# Regenerative Braking system

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***Abstract-*** *Presently what the world needs is a method or a technology that saves energy from getting wasted. Energy conservation is the hour of need. The conventional braking topologies are nowadays used. These braking techniques have lot of wastage of energy during the braking in form of heat. Thus regenerative braking is the prime method to be focus as it is energy saving method. It increases efficiency of electric vehicle by saving of waste energy. In regenerative braking mode of electric vehicle the kinetic energy of wheels is converted into electricity and stored in batteries or capacitors. In case of automobiles, energy conservation can be done by using regenerative braking systems. When driving an automobile, a great amount of kinetic energy is wasted when brakes are applied, which then makes the start up fairly energy consuming. The main aim of this paper is to develop a product that stores the energy which is normally lost during braking, and reuses it. The use of regenerative braking system in automobiles provides us the means to balance the kinetic energy of the vehicle to some extent which is lost during the process of braking. The kinetic energy which generally gets wasted is then converting into either mechanical energy or into electrical energy. Dynamo is connected to the flywheel and flywheel is used for converting the kinetic energy to mechanical energy. Also, Electric Motor is used to convert Kinetic Energy into electrical energy.*

***Keywords:*** Conventional-Braking System, Regenerative Braking, Flywheel, Dynamo, Electric Motor

## I. INTRODUCTION

Regenerative Braking System is the way of slowing vehicle by using the motors as brakes. Instead of the surplus energy of the vehicle being wasted as unwanted heat, the motors act as generators and return some of it to the overhead wires as electricity. The vehicle is primarily powered from the electrical energy generated from the generator, which burns gasoline. This energy is stored in a large battery, and used by an electric motor that provides motive force to the wheels. The regenerative braking taking place on the vehicle is a way to obtain more efficiency; instead of converting kinetic energy to thermal energy through frictional braking, the vehicle can convert a good fraction of its kinetic energy back into charge in the battery, using the same principle as an alternator. Therefore, if you drive long distance without braking, you'll be powering the vehicle entirely from gasoline. The Regenerative Braking System comes into its own when you're driving in the city, and spending a good deal of your time braking. As we know it will not be able to realize the dream of popularization of cars if only using limited petroleum resources. Therefore, the important method to solve problems is to develop electric vehicle and it is of great significance [1].For electric vehicle its power source is batteries. The mileage is still a "curse" for development of electric vehicle. As one of the major factors to decide the driving mileage, the battery technology has made great development, but due to restriction of technology and economic factors, recently there will be no big breakthrough. So another major factor to reduce energy consumption and improve driving mileage, the research of brake energy recovery technology has become popular and braking energy can be up to 50% of the total energy to drive according to related literature. The driving mileage will be increased if the part of waste energy can be reused [2-4]. The system structure is introduced and the energy recovery is researched, then the energy recovery control strategy is put forward. Finally, the control strategy is simulated in ADVISOR2002 simulation platform and the result is evaluated [5-6].

## II. CONSTRUCTION OF RBS MODEL

The working model consist of an electric geared motor (Torque 12kg-cm,speed 100 RPM) which is attached to the input shaft 1.Shaft 1 consist of wheel and brake unit and it is also consist of the pulley mounted on shaft 1 which is parallel to shaft 2. This system consists of total 3 shafts in which shaft 1 and shaft 2 is parallel to each other. While the shaft 3 is connected to the shaft 2 through the sprocket used. The second timing pulley, sprocket are mounted on the shaft 2.shaft 2 has been cut in two parts such that the further third part is become shaft 3 and when motion is provided from input shaft and when the brake is applied only the shaft 1 and half portion of shaft 2 is stopped. The shaft 3 keeps on rotating while other the two shafts are stopped by the braking force. The shaft 3 is directly attached to the flywheel which is made of mild steel material to absorb the energy coming out from the shaft 3. A dynamo is connected to the flywheel by means of 2 gear pair for which gear ratio is 1:1. Dynamo converts the rotational mechanical energy to electrical energy. This energy we can show in the multimeter which can display the ampere and voltage generated. The timing pulley is made of Teflon material while

the timing belt is made of polymer. Potentiometer which regulates the voltage is used for varying the speed. By regulating the voltage we can vary the input speed from which different readings are taken by connecting different load..

The CAD model of Regenerative Braking System with Components is shown in following figures.

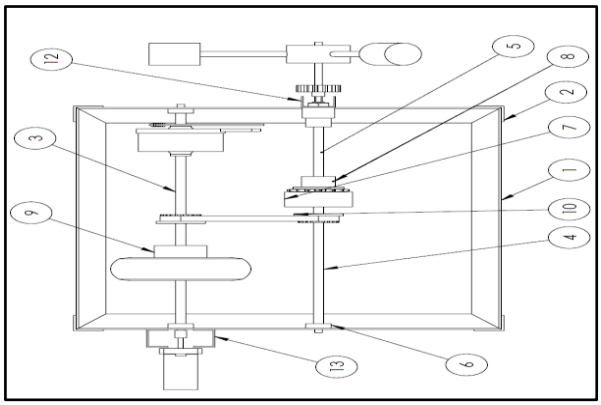



Fig.1: Components of RBS on CAD model

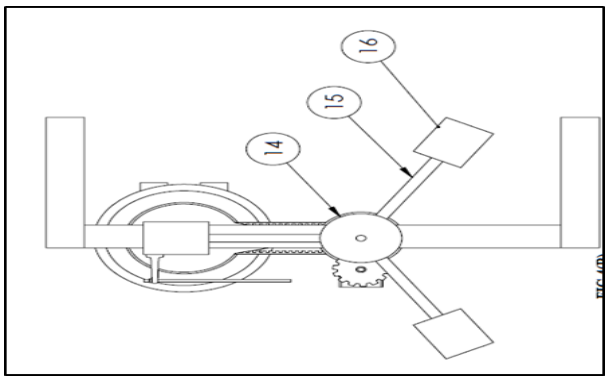



Fig.2: Components of RBS on CAD model

## III. EXPERIMENTAL PROCEDURE

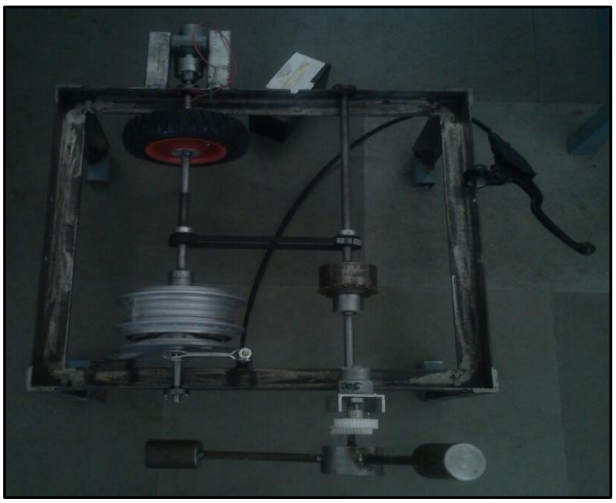


Fig.3: Actual Setup of Regenerative Braking System

When voltage is applied to the input shaft, wheel starts rotating in clockwise direction. This clockwise motion is also transferred to the second shaft through the timing pulley and hence the sprocket to the shaft 3. We are using Timing pulley since its efficiency is 99.99% hence, the friction losses are neglected. Motion which is transmitted to the sprocket shaft is carried to the third shaft from which flywheel is connected. Motion of the shaft is transmitted to the flywheel and it is connected to 1:1 gear ratio gear with the dynamo. The dynamo is used to convert the rotational energy to the mechanical energy. Basically its work is to store the energy. When we apply the brake the motor continues to work but the wheel gets stopped and thus the sprocket shaft also gets stopped but the flywheel keeps on rotating which stores the waste energy of the wheel lost due to friction or heat to the atmosphere. Now this rotating mechanical energy is transferred to the dynamo from where battery or any equipment is connected which can work by taking this energy. Dynamo is connected to the flywheel means of gear pair converts rotational mechanical energy to electrical energy. Potentiometer which regulates the voltage is used for varying the speed. By regulating the voltage we can vary the input speed from which different readings are taken by connecting different load.

## IV. RESULT AND DISSCUSSION

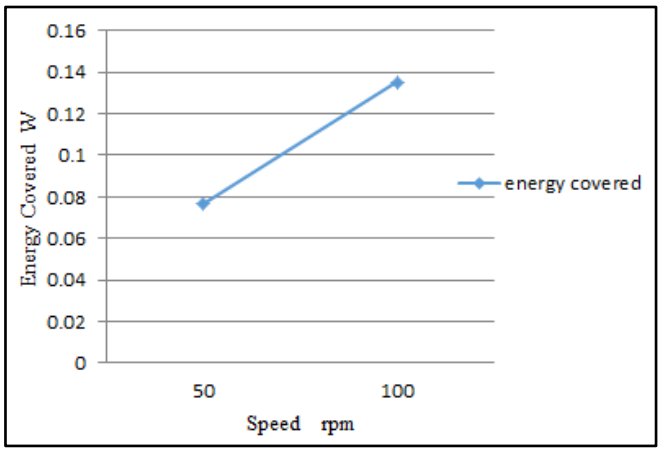
After the successful completion of experimental procedure the following readings are observed. The observations are taken in 50 rpm and 100 rpm respectively.

The voltage and Current is recorded an finally the energy covered is calculated.

| **Sr. No.** | **Speed (rpm)** | **Voltage (V)** | **Current (mA)** | **energy covered P=V×I (W)** |
|---|---|---|---|---|
| 1 | 50 | 6.6 | 11.28 | 0.0767 |
| 2 | 100 | 7.1 | 19.6 | 0.1352 |

Table 1: Observations of RBS model

From the above data we can plot a graph and shown in below,




Graph.1: Speed Vs. Energy covered by RBS

From the above graph it is clear that with more speed of Vehicle the RBS saves more energy while with lowers the speed RBS saves energy but less compared to the more speed. At 100 rpm we got 0.1352 Watt and at 50 rpm we got 0.0767 Watt power without any load considerations while at 100 rpm we got 0.0532 Watt and at 50 rpm we got 0.0402 Watt with load consideration

**Advantages of RBS**

- Increases the efficiency of overall system.
- Reduces the fuel consumption.
- Provides better fuel economy.
- Decreases friction losses.
- Heat energy which gets wasted is utilized.
- Allows the energy to be partially recovered and stored in the battery.
- Reduces CO2 emissions.

**Limitations of RBS**

- Regenerative braking is greatly reduced at low speeds. As friction is reduced at lower speeds.
- This system can be installed only on the wheel that drives the vehicle.
- Regenerative braking only occurs if no other electrical component on the same supplies system drawing power

## V. CONCLUSION

Theoretical investigations of a regenerative braking system show about 15% saving in fuel consumption. The lower operating and environment costs of a vehicle with regenerative braking system should make it more attractive than a conventional one. The traditional cost of the system could be recovered in the few years only. The exhaust emission of vehicle using the regenerative braking concept would be much less than equivalent conventional vehicles as less fuel are used for consumption. These systems are particularly suitable in developing countries such as India where buses are the preferred means of transportation within the cities. From the above graph it is clear that with more speed of vehicle the RBS saves more energy while with lowers the speed RBS saves energy but less compared to the more speed.

## REFERENCES

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