroad, parameter, diesel traction, calculated value, section, virtual.

The present studies are a logical continuation of the works [1, 2] and are aimed at substantiating the efficiency of the transportation work of diesel locomotives in real operating conditions.

The purpose of this study is to assess the fuel and energy efficiency of three-section mainline freight diesel locomotives 3TE10M and UzTE16M3 on a virtual hilly section of the railway, which is implemented using the method of averaging the calculated values, into account the differentiations of the compositions mass by value ΔQ=500t with a constant number of axles in composition equal to m = 200 axes.

The basis of the method of averaging the calculated values is the averaged values of the indicators of the movement of freight trains and the use of diesel locomotives UzTE16M3 and 3TE10M, which are defined as arithmetic mean values for both types of movement in the range of changes in masses of trains adopted by us, taking into account the subsequent comparison these
aforementioned values among themselves. The latter circumstance will allow (pro) to analyze the qualitative component of the implementation of the transportation process by diesel locomotives UzTE16M3 and 3TE10M on a given virtual hilly section of the railway.

Such statements are fair and quite objectively substantiated by numerous studies [1, 3, 4] on the effectiveness of the use of various types of locomotive traction for a wide range of various conditions for organizing freight traffic in operation.

In table 1 show the average values of the indicators of the movement of freight trains and of the use of locomotives of diesel traction for different variants of traction calculations.

Table 1.

<table>
<thead>
<tr>
<th>Traction of calculation option</th>
<th>Conditions of transportation work</th>
<th>Train travel time, min</th>
<th>Diesel fuel consumption</th>
<th>Cash costs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>composition mass Qt, kg</td>
<td>technical speed of motion Vt, km/h</td>
<td>total, t, in traction mode, t1, in idling and braking mode, t2i</td>
<td>specific per trip Еи, kg</td>
</tr>
<tr>
<td>Diesel locomotives UzTE16M3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2 2500 200 80,13 34,55 22,95 11,60</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>3000 200 77,83 35,62 25,00 10,62</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 3500 200 73,80 37,52 26,12 11,40</td>
<td></td>
<td>5 6 7 8</td>
<td>9</td>
<td>10 11</td>
</tr>
<tr>
<td>Diesel locomotives 3TE10M</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2500 200 80,13 34,55 22,95 11,60</td>
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</tbody>
</table>

Using the standard Microsoft Excel Office program, we obtained analytical expressions (polynomial dependencies) designed to calculate the parameters of some basic indicators of the transportation operation of diesel locomotives UzTE16M3 and 3TE10M on a hilly section of the railway for any i-th mass of the train Qi, where \( R^2 = 1,0 \) - a sufficient value of the approximation reliability (the necessary reliability condition is \( R^2 \geq 0,8 \)), and \( Qi = 1,2,3 \) is a traction calculation option.

Formulas for determining the parameters of some basic indicators of the transportation work of diesel locomotives UzTE16M3 and 3TE10M are given, respectively, in the numerator and denominator, with the exception of the technical speed, which will be the same for both diesel locomotives.

Technical speed of motion, km/h

\[
V_t = -0.865Q_i^2 + 0.295Q_i + 80.77 \quad R^2=1,0
\]  \( (1) \)

Total of natural diesel fuel consumption per trip, kg

\[
E = -9.87Q_i^2 + 75.37Q_i + 462.32 \quad / \\
E = -10.66Q_i^2 + 82.53Q_i + 579.69 \quad R^2=1,0
\]  \( (2) \)

Specific consumption of natural diesel fuel per trip, kg/10^4t km gross

\[
e = 0.005Q_i^2 - 4.355Q_i + 50.34 \quad /
\]

\[
e = 0.235Q_i^2 - 5.825Q_i + 57.14 \quad R^2=1,0
\]  \( (3) \)

Full cash costs of natural diesel fuel \( C_i \), thousand soums

\[
C_i = -17.47Q_i^2 + 133.47Q_i + 818.57 \quad / \\
C_i = -18.86Q_i^2 + 146.06Q_i + 920.14 \quad R^2=1,0
\]  \( (4) \)

Present value of natural diesel fuel \( c_i \), thousand soums /km

\[
C_i = -0.3825Q_i^2 + 2.9145Q_i + 17.827 \quad / \\
c_i = -0.405Q_i^2 + 3.155Q_i + 20.07 \quad R^2=1,0
\]  \( (5) \)

On fig. 1 shows the dynamics of the averaged parameters of some main indicators of the use of diesel locomotives UzTE16M3 and 3TE10M on a given virtual hilly section of the railway, where the values of specific consumption \( e, \) kg/104 t km of gross natural diesel fuel per trip for diesel locomotives 3TE10M and UzTE16M3 are increased by 10 and 15, respectively once.
Analysis of the results of the conducted research showed the following:

- the dynamics of the average values of the parameters, some of the main indicators of the use of the studied diesel locomotives, depending on the mass of the freight train, is described by polynomial laws;
- an increase in the mass of the composition and the operating time of power power plants of diesel locomotives UzTE16M3, 3TE10M in traction modes leads to an increase in the amount of diesel fuel consumed by them for train traction;
- for the studied series of diesel locomotives, a consistent increase in the mass of the composition of freight trains for every $\Delta Q = 500$ tons leads, respectively, to an increase in the cost of rail transportation of goods and a decrease in the specific consumption of diesel fuel for train traction;
- diesel locomotives UzTE16M3, in comparison with diesel locomotives 3TE10M, with a differentiation of changes in the mass of the train in $\Delta Q = 500$ tons, save diesel fuel for train traction and money for the transportation of goods, on average, by approximately 11.99 percent.

Thus, the replenishment of the locomotive fleet with new, modernized, mainline freight diesel locomotives of the UzTE16M series in various sectional designs will provide better indicators for the use of diesel traction and reduce the cost of freight rail transportation on a virtual hilly section of railways.

The analytical dependencies (regression equations) obtained by us will be useful to drivers-instructors in heat engineering and specialists of the locomotive complex, whose work is directly related to the organization and implementation of the transportation process of traction (main) diesel rolling stock in freight of motion.

Reference: