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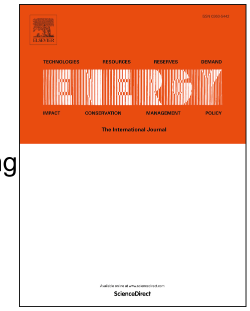

A high-efficiency energy regenerative shock absorber using helical gears for powering low-wattage electrical device of electric vehicles

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A high-efficiency energy regenerative shock absorber using helical gears for powering low-wattage electrical device of electric vehicles

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Abstract

In this paper, a regenerative absorber based on helical gears and dual tapered roller clutches is presented for electric vehicles. The absorber can scavenge energy that dissipated in the suspension from vibrations induced by the road roughness. To achieve this, three parts are necessary in the proposed absorber, which are the suspension vibration input module, the transmission module and the generator module. These are installed between the chassis and the axle. The suspension vibration input module transmits kinetic energy to the transmission module, and moves the shafts bi-directionally. The transmission module consists of helical gears and one-way clutches, and converts the bi-directional shaft motion to unidirectional motion for a motor. The generator module generates electric energy to power the low-wattage electrical device of electric vehicles. The characteristics of this homemade prototype containing different helical gear angles are studied using a Mechanical Testing and Sensing test fixture. A peak efficiency of 52 % and an average efficiency of 40 % are demonstrated in the bench tests, verifying that the proposed regenerative absorber is effective and practical for renewable energy applications in electric vehicles.

Keywords: Regenerative shock absorber; Helical gears; One-way clutch; low-wattage electrical device

1. Introduction

In recent years, the worldwide energy crisis has become more serious, and the number of fuel vehicles is increasing sharply. These phenomena put pressure on fossil fuel supplies [1] and cause hazardous emissions, including carbon monoxide, nitrogen oxide and hydrocarbon pollution [2]. Many automakers worldwide are beginning to pay more attention to the progress of electric vehicles (EVs), which are regarded as alternatives to traditional fuel vehicles because the energy-savings and clean environmental impact they have [3]. However, power supply for electric vehicles is a serious challenge and is hampered by various characteristics of the fuel cell, such as capacity, materials and reliability. Recently, some solutions of power supply for EVs concentrating on power management strategy, energy management strategy, fast charging strategies, signalling strategy for the public fast charging station and analysis of fast charging station for EVs have been developed. Du et al. [4] have investigated an optimal design method of global optimization-based strategy to improve the energy efficiency of range-extended electric buses. Li [5] has presented an optimal control-based energy management strategy for a parallel hybrid electric vehicle. The simulation results showed that control strategy enable to reduce battery wear by decreasing battery operating severity factor. In the literature [6], Brito assessed the use of fast charging stations for Electric Vehicles and an energy and cost analysis showed that this concept was technologically and economically viable. Tomislav [7] has propsed a flywheel-Based internal power balancing strategy for fast charging stations and this strategy has been validated through real-time simulation. Zenginis et al. [8] analyzed the operation of a fast charging station based on using a novel queuing model and the precision of the proposed analytical model was confirmed based on simulations. In addition to these solutions, energy recovery also has the potential to increase energy efficiency and is a prospect that may lead to a better solution. Khalfan and Khalfan [9] have conducted an experimental analysis to investigate the possibility of generating energy through the weights of vehicles running on the roads. Briggs [10] has investigated the exhaust energy recovery on a diesel-electric hybrid bus using whole vehicle modelling and the results have showed that the proposed turbogenerator produce a valuable reduction in fuel consumption. Zhang et al. [11] have developed a high-efficiency electromagnetic energy harvesting system to scavenge the vibration energy of rail track. The results showed that an efficiency of 55.5% could be obtained