IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Impact Factor: 6.252
Volume 2, Issue 2, May 2022

# Braking System in Electric and Hybrid Vehicles

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**Abstract:** *Nowadays energy crisis is the most important issue faced by many countries. To tackle it efficient machine design and electric vehicles are best fit practical solutions. Ideal for this situation is to use regenerative braking system. In advanced countries regenerative braking system is the area where most of the work is going on. By using this regenerative braking concept to apply brakes to vehicle and creating electrical energy simultaneously by using alternator.*

**Keywords:** Kinetic energy, Alternator, Electric Motor, Electrical energy, Regenerative Braking system

## I. Introduction

Moving vehicles have a lot of kinetic energy, and when brakes are applied to slow a vehicle, all of that kinetic energy has to go somewhere. Back in the Neanderthal days of internal combustion engine cars, brakes were solely friction based and converted the kinetic energy of the vehicle into wasted heat in order to decelerate a car. All of that energy was simply lost to the environment. Fortunately, we have evolved as a species and developed a better way.It is important to realize that on its own, regenerative braking isn't a magical range booster for electric vehicles. It doesn't make electric vehicles more efficient per se, it just makes them less inefficient. Basically, the most efficient way to drive any vehicle would be to accelerate to a constant speed and then never touch the brake pedal. Since braking is going to remove energy and require you to input extra energy to get back up to speed, you'd get your best range by simply never slowing down in the first place.

But that obviously isn't practical. Since we need to brake often, regenerative braking is the next best thing. It takes the inefficiency of braking and simply makes the process less wasteful.Regenerative braking is an energy recovery mechanism that slows a vehicle or object by converting its kinetic energy into a form that can be either used immediately or stored until needed. we are applying this concept to one wheel which is rotating. Its mechanical rotary energy is converted into the electrical energy. This electrical energy can be stored and utilized in critical situations or to run the internal components present in the car.

Efficiency of the regenerative braking process varies across many vehicles, motors, batteries and controllers, but is often somewhere in the neighbourhood of 60-70% efficient. Regen usually loses around 10-20% of the energy being captured, and then the car loses another 10-20% or so when converting that energy back into acceleration, according to Tesla. This is fairly standard across most electric vehicles including cars, trucks, electric bicycles, electric scooters, etc. This system is called regenerative braking.

## II. Components

### 2.1 Basic Components of Braking System

1. Electric Motor
2. Shaft
3. Alternator
4. Tyres
5. Battery

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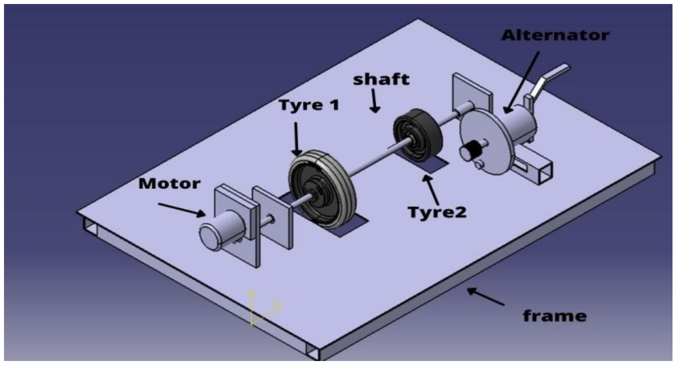


## III. Literature Review

The first novel control strategy of regenerative braking system for electric vehicles under safety critical driving situations invented by an Chengqun Qiua, Guolin Wang, Mingyu Meng, Yujie Shen. He mainly focuses on control strategy of the regenerative braking system of an electric vehicle under safety critical driving situations. With the aims of guaranteeing the electric vehicle stability in various types of tire-road adhesion conditions, based on the characteristics of an electrified power train, a novel control strategy of regenerative braking system is proposed for electric vehicles during anti-lock braking procedures. Later on Gearshift and brake distribution control for regenerative braking in electric vehicles with dual clutch transmission by Jiejunyi Liang, PaulD. Walker, Jiageng Ruan, Haitao Yang, Jinglai Wu, Nong Zhang.To alleviate the problem of limited driving range per charge in electric vehicles, a dual clutch transmission based regenerative braking power-on shifting control system is pro- posed and investigated by them.The system is based on a full-size sedan to which regenerative braking is more significant. A new electric braking system with energy regeneration for a BLDC motor driven electric vehicle invented by A. Joseph Godfrey, V. Sankaranarayanan. He presents, a new electric braking system is proposed for a brushless DC (BLDC) motor driven electric vehicle (EV) in this paper based on stopping time and energy regeneration. The proposed strategy is able to stop the vehicle at any speed with possible energy regeneration. Simulation and experimental results are presented to show the effectiveness of the proposed method.

## IV. Methodology

- Step1: Concept design
- Step2: Find out literature survey and gathered research paper
- Step3: Design of mechanism
- Step4: Finalize concept 3d model and drafting will be done
- Step 5: Material selection and design calculation
- Step6: Development of prototype
- Step7: Testing and performance

## V. Working Principle

The purpose of generating electricity from kinetic energy simultaneously applying the brakes. When wheel is rotating, on the same shaft disc is attached. The arrangement is made in such a way that when we make alternator to come in contact with the disc, it acts as a braking element. The alternator starts rotating in the opposite direction as that of the wheel direction. As the diameter of alternator face is very small we get high rpm as an input for the alternator. These rpms are used to generate electricity and mechanical kinetic energy of the system is gets converted in to the electrical energy. This energy is can be stored with the help of battery or can be directly utilize for other work.

## VI. Calculation

By using 12v ,8amp current dc motor (96 watt) 1000rpm used for rotating motion supply.

For 75 mm disc radius of the prototype wheel supplying torque for 1000 rpm is calculated as,

P=2*3.14*1000|*T/60

Hence, T=3.14 Nm……. A

Now, the required torque calculated as,

T=F*R (let 1kg of mass of plate)

T=1*9.81*0.075

T=0.7358 Nm……. B

As, A>B design is safe.

Now here we are generating the electricity, when the motor is rotating with 1000rpm the disc will also rotates at 1000 rpm speed, with outer diameter as 150mm.

When alternators come in contact with disc it will rotate with 1000rpm.

N1/N2=D2/D1

(1000/N2)= (25/150)

N2=6000rpm.

So this much rotation will be taken as input for the alternator.

so, regenerative power can be calculated as,

P=0.1047 *N*T

P=77.038 Watt

But we can capture only 40-50% energy from alternator due to frictional losses between alternator and wheel during braking system.

So considering frictional losses the power we get,

P=46.2 Watt (approx.)

## VII. Main Assembly


Electric vehicles (EVs) are recognized as one of the most efficient modes of transportation with zero trailing emission. Considering the advantage of EVs, 3 million vehicles are already deployed on the road, and it is expected to cross 100 million by 2030. However, the execution of proposed plan demand for huge charging infrastructure and enormous electrical energy. Moreover, EVs can only be sustainable when the electrical energy required for charging is generated from renewable and sustainable energy sources. However, the use of fossil fuels for electricity generation, does not reduce the emission but merely shift it from vehicles to the power plant. Therefore, the use of renewable energy sources for electricity generation can completely eliminate the emission and provides an environmental benefit. Among various available renewable energy sources, solar PV array, wind energy, hydro energy and fuel cell based energy, solar PV based generation is a most feasible solution for EV charging because it is available almost everywhere irrespective of the rural or urban region. As far as the Indian region is concerned, it is available almost throughout the year. On the contrary to the solar PV array, the wind and hydro energies are location specific. The wind energy is mostly useful in the coastal region, and hydro energy is useful for hilly region. Though, the renewable energy based charging stations are the most feasible solution for the EV charging, however, their integration to the existing charging system introduces the additional power conversion stage, which increases the complexity and power loss in the system. Moreover, each conversion stage needs an individual controller, which needs to be integrated with the existing control. Therefore, it is imperative to design an integrated system with multifunctional and multimode operating capability, for which a unified control and coordination between the various sources are essential. Many efforts have been made to develop the renewable energy based charging station. Ugirumurera et al. have discussed the importance of renewable energy for the sustainability of the EV charging station

Renewable energy based charging station, are mostly focusing on the optimization of different aspects of charging such as the size of the renewable energy sources, size of the storage unit, vehicle driving pattern, charging time, charging cost, charging scheduling etc. However, in present scenario only few publications have actually implemented the charging station using renewable energy sources. Moreover, the performance of charging station under real circumstances, is also less discussed. Moreover, in most of the literature, the performance of CS, is discussed only in either grid connected mode or islanded mode. However, due to the single mode of operation in grid connected mode, the solar PV panel becomes unusable if the grid is not available even if the sun (solar irradiance) is available. Similarly, in islanded mode, the PV power is disturbed by the intermittency of solar irradiance. Therefore, a storage battery is required for mitigating the effect of variable solar irradiance. However, in case of the fully charge storage battery, the maximum power point tracking (MPPT) has to be disabled to avoid the overcharging of the storage battery. Therefore, in this paper, a PV array, grid, energy storage and DG set supported CS is presented, which operates in islanded, grid connected and DG set connected modes, so that the PV array energy is utilized for all operating conditions. Some publications [15] have discussed both islanded and grid connected modes. However, these two modes are controlled separately and the automatic mode switching between two modes are not presented. Therefore, without automatic mode switching capability, the PV array power is to be interrupted and the charging of the EV is not to be continuous. Therefore, in this paper, an automatic mode switching logic is presented, so that the controller automatically switches between different operating modes depending on the power generation of PV array and the charging demand of EV. Due to the unavailability in the night and the intermittent nature of the PV array, storage battery with PV array is used for continuous and reliable operation of CS. However, due to the limited storage capacity of the storage battery, it is hardly possible to provide backup all the time. Therefore, the CS needs support of the grid in case of PV array energy is unavailable, and energy storage is also discharged. However, due to the limited availability of grid, especially in remote areas, the DG set may be required for maintaining the continuity of the charging.

## VIII. Conclusion

Important thing about regenerative braking is that it may be able to capture as much as half of the waste energy and putt back to work. This reduces energy consumption by 10 to 25 percent. hence regenerative braking system plays an important role on energy conservation and increasing shelf life of battery. Its good alternative for fuel and save a lot of energy also helps to save natural resources.

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