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Suspension System Using Energy Regeneration

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ABSTRACT: ***Vehicles are developing within the direction of energy-saving and electrification. Suspension has been widely developed within the field of vehicles as a key component. Traditional hydraulic energy-supply suspensions dissipate vibration energy as waste heat to suppress vibration. This a part of the energy is especially generated by the vehicle engine. So as to effectively utilize the energy of this part, the energy-regenerative suspension with energy recovery converts the vibrational energy into electricity because the vehicle's energy supply equipment. This text reviews the hydraulically powered suspension of vehicles with energy recovery. The importance of such suspension in vehicle energy recovery is analyzed. The most categories of energy-regenerative suspension are illustrated from different energy recovery methods, and therefore the research status of hydraulic energy-regenerative suspension is comprehensively analyzed. Important factors that affect the shock-absorbing and regenerative characteristics of the suspension are studied. Additionally, some unresolved challenges also are proposed, which provides a reference value for the event of energy-regenerative suspension systems for hybrid new energy vehicles.***

KEYWORDS: Energy Regeneration, Regenerative Suspension, Shock Absorber Suspension System.

INTRODUCTION

Since the energy-saving idea was introduced within the 20th century, energy efficiency has gained attention within the industry. Unlike traditional energy-regenerative suspension, which may only absorb vibration passively, the energy-regenerative suspension with energy recovery cannot only recover vibration energy but also convert it into electricity, which may be stored in devices as power supply[1]. Existing research and technical means confer the suspension with characteristics of nonlinearity and variable stiffness to realize smooth driving on flat pavement and absorb considerable impact energy when driving on bad pavement, thereby effectively isolating and attenuating the vibration excitation of the pavement to the car body . A regenerative suspension is introduced within the vibration exciter assembly to attenuate or eliminate the energy generated by the excitation vibration within the vertical direction[2]. This technique converts energy into electromagnetic energy through an actuator, and therefore the electromagnetic energy is stored by energy storage elements, which may reduce vibration and recover excess energy.

Harvesting wasted energy is a way to improve fuel economy of vehicles. In design practice, energy regeneration is especially achieved through regenerative braking techniques. Although this method is sort of effective, there are still other energy losses, that current vehicles have a limited or no means of recovering[3]. The conventional shock dampens vehicles unwanted vibration by means of viscous damping and cooling. There exists a substantial amount of harvestable energy is wasted within the suspension under the operation of road vehicles. Regenerative shock absorbers are reported within the literature with a particular focus on electromechanical regenerative devices. Attention has also been paid to the regenerative shock absorbers. The hydraulic designs show promising energy-regenerative benefits considering the very fact that hydraulic systems/components are commonly utilized in road vehicles[4].

Typically, there exist some design trade-offs for energy regeneration and control in vehicle suspension. The relationship among energy harvesting, ride comfort, and road handling was

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analyzed and discussed during a design of regenerative vehicle suspension. Past investigations on regenerative suspension systems were mainly supported numerical simulations, while little attention had been paid on prototype evaluation of those energy harvesting systems[5]. This paper presents the planning and prototype assessment of a hydraulic-electric energy regenerative shock (HEERSA). To estimate the P.E. that would be harvested by the HEERA, a quarter vehicle model is generated, and simulations are conducted under the road conditions specified by ISO-8608. Built upon the simulations using MATLAB and CarSim software packages, a physical prototype of the HEERSA has been fabricated using off-the-shelf components. The experimental apparatus is in a position to realize variable stroke and an adjustable frequency of excitation. The prototype has been tested under various road conditions so as to examine the feasibility of the appliance of the HEERSA.Most of the research is predicated on the influence of road irregularity and driving speed on the energy recovery efficiency of passenger cars, while the impact on vehicle parameters has only been proposed during a few studies. Therefore, additionally to the analysis of the hydraulic energy-regenerative suspension, the impact of auto adjustment parameters on the recovery efficiency of the energy-regenerative suspension was further analyzed.

The main contributions of this work consider three aspects,

1. The general design scheme of the energy-regenerative suspension is meant, and therefore the model of the energy-efficiency of the hydraulic energy-regenerative suspension is established.
2. The influence factors of auto adjustment parameters on the recovery efficiency of the hydraulic energy-regenerative suspension were qualitatively analyzed, and therefore the dynamic characteristics of the double-tube shock were simulated and analyzed.
3. Aiming at the differences within the efficiency of current hydraulic energy-regenerative suspension key challenges are raised.

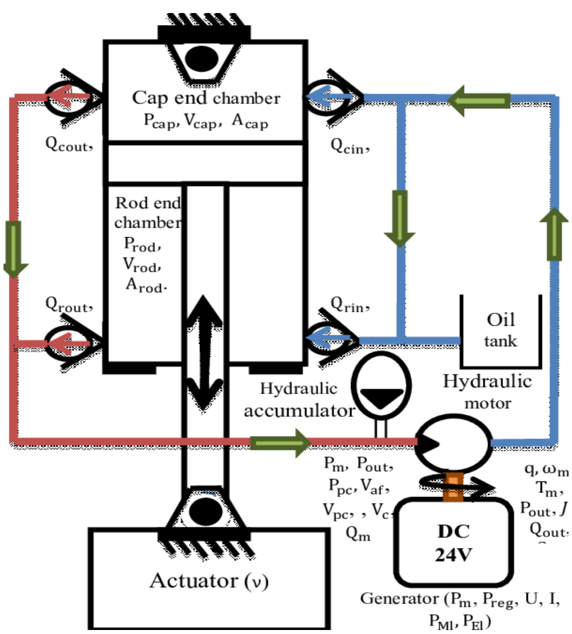

Figure 1: Energy Regenerative Suspension System[6]

The shock absorber removes the energy dissipated within the suspension from the vibration caused by rough pavement (figure 1). The shock needs three parts, namely, suspension vibration input, transmission, and generator modules. The suspension vibration input module transfers K.E. to the transmission module, which makes the shaft move in both directions. The transmission module consists of helical gear and one-way clutch, which converts the motor's two-way shaft movement into one-way movement. The generator module generates electricity to power the low-power electrical devices of electrical vehicles. The entire damping force of the energy-regenerative damper is split into equivalent controllable and passive damping forces. The equivalent controllable damping force is that the rotary resistance of the hydraulic motor caused by the back-emf of the generator, which is used to realize the semi active control of the suspension. The passive damping force is that the uncontrollable damping force caused by the rotation resistance of no-load rotation and therefore the passive damping of orifice and oil pipelines within the actuator. A DC brushless generator is employed, and therefore the obtained three-phase AC power is converted into DC by full-wave rectification to charge the battery.

Hydraulic regenerative suspension system

A regenerative safeguard is a sort of safeguard that changes over parasitic discontinuous direct movement and vibration into helpful energy, for example, power. Customary safeguards basically disseminate this energy as warmth. At the point when utilized in an electric vehicle or mixture electric vehicle the power created by the safeguard can be redirected to its powertrain to expand battery life. In non-electric vehicles the power can be utilized to control embellishments, for example, cooling. A few unique frameworks have been grown as of late, however they are still in phases of improvement and not introduced on creation vehicles.

CONCLUSION

The introduction of the energy-regenerative system within the traditional suspension can improve the energy utilization rate of vehicles on the one hand and be beneficial to energy regeneration on the other hand to enhance the great performance of vehicles. Combined with the research on the existing hydraulic energy-regenerative suspension of vehicles, additionally to the loss of hydraulic energy-regenerative within the process of energy consumption, there's also a neighborhood of the loss within the process of turning energy to electric. The way to reduce the general energy consumption will be a crucial problem. Additionally, the matching problem of the hydraulic energy-supply suspension system and therefore the vehicle power grid should even be considered. When the hydraulic energy-regenerative system is applied to the vehicle, although the vehicle features a large capacity of energy storage equipment, it still must solve the matter of matching charging equipment and charging equipment.

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