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Energy recovery hybrid system with the flywheel

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Abstract: The coupling of drive units of electric and hybrid vehicles with flywheel-based kinetic energy recovery systems is one of the best suitable options to reduce fuel energy usage. And, in consequence, it is also a convenient method to reduce greenhouse gas emissions. The essence of the work will be to design a hybrid traction system cooperating with a flywheel that collects kinetic energy during vehicle braking.

Keywords: electric and hybrid vehicles, flywheel energy storage system, continuously variable transmission

1. Introduction

Electric cars are well known already over one hundred years, but despite this, they are only now beginning to appear on the streets of cities in a noticeable number. Despite the view of many people, an electric car is not a modern idea at all. It cannot be unambiguous to attribute the invention of the electric vehicle to only one originator. In 1828, a Hungarian engineer, physicist, and Benedictine priest, Ányos István Jedlik, created a tiny model of some vehicle powered by the world's first electric motor invented by him. Robert Anderson, the Scottish inventor, created the first-ever prototype of such a vehicle (exactly an electric crude carriage) between 1832 and 1839 (the exact year is uncertain). Non-rechargeable primary power cells powered his electric carriage. However, in 1835 Sibradus Stratingh (Dutch professor of chemistry, as well as an inventor), with Christopher Becker, his assistant, constructed a small-scale cart called the forerunner of the electric car. Their cart used the voltaic pile. Other great inventors built themself their vehicles powered by electricity. One of them was Thomas Alva Edison. Inventors of electric cars were facing to find as possible both extremely capacious- and durable batteries at those times. By the way, it applies especially to current times as well. Rechargeable batteries of modern electric cars provide them approximate ranges from 100 to over 500 km, depending on their capacities. The maximal car driving range above about 500 km often requires an application of rechargeable batteries with a total capacity of over 100 kWh. For small cars, ranges of 250 km are possible owing to rechargeable batteries of a capacity of 30 kWh at least.

However, the common problem in the electric vehicle implementation on a large scale is that they require a long time to full charge (repeatedly longer than refuelling at a gas station). Compared to internal combustion-powered cars, the most popular electric vehicles are not yet providing such long ranges.

In many electric vehicles, additional cooling and/or heating systems provide advantageous conditions for rechargeable battery packs that guarantee their high efficiency. Such systems also occur in advanced hybrid cars with expanded battery packs. At present, engineers and scientists have coped with many initial technological barriers limiting the application of electric vehicles from 100 years ago. Increasing the driving range of electric cars in a built-up area of cities with frequent start-stops can be performed utilizing kinetic energy recovery systems. However, such systems have a less meaningful effect on fuel efficiency during highway driving. For electric and hybrid vehicles recovering kinetic energy through regenerative braking seems to be very promising (see [1] & [2]). A flywheel energy storage system is often used. However, the advantage of such energy storage technology in mechanical form is partly lost when this system has electrical or hydraulic type transmission. Such systems with flywheel require the application of low-cost, high-efficiency, continuously variable transmissions. Up to now, no completely satisfactory solution has been found.

2. Results and Discussion

The work aim is to build a modified hybrid kinetic energy recovery system with the flywheel. This system uses an innovative, continuously variable transmission of mechanical energy. An additional benefit resulting from the application of this system will be the improvement of a vehicle's stability by reducing loss of traction (skidding) during braking and acceleration. The torque, M, generated by the flywheel due to the angular momentum change over time will protect against squat, dive, and lift of the vehicle body, as shown in Fig. 1. In other words, this system alters and controls the amount of compression of suspension springs due to acceleration, deceleration, or braking conditions. In Fig. 1, F_{IN} is the inertial force (also called a fictitious force), which appears to act on a vehicle body whose motion is described using a non-inertial frame of reference, such as a deaccelerating reference frame, in the considering case.

Verification calculations were carried out using the SCILAB development environment to verify the correctness of the design of the vehicle's traction control system.

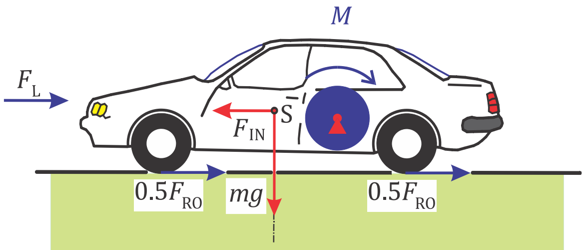

Fig. 1. Forces acting on the vehicle during braking

3. Concluding Remark

This concept of the drive of electric and hybrid vehicles belongs to energy-saving methods. Thus, this method makes the reduction of greenhouse gas emissions possible.

References

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