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Evaluation of Current Powertrain for Specific Railway Vehicle Traction and Energy Characteristics

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INTRODUCTION

The deployment of electricity in rail infrastructure is preceded by electrification. However, full electrification may not always be feasible. In such cases, alternative solutions and propulsion sources must be explored. One promising option is the conversion of existing diesel-powered vehicles to hydrogen-powered system.

The research is grounded in analyses of traction/brake work, running resistances, speeds, and the applicability of the traction characteristic, considering the energy parameters of the vehicle. The approaches and methodology are described in detail (computational model, its components and their interrelationships).

The analyses were carried out for selected track sections with specific characteristics, for which parameter data were obtained through experimental measurements. The insights gained from the investigation of energy ratios provide a crucial foundation for the subsequent design of alternative rail vehicle propulsion system.

MATERIALS, METHODS & IMPLEMENTATION

The study presents research focused on analyzing the running characteristics of the railway vehicle, the railway motor unit type 861, in the context of a potential propulsion system change, through a series of simulation calculations. To enable the conversion of the vehicle powertrain, it is essential to investigate the running characteristics of the original vehicle concept on selected lines in Slovakia. A series of simulation calculations were carried out to compare the running characteristics of the two rail multiple unit concepts. These calculations focused on key parameters such as speed, tractive effort, running resistances, and the efficient utilization of the traction characteristics across specifically defined track sections. The simulation calculations were carried out in the Matlab Simulink environment. For the simulation, it was necessary to convert the graphical data into a tabular format that defines the main input parameters of the vehicle, including traction characteristics, braking characteristics, and values of individual running resistance.

RESULTS

Due to the limited scope of this article, there is presented the results for two track sections with significant profile differences: Prievidza - Horná Štubňa (Fig. 1) and Prievidza - Topoľčany – Nitra (Fig. 2) . The first track section Fig. 1 is characterized by a lower line speed and contains significant gradients and tunnels, passing through several mountain sections. This section was chosen with the aim of maximizing the traction characteristics of the vehicle (railway motor unit type 861- Fig. 3, particularly on the steep gradients of the line. The second track section Fig. 2 was selected for its potential to reach higher speeds, up to 100 km/h, and is characterized by a relatively flat track profile with minimal elevation changes.
Based on the input parameters, there is performed a simulation of a vehicle using the current drive concept on selected lines. As mentioned before, the simulation of the existing propulsion is crucial to compare its performance across specific track sections.
The analysis of the simulation results for the train route section Prievidza - Horná Štubňa (Fig. 1) indicates that the vehicle is capable of reaching the required speed between stops, even with maximum passenger occupancy and when operating on an irregular track. Therefore, the current propulsion system is fully suitable for lines with steep gradients and lower speeds, which is essential for further comparison of the different propulsion concepts.
For lines with higher speeds and a flat profile, there is selected the Topoľčany - Nitra section (Fig. 2) , where the maximum track speed reaches 100 km/h. This section was chosen to compare the vehicle's ability to achieve the highest track speeds with different propulsion systems. In this section, the vehicle also reached the desired speed between stops, demonstrating that the current powertrain is suitable for tracks with a flat profile as well.

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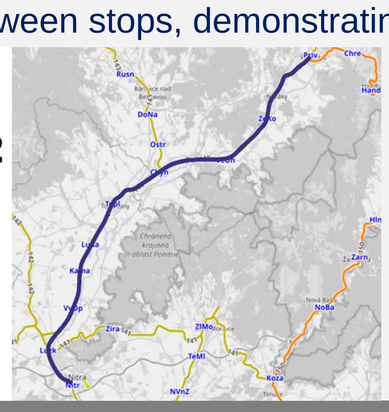

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CONCLUSION & IMPLEMENTATION PATH

This research provided a comprehensive analysis of the current propulsion system of a rail motor unit under two distinct operating conditions: a rugged profile with gradients and tunnels and a flat profile allowing higher speeds. By conducting detailed simulations based on precisely defined input parameters, the study evaluated the vehicle's running characteristics, energy consumption, and traction performance. The results demonstrated that the current propulsion system is well-suited for both track types, achieving the required speeds and handling the varying demands of the routes.
These findings establish a solid foundation for further investigation into alternative propulsion systems, such as zero-emission technologies. Future studies will apply the same methodology to evaluate the performance of these systems on identical track sections. This comparative analysis will determine whether an alternative powertrain can meet or exceed the operational effectiveness of the current system, paving the way for environmentally sustainable advancements in rail transportation.

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