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EXPERIMENTAL STUDY OF REGENERATIVE BRAKING SYSTEM (RBS)

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Abstract - *In this era, the automobile sector is facing a major challenge to reduce consumption of fuel and greenhouse gases emission, this is often because limited fuel reserves and continuous degrade in air quality. An experimental setup is made for the current study to reduce the loss of energy by reusing it. In this present study, an alternator is connected to the driver shaft through chain and sprocket. When brakes are applied to slow the vehicle down or make it come to a halt, the alternator is activated with an electromagnetic clutch, and the energy lost during braking is utilized to generate electrical energy.*

Key Words: Regenerative braking, Electromagnetic clutch, Energy recovery system, Automobile, Generator

1. INTRODUCTION

Generally, braking system are employed to retard or halt the vehicle. It is one of critical system of any automobile. It performs its function by conversion of kinetic energy into friction which is ultimately loss of high-grade energy into low-grade energy i.e. heat. Whenever we press the brake pedal, the kinetic energy of the automobile gets lost and if we want to gain same speed, we have to start from zero which draws extra power from source which will result in significant wastage of energy. With the help of regenerative braking system (RBS) we can achieve braking along with harnessing a part of waste energy.

RBS is method of energy recovery that retards the automobile by transforming rotational or kinetic energy in any usable form such as electrical energy or mechanical energy to be used instantaneously or after sometime when required. Further the harnessed energy can be either supplied to the auxiliary system or charging any energy storing device such as ultra-capacitor, battery. Following approaches has been used so far for RBS: -

1) By making motor work as generator. This approach can be used only in EV's and HEV's.
2) By engaging generator or alternator with rotating shaft at the time of braking.
3) By using flywheel.

2. LITERATURE REVIEW

Several energy transformation methods for RBS's includes the use of springs, electromagnetic system, flywheel and hydraulic system. Recently, a hybrid RBS containing electromagnetic-flywheel has also been developed. The effect of regenerative brakes is lesser at lower speeds as compared thereto at higher speeds of automobiles. So, the friction brakes are needed to halt the vehicle completely in case of failure of RBS mechanism. Various researches have been done on various kinds of RBS and their performance.

S. Suyambazhahan [1] designed a regenerative braking system that charges a 12V battery by operating an alternator that gets engaged to the main shaft with the help of a magnetic clutch during the application of the brake. In his study, he found out that up to 2.9 KW energy was recovered while braking.

While driving different braking patterns can be observed. Gao et al. [2] researched on three different braking patterns and evaluated the recovered energy. He found out in simulation results that by using a simple parallel braking approach a significant amount of energy can be recovered.

Cikanek et al. [3] designed a system that improved the performance efficiency and reliability of previously existing regenerative braking system for a PHEV (Parallel Hybrid Electric Vehicle). The design of their system consisted of a single-geared direct-drive transaxle that has high efficiency. He found verified his simulation results by practical application.

Tur et al. [4] proposed a model of RBS which could also work as an antilock braking system. They created a quarter car model and did a simulation on ANSOFT. They concluded that regenerative Antilock Braking System responses were better for an emergency braking condition.

3. OBJECTIVE AND SCOPE

1) Fabrication of a working model of the RBS.
2) Energy-saving capability of the model is to be tested.
3) Percentage of regeneration.

4. METHODOLOGY

Different methods can be used to harness the energy which is being lost as heat during the application of brake. Using inertia of the rotating shaft to rotate the armature of the alternator is one such method. We use this approach to convert some part of this braking energy in electrical energy which further stored in a battery. In our set up we have used a chain sprocket arrangement in which the motor is mounted on the primary shaft and an alternator which is connected to the secondary shaft with the help of an electromagnetic clutch. The motor and electromagnetic clutch are connected to an electronic circuit that consists of relay circuits and rectifiers for the switching mechanism.

5. EXPERIMENTAL SETUP

Fig -1: Quarter model vehicle with Regenerative Braking System

6. RESULTS AND DISCUSSION

Table (1) shows the results taken while testing quarter model vehicle at different speeds. The vehicle was operated at various speeds ranging from 120 to 400 RPM.

Table -1: Output from alternator at various speed.

S. No	Voltage (V)	Current (mA)	RPM	Power (Watt)
1.	12	14.6	120	0.1752
2.	12	15.3	150	0.1836
3.	12	16.5	240	0.1980
4.	12	19.1	340	0.2292
5.	12	22.3	400	0.2676

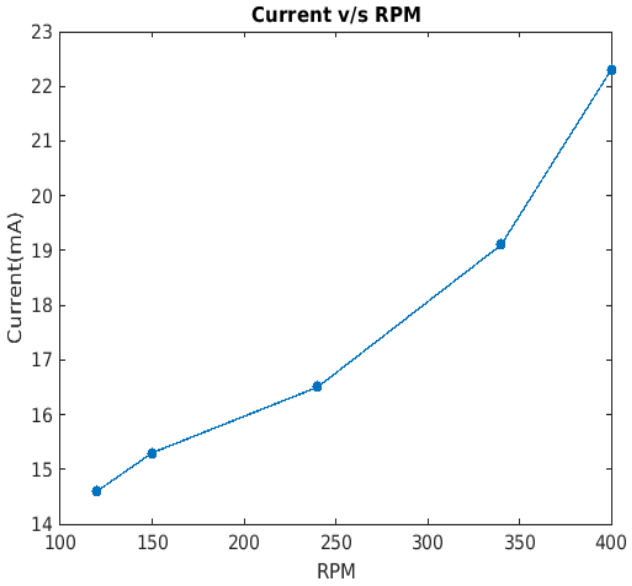

Chart -1: Variation of current output from alternator with respect to engine speed.

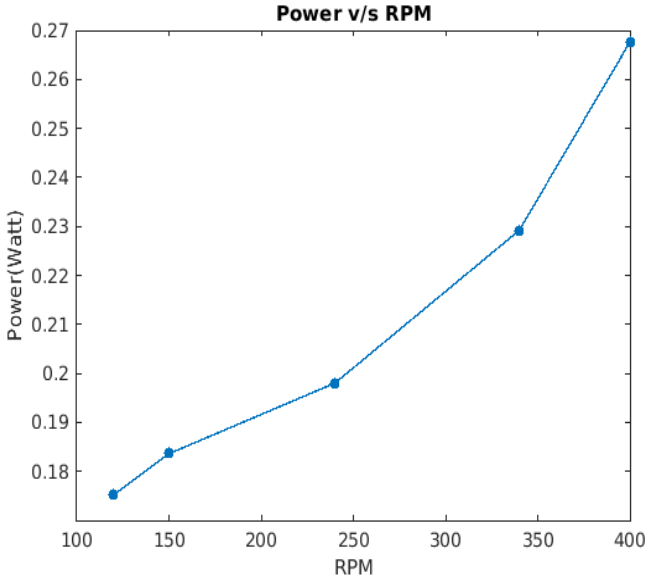

Chart -2: Variation of Power output from alternator with respect to engine speed.

The current from the alternator increases with engine speed. At lower speed the behaviour of curve is linear and as speed increases the slope becomes steeper. In the experiment, 16.32% of brake energy was recovered.

7. CONCLUSIONS

Increasing the efficiency of automobiles is such an area where numerous researches have been completed since a decade. Because of various losses, the desired efficiency cannot be reached. Also, in braking, a large portion of the energy is wasted. In this project, we discovered a method to recover fraction of energy that is getting wasted while

braking. Same energy can be used to power the auxiliary units or can be stored for further use. This will decrease the fuel consumption of the vehicle and will help in reducing air pollution by the vehicle. So, this idea makes the vehicle more efficient and maintains a better environment by decreasing emission.

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