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Analytical Study on Performance of Regenerative Braking System using of Plastic Matrix Material Flywheel in Automobile

Abhisheak Gangwar[1], Himanshu Dixit[2]

[1]Student of Mechanical Engineering Department, RRSIMT, Amethi (U.P), 227405, India

[2]Assistant Professor, Mechanical Engineering Department, RRSIMT, Amethi (U.P), 227405, India

Abstract: ***As in today's century, where there is more requirement of energy and the use of this energy at higher rate, but the sources are very less in today's time so there is a need of specific technology that recovers the energy, which usually gets wasted. In case of automobiles one of the latest technologies is the regenerative braking system with some advance changes and new techniques. Generally in automobiles whenever the driver use the brake paddle to stop or slow down the vehicle then the kinetic energy gets wasted due to friction in the form of heat energy. Using regenerative braking system in automobile we can store this wasted energy and again use this energy in the vehicle to accelerate it or to drive some electrical components [14]. There are two methods of utilizing the kinetic energy that is usually wasted by converting it into either electrical energy or into mechanical energy. Regenerative braking system can convert the kinetic energy into electrical energy with help of electric motor/generator. And it can also converts the kinetic energy into mechanical energy, which is supplied to the vehicle whenever it is needed, with the help of a flywheel which is made of advance material(plastic matrix) and new design. Today, almost every manufacturer is developing the ways to recover a significant portion of this wasted energy with the use of regenerative braking.***

Keywords: Conventional Braking System, Regenerative Braking, Electric Motor, Flywheel as a Energy Storage device of advance material, Battery

1. Introduction

Conventional Braking System

In conventional braking system the application of the brakes to slow or stop the vehicle, usually by pressing a pedal. The braking distance is the distance between the time the brakes are applied and the time the vehicle comes to a complete stop .When brakes are applied to a vehicle using conventional braking system, kinetic energy is converted into heat due to the friction at that time between the wheels and brake pads. This heat is carried away inthe air stream and the energy is wasted. The total amount of energy lost in this process. In this process brakes are depends on how often, how hard and for how long the brakes are applied.

Regenerative Braking System

Regenerative braking is one of the latest technologies which can prove very beneficent. With the regenerative braking in a vehicle not only recover the energy but it also increases the efficiency of vehicle(in case of hybrid and normal vehicles) and saves energy, which is stored in the battery .Conventional braking technologies convert the potential and kinetic energy of a moving vehicle into thermal energy by means of friction. This thermal energy is practically wasted, as it is carted off by air streams. In contrast to that, regenerative braking technologies do capture and store kinetic energy in a converted form while braking. They can either feed energy back to the motor while accelerating, or recharge the power supply. The amount of energy, which is available for storage, depends on multiple factors including car efficiency drive cycle, inertia , weight and type of storage.

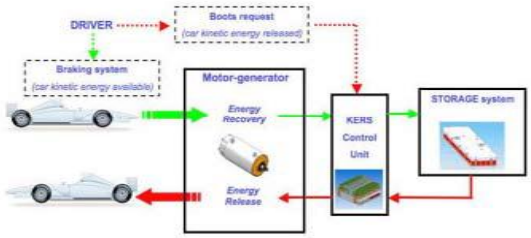

Figure A: Block diagram of Regenerative braking system

2. Importance of Regenerative Braking System

The importance of regenerative braking is very fruitful to the green environment and to reduce the fuel consumption in comparison to conventional braking system.

With an increased demand for less consuming and less polluting vehicles, electric vehicles and hybrid vehicles have gained popularity. These vehicle types assure reduced operating cost . However, even though vehicular control technology and integrative technology have been developed intensively, the limitation of driving mileage for electric drives is still an obstacle that has to be remediated. One way of doing so is using an RBS (regenerative braking system). In urban driving, about one third to one half of the entire energy necessary to operate the vehicle is used for braking. Studies have presented that fuel economy for hybrid vehicles could be enhanced up to about 40% with regenerative braking.

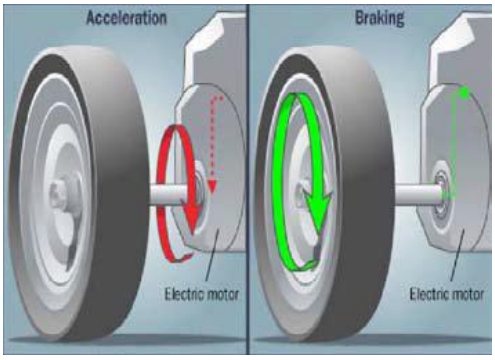

Figure B: Energy conversion with the electric motor

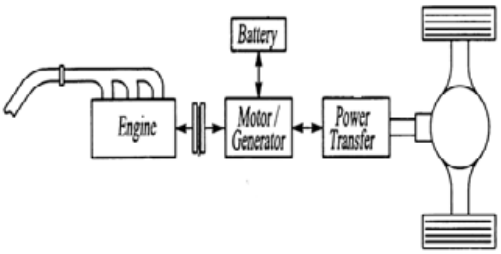

Figure C: Simple Representation of Regenerative Braking System

3. Flywheel

The mechanical energy stored in the flywheel is directly given to the vehicle so as to boost its acceleration instantaneously, whenever the vehicle needed. Generally, the method of transmission of energy directly to the vehicle is more efficient rather than storing it in the battery, as it does not consists of the conversion of energies. As, during the recharging of battery, mechanical energy is converted into electrical energy and during discharging electrical energy is converted into mechanical energy. So, due to these conversions transmission loses occur and the efficiency reduces. As, in the other case, there are no transmission loses since mechanical energy stored in the flywheel is directly transferred to the vehicle in its original form. Because of the instant energy supply and high efficiency.

3.1 Research Effort in Flywheel

Basically in vehicle the material of flywheel is normal in automobile but here the use of advance material plastic matrix is rapidly increase the efficiency of the system because the composition of the material is technically advance and fulfill the criteria of efficient flywheel. Here the design is also to be changed because by applying the force in only one direction it can reaches it maximum tensile strength to absorb the more power and save the energy. Here the metal of the gears and the differential box is also changed to reduce the weight of the vehicle, the metal used to make a gear is Dupont material which is light in weight and also increases the life and efficiency of the gear system up to 12 % in comparison to other metal.

This is anew type of flywheel has evolved in which high stress fibres are used plastic matrix. The fibres are aligned so that the centrifugal force acts along the fibre in the direction of its high tensile strength. The specific energy density of a flywheel is proportional to the ratio of tensile strength to specific density.

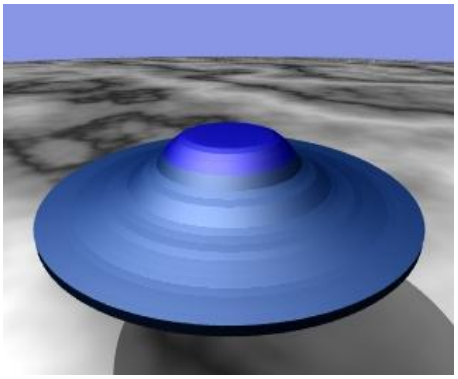

Figure D: Flywheel of plastic matrix

3.2 Advantages of Material Plastic Matrix in Flywheel

- No damage generate in flywheel during operation
- During the operation the diameter is expand and store the energy
- By using this material the efficiency of the vehicle in increased

4. Results

- Better fuel economy.
- Reduced CO_2 emissions.
- Approximately 40% saving in fuel consumption. The lower operating and environment cost of the vehicle with regenerative braking system.
- The plastic matrix material flywheel has increased the efficiency of the system up to 65%, and in comparison to previous braking system up to 15%.

5. Conclusion

The regenerative braking system used in hybrid and normal vehicles satisfies the purpose of saving a part of the energy lost during braking in the vehicles. Also it can be operated at high temperature range and are efficient as compared to conventional braking system. The results generated mathematically in this paper is showing that from some of the test conducted show that around 45% of the energy delivered can be recovered by this advance braking system. Regenerative braking system has a wide scope for further development and the energy savings. The use of more efficient systems or latest material to manufacturing component of vehicle could lead to huge savings in the economy of any country.

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Author Profile

Abhisheak Gangwar persuing his B.tech degree from Rajarashi Rananjay Sinh Institute Of Management & Technology, Munshiganj Amethi of Mechanical Engineering Branch. He is highly interested on studying of new topics which is related with energy saving methods. He is currently is in 6th semester of his course and has good command in Automobile and Energy management subjects.

Himanshu Dixit received the B. Tech degree in Mechanical engineering from Skyline Institute of Engineering & Technology in 2012 and M. Tech. degree from HPT&E branch from Technocrats Institute of Technology & Science. He has a vast experience in Automobile Engineering and in Thermal Engineering area.