Performance testing of a Regenerative braking systems

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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. 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 project was 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 authors of the paper have discussed and presented two methods of using the kinetic energy which generally gets wasted by converting it into either mechanical energy or into electrical energy. Flywheel is used for converting the kinetic energy to mechanical energy. Also, Electric Motor is used to convert Kinetic Energy into electrical energy.

***Keywords*—** *Regenerative Braking, Flywheel, Electric Motor.*

I. INTRODUCTION

Nowadays electric vehicles become popular as we know it is green vehicle producing zero emission to the air which is general cause of depletion of ozone layer. There are no toxic gases releases from vehicle to pollute the atmosphere.

In recent years the Electric vehicle population starts increasing according to demand in the market. Besides, government is more serious for the production of electric vehicles. All the humanities are trying to save Mother Nature & natural resources such as crude oil & gases in the earth. In twentieth century, vehicular technology such as control technology and integrative technology have been developing aggressively. Somehow, the limitation of driving mileage still becomes an obstacle for the development of electric vehicles. This problem had been tackle by using regenerative braking;

It has become one of the ways to improve the driving range as this method can increase an EV's driving range by 8-25%.

This technology had mostly replaced the traditional braking system in the vehicles because the traditional braking system always utilizes mechanical friction method to dissipate kinetic energy as heat energy in order to achieve the effect of stopping.

Studies show that in urban driving, about one third to one half of the energy required for operation of a vehicle is consumed during braking. Base on the energy perspective, the kinetic energy is a surplus energy when the electric motor is in the braking state since it dissipated the energy as heat and causes a loss of the overall energy.

This wasted energy actually can be converted to a useful energy especially for the hybrid and electric car. Therefore, regenerative braking had been implemented in the car braking system to recapture this wasted energy. In addition, the total energy saves is dependent on the driving condition, normally it is more effective in city driving rather than highway whereas little braking occurs.

II. DESCRIPTION

A. Flywhell

A flywheel is a type of energy storage system which is used to store mechanical energy and then release the stored energy when needed for acceleration. Flywheel is a heavy, high-speed rotating disc that builds up kinetic energy (the force that

causes movement) as it spins. The amount of energy stored depends upon how heavier it is and how fast it rotates. Heavier weight and faster rotation results in higher energy storage.

B. Specification of flywheel and DC Motor

TABLE I.

S.No	Specification of flywheel & DC Motor	
1	Flywheel diameter	300mm
2	Width	25mm
3	Mass	3.5 kg
4	Voltage	24V
5	Output power	300W
6	Max.torque	3.8 N-m
7	rpm	1500

III. WORKING PRINCIPLE

The most common form of regenerative brake involves using an electric motor as an electric generator. The working of the regenerative braking system depends upon the working principle of an electric motor, which is the important component of the system.

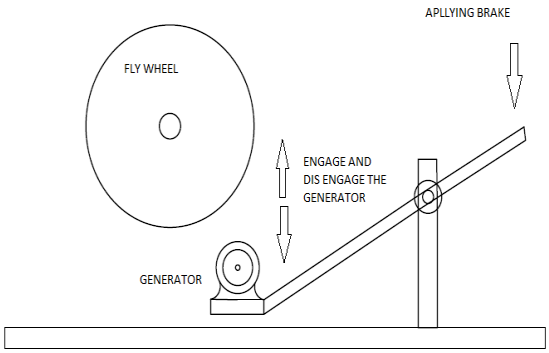

Fig. 1. Testing setup

To engage the generator setup to the fly wheel while applying the brake and generate the electricity by converting its kinetic energy into electrical energy

Electric motor gets activated along with the braking system, when applying brake. This will engage the dc motor with flywheel (during the braking), then it behaves as a generator and generates electricity. Then converts kinetic energy of flywheel into electrical energy, which results in regenerating electric energy for storage in the battery. This electricity is used for further purpose.

IV. ADVANTAGES

There are several advantages of regenerative braking taken over the traditional braking system such as:

1. More control over braking
2. More efficient & effective in stop-&-go driving conditions
3. Prevents wear on mechanical brake systems
4. Better fuel economy

The kinetic energy which is lost at the time of braking can be converted back into electrical energy and stored in battery

V. RESULTS AND DISCUSSION

Experimental tests show that an electric regenerative braking system seems to offer the most promising technology. The various experimental outputs observed during various test runs are tabulated as below. The parameters compared during the observations include flywheel speed, breaking time and time taken. Power output and time taken for various speeds of flywheel is shown in Table II and the power generation for various braking time is shown in Table III.

A. Power Output and time taken

TABLE II.

Fly wheel rotation (rpm)	Time taken	Power output
1000	3sec	27 W
1500	5sec	41 W
2000	7sec	54 W

B. Relationship between power generation and braking time

TABLE III.

Braking time	Power generation
3 sec	20%
5 sec	35%
7 sec	55%
8 sec	75%

The power generation for various time period is shown in Fig.2, it was observed that the maximum power generation was observed at 8 secs as shown in graphical plot.

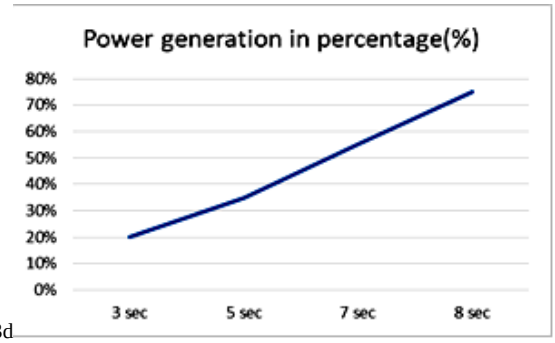

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Fig .2. Power output vs breaking duration

The results from some of the test conducted show that around 70% of the energy delivered can be recovered by the system. Problems are expected as any new technology is perfected, but few future technologies have more potential for improving vehicle efficiency than does regenerative braking.

V. CONCLUSION

Regenerative braking is an energy recovery mechanism which slows a vehicle or object by converting its kinetic energy into a form which can be either used immediately or stored until needed. When the driver hits the brakes, energy that is normally lost as heat is instead converted into electricity and stored in a battery.

The regenerative braking system used in the vehicles satisfies the purpose of saving a part of the energy lost during braking. Also it can be operated at high temperature range and are efficient as compared to conventional braking system.

The results from some of the test conducted show that around 30% of the energy delivered can be recovered by the system. The results say that the torque driven by the vehicles is measured. Electrical power generated by motor, generator and battery is very useful and hence it should be used in electric vehicles. The flywheel absorbs energy when braking via a clutch system slowing the car down and speeding up the wheel.

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