Field test of regenerative suspension system on an actual vehicle

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ABSTRACT – The technology of hybrid and electric vehicle are rapidly developed in the past few years because the main resource of vehicle energy is not renewable which is known as fossil fuel. It will be depleted in the future. This research emphasizes the test of the energy regenerative suspension system (EReSS) that uses as the alternative energy resource for the vehicle. It can be used on the vehicle as it can produce voltage output for charging the vehicle battery or other electronic components. The EReSS is attached to the stock vehicle suspension system and the test is done on a road with low traffic situation with various conditions. The voltage produced by the EReSS is maximized by optimizing the resistor in the circuit of half bridge which converts the alternate current (AC) to direct current (DC). The maximum voltage produced by the EReSS during the test is recorded and discussed.

1. INTRODUCTION

All vehicles have suspension system installed that uses to isolate the car from road disturbance and balance the contact between the tyre and the road. This system used on vehicle to achieve comfort driving and road holding [1,2]. Most of the mechanical energy on the suspension system is converted to heat and it is believe that the energy can be harvested and uses for other usage. The research on harvesting energy from suspension system is getting popular and taken much interest by many researchers [3,4].

They introduce several types of regenerative system that can be use on the vehicle suspension system as a harvesting device. There are several types of system introduced such as piezoelectric, electromagnetic and hydraulic. From all the research, mostly their regenerative system can harvest energy but different in results which some is small value and some is high value of voltage produces [5,6]. The energy harvested from the suspension can be used for the vehicle itself for electronics usage and charging the battery. This will reduce the workload of the alternator which is the main resource of charging the vehicle battery [7,8].

In this paper, an electromagnetic regenerative suspension system [9] that is self operates is tested on an actual vehicle. This is to predict the function and voltage generated by the regenerative system.

2. METHODOLOGY

The electromagnetic regenerative suspension system is designed and the system does not disturb the vehicle original suspension system where the regenerative system is only attached to suspension system as shown in Figure 1.

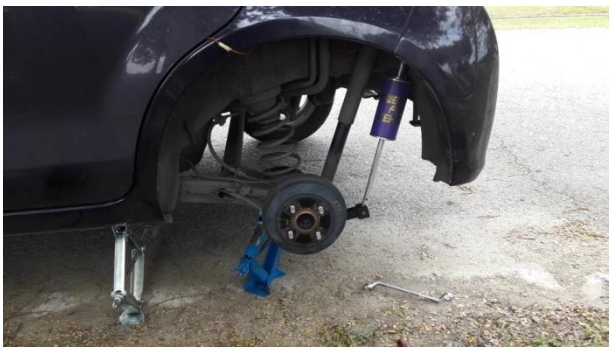

Figure 1 Regenerative system is attached to the vehicle.

The diameter of the coil is changed when each type of diameter of coil test is completed. The diameter of the coil for test is 0.29 mm, 0.4 mm and 0.8 mm using copper. The magnet uses for the test remain the same which is permanent magnet (NdFeb) grade N35 with Ni coating. The length, width and thickness of the magnet is 30 mm, 15 mm and 5 mm respectively which six (6) pieces used in the regenerative system. The regenerative system is attached to the rear left vehicle suspension system. The test is made in a low traffic road with various road conditions such as corner, slope and bump. The test goes through the road for three (3) times to see the reading different of voltage produces by the regenerative system for a long driving maneuver.

3. RESULTS AND DISCUSSION

The test is completely done for all of the parameters set. The test data is recorded by using a multi-meter and a half bridge circuit to convert the AC voltage to DC voltage. The data is recorded from the output of the bridge. The data is then analyzed to get the maximum voltage generated by the regenerative system. By using the different value of resistor, the voltage produced can be maximized and the parameters used can be optimized. This is to ensure that the system generated the best voltage charge for the vehicle usage.

The maximum voltage generated by the regenerative system by using the electromagnetic principle is shown in Table 1 with different value of resistor in the bridge and different diameter of the coil used for the each test.

Table 1 Voltage generated by the regenerative system.

Diameter of coil (mm)/	**Voltage (V)**			
Resistor value (Ohm)	**1 M**	**2 M**	**3 M**	**700 k**
0.8	8.6	9	8.7	8.4
0.4	7.9	11.3	13.1	9.8
0.29	17.2	17.2	14.7	13

The maximum voltage produced by the regenerative system is 17.2 Volts by using the 0.29 mm diameter of the coil and 2 M Ohm resistor. Thus, the resistor that is suitable to be used on the car test is 2 M Ohm where most of the voltage produced is the highest. Highest voltage generated will be more useful for the vehicle. From the results, it is get that the diameter of the coil also plays important role for the regenerative system where the smaller the diameter of the coil the higher the voltage generated. This is because smaller diameter can maximize the number of windings of the copper coil in the regenerative system. The highest value shown is when the car is taking a corner in an upward slope followed by downward slope. During this time, the vehicle suspension system movement maximized the regenerative system displacement thus highest voltage is generated. The other value that is higher is when the vehicle is in braking and moving through a bump but the voltage is not as high as taking the corner with a slope. In a normal cornering, the voltage higher than only moves in a straight road. A slalom type of driving maneuver will give out more voltage where the frequency of the suspension system is higher.

In a constant driving in a straight road, the voltage reading is slightly lower but with a constant charge. This voltage generated by the regenerative system can be used for vehicle electronics system such as lighting and electronic control unit (ECU). Other than that, the voltage can be uses as alternative source of energy for charging the vehicle battery. Thus, the main source of power supply unit which is the alternator usage can be reduced. As the alternator usage is reduced, the workload on the vehicle engine is also reduced and the fuel consumption will be also reduced.

As a result, the natural fuel fossil used can be reduced. Moreover, the fuel can be used efficiently to give more power to the vehicle engine and achieved the energy efficient vehicle (EEV).

4. CONCLUSION

The test of the regenerative suspension system on the vehicle proved that the system can harvest the vertical energy on the vehicle suspension system where voltage is generated. The electromagnetic system is a system that is simple and save the cost better than other systems. Moreover, the regenerative system can be used in the hybrid and electric vehicle as an additional feature for alternative source of energy different than the current features used in the vehicle. This regenerative suspension system has a bright future usage on the vehicle to achieve the world requirement on automotive industry where fuel consumption of a vehicle should be reduced and maximized the vehicle power with optimized fuel fossil usage.

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