6th Transport Research Arena April 18-21, 2016

Calculation of the parameters of hybrid shunting locomotive

Anatoliy Falendysh [a], Pavel Kharlamov [a], Olga Kletska [a,*], Nikita Volodarets [a]

[a]Ecspluatation and repair of rolling stock chair, Ukrainian state university of railway transport, Kharkov, Ukraine

Abstract

The major part of the locomotives under operation requires increase of the maintenance and repair expenditures by 40-60% in comparison with the modern models. Creating a hybrid shunting locomotive is an effective solution to the shortage of finance and the high cost of a new locomotive fleet. It was the analysis of methods and models for determining the technical and economic parameters of hybrid vehicles, which have been developed by scientists from different countries. It was created a mathematical model to determine the optimum parameters of the motor and energy storage, depending on the operating conditions. It was calculated coefficient of technical level, life cycle and on the basis efficiency ratio is defined hybrid shunting locomotive for different operating modes, which fully confirms the efficiency of introduction this type of locomotives instead of the diesel locomotive series CHME3. Traction calculations confirm the efficiency of proposed solutions.

Keywords: Hybrid shunting locomotive; rational parameters; model; power plant; storage

1. Introduction

The state of the shunting locomotive stock of Ukrainian railways fails to satisfy the railroad transport needs and to meet European transportation service quality standards in Sergienko N. (2010), Lashko A., Samsonkin V., Goncharov

---

* Corresponding author:
  E-mail address: gurao@yandex.ru

A., Konovalov A. (2006) throughout many parameters. The major part of the locomotives under operation requires increase of the maintenance and repair expenditures by 40-60% in comparison with the modern models.

Problem statement. The analysis of the shunting locomotive operation has revealed that they are characterized by sharp changes in the operation mode whereby 50-60% of the operational time is taken by the run at idle speed, 45-70% - under low loads and only 2-5% of the operational time – under the nominal ones.

One of the methods to increase the cost effectiveness of operation of the shunting locomotive is replacement of diesel generator unit with the low power energy storage units. Apart from the economic factor, such a locomotive modernization will allow to improve environmental values.

The attempts to implement hybrid power transfer at the railroad transport have been made all over the world in Falendysh A.P., Volodarec N.V. (2010). Nevertheless, all operated shunting locomotives produced in Ukraine use the transmission without energy storage.

Analysis of the recent studies and publications. Many scientists from different countries have been conducting researches to determine the performance parameters of motive power for a long period of time in Wolfs P. (2005), Donnelly, F.W.; Cousineau, R.L.; Horsley, R.N.M. (2004), Akli, C.R.; Sareni, B; Roboam, X; Jeunesse, A. (2009), Lohner, A.; Evers, W. (2004), Yap, H.T.; Schofield, N.; Bingham, C.M. (2004), Cousineau, R. (2006), Liudvinavičius, L. Lingaitis, L.P. (2011), Liudvinavičius L., Lingaitis L.P. (2010). Under the analysis results for the scientists' works, the methods of selection of power unit parameters have been broken down into five categories: the methods based on the average locomotive performance indicators; the methods based on the comparative evaluation of various options with the total power selected under the primary standard depending on the predetermined locomotive operation mode (with and without recuperation); the methods based on loading of the power unit while operated at certain areas (the power unit is selected under the average power and the energy storage –under energy deficiency); the methods under which the energy storage is selected based on the performance indicators of its exploitation.

It has been discovered that these methods fail to account for either the cost parameters, the actual operation conditions, the dimension and mass indicators of the energy storage and power unit or these parameters combined. For this purpose, it is necessary to improve the reviewed methods taking into account the gaps hereinabove.

Objective. The objective of the article is to calculate the parameters of hybrid shunting locomotive and elaborate the corresponding models.

Research results. There are many varieties of hybrid locomotive traction drive systems [3-11]. They use various patterns and elements. Based on the analysis of these systems, the generalized schematic structure of power circuit of shunter with hybrid power transmission (fig.1) has been created.
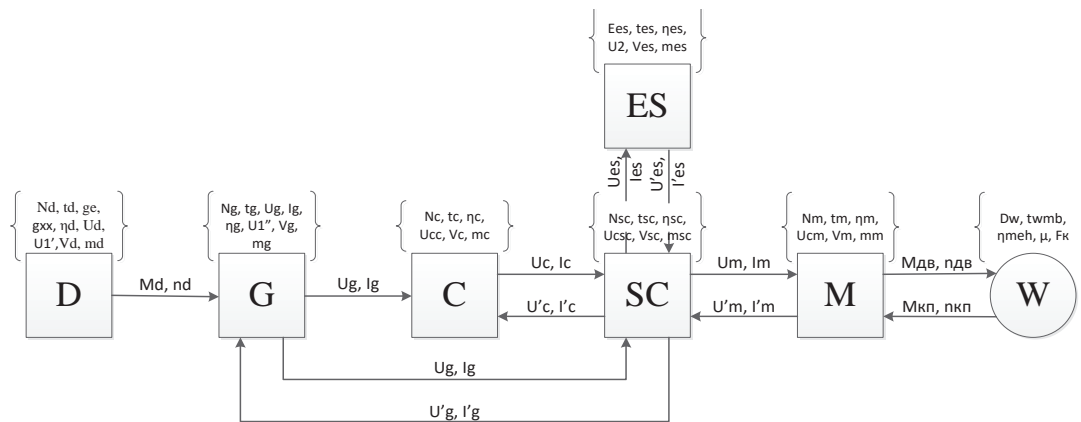
D - diesel; G - traction generator; C- converter; SC - control system; ES - energy storage; M - traction motor; W – wheel set

Fig. 1. Structural diagram of the shunter locomotive power circuit with hybrid transmission.

The energy is transferred to the generator from a diesel, then to a converter, if available, and then to the control system. The control system connects the energy storage, the electric traction and the traction generator. In the traction