

Assessment of the worthwhileness of efficient driving in railway systems with high-receptivity power supplies

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Abstract-

Eco-driving is one of the most important strategies for significantly reducing the energy consumption of railways with low investments. It consists of designing a way of driving a train to fulfil a target running time, consuming the minimum amount of energy. Most eco-driving energy savings come from the substitution of some braking periods with coasting periods. Nowadays, modern trains can use regenerative braking to recover the kinetic energy during deceleration phases. Therefore, if the receptivity of the railway system to regenerate energy is high, a question arises: is it worth designing eco-driving speed profiles? This paper assesses the energy benefits that eco-driving can provide in different scenarios to answer this question. Eco-driving is obtained by means of a multi-objective particle swarm optimization algorithm, combined with a detailed train simulator, to obtain realistic results. Eco-driving speed profiles are compared with a standard driving that performs the same running time. Real data from Spanish high-speed lines have been used to analyze the results in two case studies. Stretches fed by 1 × 25 kV and 2 × 25 kV AC power supply systems have been considered, as they present high receptivity to regenerate energy. Furthermore, the variations of the two most important factors that affect the regenerative energy usage have been studied: train motors efficiency ratio and catenary resistance. Results indicate that the greater the catenary resistance, the more advantageous eco-driving is. Similarly, the lower the motor efficiency, the greater the energy savings provided by efficient driving. Despite the differences observed in energy savings, the main conclusion is that eco-driving always provides significant energy savings, even in the case of the most receptive power supply network. Therefore, this paper has demonstrated that efforts in improving regenerated energy usage must not neglect the role of eco-driving in railway efficiency.

Index Terms- railway transport; eco-driving; energy efficiency; optimization algorithm; power systems

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Citation:

Cunillera, A.; Fernández Rodríguez, A.; Cucala, A.P.; Fernández-Cardador, A.; Falvo, M.C. "Assessment of the worthwhileness of efficient driving in railway systems with high-receptivity power supplies", Energies, vol.13, no.7, pp.1836-1-1836-24, April, 2020.