International Journal of Recent Advances in Multidisciplinary Topics
Volume 3, Issue 4, April 2022
https://www.ijramt.com | ISSN (Online): 2582-7839

Electrical Power Generation by using Suspension System and Regenerative Braking System of Off-Road Vehicle

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***Abstract*: Today's generation depends on automobile various reasons like transportation, traveling and other purposes. There are many kinds of vehicles available in the market for different usages. Considering today's scenario fuel costs are increasing but no one is reducing the use of vehicles. We are going to consider the loss in dissipation of vibration energy which takes place in shock absorbers of vehicles. Our suspension system will work more effectively in off-road, irregular roads. In this system we used spring, rack and pinion arrangement. Our main objective was to capture the energy which is wasted during the both expansion and compression of the suspension spring in the form of heat & which can be further utilized in the form of electrical energy. The developed energy is then used to recharge vehicle battery for further use. Project also involves the one of the braking systems which is nothing but the regenerating system. in this Project contains the electric motor for converting the losses which will takes place on the suspension system during friction as well as in braking. Here motor acts as electric generator. The energy which lost during braking is given to the motor for further conversion. The losses which are fed to motor are shifted the rectifier circuit. Converted energy is stored in the battery. Energy stored in batteries during regenerative braking can be used for many applications.**

***Keywords*: Power generation, suspension system, rack and pinion mechanism, regenerative braking system.**

1. Introduction

Human made one of the most useful and important invention, that is the invention of automobiles. As per the demand of people there are many advanced systems generated in vehicles. Automobiles have taken an important role in today's generation. So, we come up with idea to make something different in this system coupling with our electrical engineering. In this project we are focusing on suspension system. Vehicles having suspension which plays important role in vehicles. Suspensions are mostly applicable for the off roads where roads are irregular. The main objective of project is to develop such a system which will convert those losses into useful applications. In our project we used two techniques to generate electricity.

- *Technique-1:* Electricity generation with the help of suspension.
- *Technique-2:* Regenerative Braking System

Electricity generation with the help of suspension: In this system we used spring, rack and pinion arrangement. The energy which is wasted during the both expansion and compression of the suspension spring in the form of heat & which can be further utilized in the form of electrical energy. The proposed system converts mechanical motion of the suspension and convert that motion into electrical energy. The developed energy is then used to recharge vehicle battery for further use.

Regenerative braking: Project also contains the one of the braking systems which is nothing but the regenerating system. Regenerative system is mostly used technique in electrical field so our main focus is to generate electric power from losses while braking. It is also known as the energy recovery system

2. Literature Survey

Sunny Wagh [1] Author describes a magnetic shock absorber that uses magnetic repulsion between dipoles to absorb vibrations and creates DC current by deploying magnets in a cylindrical shaped suspension with opposing poles. The charger and the battery both store the DC current output.

Rahul Uttamrao Patil, S. S. Gawade [2], "Design and static magnetic analysis of Electromagnetic regenerative shock absorber" Precision systems are electronic equipment systems. In moving vehicles for road conditions, there are occasional vibrations and impacts. As a result, the role of the shock absorber in the protection of electronic equipment in moving vehicles is critical. A thorough investigation of the design or evaluation of a shock absorber for the protection of electronic equipment systems in a hostile vibration-impact environment is presented in this study.

Yang Yang, Xiaolong He, Yi Zhang, 2018, They developed a technique based on the motor's maximal breaking force and needed breaking force to fully utilise the motor's breaking power. They ran simulations for three different breaking scenarios and discovered that the method they used improved the motor's operating efficiency and front braking power.

Zhijun, Dongdong, & Jingbo, 2017, They looked at how an electric vehicle's regenerative braking system works. They used

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the particle swarm optimization (PSO) technique to optimize the various parameters. Breaking strength, state of charge, battery charge capacity, and speed are the guiding parameters of their research. They came to the conclusion that the PSO model can improve vehicle stability and brake energy recovery.

3. Methodology

The main objective of project is to develop such a system which will convert those losses into useful applications. In our project we used two techniques to generate electricity.one is suspension system and another is regenerative braking system.

In this system we used spring, rack and pinion arrangement, Dc motor work as a generator, Voltage Tripler circuit, Battery, Inverter. The suspension system absorbs the small vibrations that occur in the vehicle. Rack and Pinion converts that linear motion into the vibration motion. Due the small vibration in the vehicle rack and pinion provides the input power. Due the pinion mechanism the linear force is converted into rotary movement, and this rotary force is applied to the dynamo through spur gear. Generator gets powered, and it produces electric energy by rotating mechanically. This energy is stored into the battery.

Vehicles driven by electric motors use the motor as a generator when using regenerative braking, it is operated as a generator during braking and its output is supplied to an electrical load; the transfer of energy to the load provides the braking effect. due to back emf in motor, motor works as brakes. In this system we attached generator to the friction brake of bike when brakes are applied the generator gets in contact with wheel of bike and rotates with the rotational motion of bikes wheel. the motor is operated as a generator during braking. When generator rotates it generate electricity and this generated electricity given to the energy storage device and then generated electricity utilized for other application of bikes.

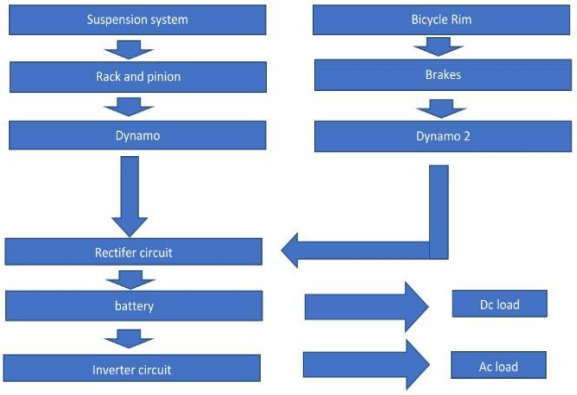

Fig. 1. Block diagram of proposed system

A. Hardware Requirements

1) Rack & Pinion assembly

To convert linear motion to rotary motion and vice versa, a rack and pinion system is utilized. A circular spur gear, known as the pinion, meshes with a spur gear with teeth positioned in a straight line, known as the rack. A rack and pinion linear actuator are made up of a pair of gears that convert linear motion into rotational motion. A circular gear known as "the pinion" engages teeth on a linear "gear" bar known as "the rack"; linear motion supplied to the rack causes the pinion to move, transferring the linear motion of the pinion into the translational motion of the rack.

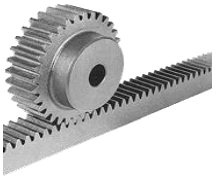

Fig. 2. Rack and Pinion

2) Spring

A spring is defined as a versatile body with the ability to twist when loaded and recover its original shape when the burden is removed. There are many different types of, but we used a helical compression spring.

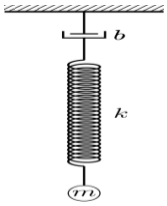

Fig. 3. Spring

Table 1
Specifications of spring

Wire diameter	3.36mm
Spring index	15.76
Mean coil diameter	51.05 mm
Number of active coils	8

3) Spur Gear

In the design of the project, two types of gear wheels have been used. Spur gears or straight cut gears are very simple. They contain a cylinder or disk with teeth that appear brightly. To view the gear 90 degrees from the shaft length (side) the tooth surface is straight and aligned with the rotating axis. Spur gear gears blend well only when fitted to compatible shelves. No axial thrust is caused by dental loads. Spur gears are best at medium speed but are usually noisy when running at high speeds.

Fig. 4. Spur gear

Table 2
Gear specifications

Spur gears	2
Number of teeth	35 and 18
Addendum diameter	74.22mm and 43.3m
Module	2.0mm
Face width at base	4.16mm and 4.3mm

4) DC motor

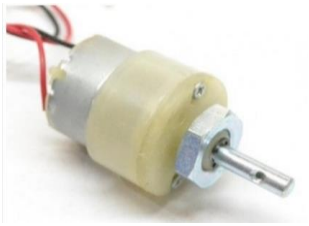

Fig. 5. DC motor

The dc generator produces electricity. The commutator mechanically reverses the connection of the stator loop to the external circuit. The flow current when the polarity of the voltage in the stator loop alters. The commutator in this process converts the generated alternating current voltage to pulsating direct current voltage

Table 3
Specification of DC motor

RPM	200
Operating voltage	12v
Shaft diameter	3 mm
Torque	1 kg-cm
No-load current	300 (max)

5) Battery

A battery is used to store the generated electricity. The size of 12V and 3Ah (3.30Ah) capacity batteries vary significantly based on the ampere hour they are designed to produce. The most common use for 12-volt batteries is in transportation applications such as automobiles and boats.

Fig. 6. Battery

6) Inverter

Fig. 7. Inverter

An inverter is a circuit that converts dc into alternating current. The goal is to generate ac voltage when only one dc voltage source is available. A variable output voltage can be achieved by changing and maintaining the input voltage. Inverter gain is fixed. It provides a cheap and easy solution of powering devices that need ac power. Their purpose is to provide a convenient and portable ac power source. A pure sine wave inverter is 5% less efficient, but this rating converts battery energy into a modified sine wave output.

4. Calculation

Weight given=20 kg
Force (F)=mg=20*9.8=196 n
Radius of gear =5cm= 50mm
T=50*10^-3*196 = 9.8 nm

Output power (from suspension):
Power = P = (9.8*2pi*n)/(60), if n=15 revolutions
= (9.8*2*3.14*30)/(60)
= 923.16/60 = 15.386 w
= 15w power generated per transition
Total power generated will be = forward + reverse
= 15+ 15= 30 w

Output power (from generative braking)

Braking Energy:
m = 5 kg, let N= 900 RPM
Radius of Wheel = 0.3 m
weight of tyre = 1.2 kg
Final velocity = 0
Initial velocity = 50 kmph = 13.8889 m/s
$E_b = 0.5 * m * (vi^2 – vf^2)$
$= 0.5*5*(13.8889^2 – 0^2) = 482.25$ J

Electrical Output:
Output voltage =7.4 volt
Output current range = 2 Amp
Time required to stop the vehicle = t = 5s
Speed of wheel= N= 900 RPM
W= V*I = 7.4*2=14.8 w = 15w
Combined output from both systems
30 w + 15w = 45 w
Charging time: 3.30ah/3amp=1.1hrs

5. Results

Fig. 8. Model of suspension and regenerative braking system

Fig. 8 shows the final result of Suspension and Regenerative braking system. This kit contains cycle rim, belt, motor, rack and pinion, Spur gear etc. by running above kit we got 9-10 volt output which is useful for further applications. We attached one

bulb with this circuit which glows when output generated.

Fig. 9. Assembly kit

6. Conclusion

We mainly conclude that, the energy which is wasted during both the expansion and compression of the suspension spring in the form of heat and losses are further utilized in the form of electrical energy.

It is observed that**,** suspension system is working more effectively in off-road, irregular roads. Main aim was to achieve highest efficiency using regenerative braking system. Regenerative braking system is nothing but, the system which generates the power from losses in system. That power is stored in the battery. We attached a bulb on our project kit which is glowing on the generated energy.

References

[1] Arekar M. P. and Shahade S. (2015). Power generating shock absorber. International journal of innovative research in science, engineering and technology, vol. 4, no. 3, pp. 169-178.

[2] Patil M.D, Aush, M.G, Mahadik Y.V, Kamble, S.G, Patil, S.V, Kharade, J.M, Energy management between electric vehicle charging stations and electric distribution system considering quality of service using IACSO-MPA approach. Int Trans Electr Energ Syst. 2021.

[3] Jolly M, Margolis D, "Regenerative Systems for Vibration Control", Journal of Vibration and Acoustics, 1997, 119(2), pp. 208-215.

[4] Robert A, Nakano, Suda and Nakadai, "Self-powered active vibration control using a single electric actuator", Journal of Sound and Vibration, 260, pp. 213-235, 2003.

[5] Suda Y, Shiiba T, "A New Hybrid Suspension System with Active Control and Energy Regeneration", Vehicle System Dynamics, pp. 641-654, 1996.

[6] Ranjan Kumar, "Regenerative Brake: To Harness the Kinetic Energy of Braking" JETIR, vol. 2, no. 1, January 2015.