Renewable Energy Generation in Automobiles

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Abstract: This research paper explores novel approach in renewable energy generation in Automobile system. We're introducing two methods of electromagnetic braking systems which also generate energy while braking. Method A specify that when the vehicle's engine handles braking, it generates energy by applying load. Method B gives energy by changing load with respect to varying magnetic field of rotor. Instead of traditional braking system, this system not only decelarate vehicle but also generate energy.

Keywords- Renewable energy generation in automobile, Energy production while deceleration of vehicle, Advanced regenerative braking

INTRODUCTION

This paper explores methods for generating energy in the driving vehicle. In traditional braking systems, frictional force is used to stop the vehicle. In that systems mechanical components like wire, incompressible fluid is used for transferring lever force to braking system leads to lag in the output responce also these systems become less reactive with time due to friction and material properties. To overcome these problems, we designed system with electromagnetic braking as it is more reactive, less chances of failure. In advancement in electromagnetic braking system, this research paper introduces two different techniques use for generate electric energy from rotational energy of the wheel by using generator principle. As in brushless DC machine power is depend on energising timing circuit i.e. Commutation circuit. In method A, We're switching different commutation circuit with respect to lever position in analog ways. In advancement of method A and overcome problem of analog output Method B introduces. In method B, Power of DC machiine is varring with varring magnetic field.

LITERATURE SURVEY

- "Automotive Power Generation and Control"[1]

In this paper auther develops new load-matching technique that uses a simple switched-mode rectifier to achieve dramatic increases in peak and average power output from a conventional Lundell alternator. Dual-output extensions of the technique are also introduced. The new technology preserves the simplicity and low cost of conventional alternator designs. As it can be only implemented within the existing manufacturing infrastructure so, this system we can't be used in electric vehicle and it has poor efficiency because of law of conservation of energy as alternator also takes energy from base power source.

- "Research in Vehicles with Thermal Energy Recovery Systems" [2]

This feasibility report presents results in the thermal energy recovery systems (TERS) investigation, and the possibility of introducing them to production vehicles as subsystems. This prospective new technology should reduce dependence on fossil fuels. The future scope of this research paper is whenever we are going to collect energy which is already to be converted in another form from mechanical system, its hard to reach maximum efficiency.

- "Energy generation from road vehicle" [3]

This paper has used non conventional energy source for power generation. Here we can generate energy by air compression. All the setup is placed under speed bumper when vehicle passing from speed bumper it generates electricity. Here the key principle is generation of electricity with air compressor at speed breakers. If we see the key parameters while designing any type of suspension in any vehicle it directly effects on rider's comfort. So, these system can only use in heavy weight vehicles.

- "STUDY AND FABRICATION OF ELECTROMAGNETIC BRAKING SYSTEM" [4]

This project aims to create a electromagnetic braking system model which is capable of applying brakes without any friction loss and without losing the energy supplied.This model helps in a way to be a used a

retardation equipment in vehicles. It is more efficient way of braking beccause it is more responsive and without friction. The scope in this research is to create energy simultaneously while retardation of vehicle.

• "Research on Regenerative Braking Systems" [5] This paper provides comprehensive advanced information about regenerative energy systems. These systems provide economic benefits via fuel savings and prevention of material loss. Their use also contributes to a clean environment and renewable energy sources, which are among the most important issues on the global agenda. As it only use in hybrid and elecric vehicle, it has to take more advancement. Researchers also works on its low responce, more maintainence, system optimization.

Renewable sources in automobile-

In search of renewable energy sources in vehicle we have observed that a average car engine only transfer 70% of input energy for the driving of the vehicle, rest of 30% energy is wasted in the form of frictional and thermal emission.

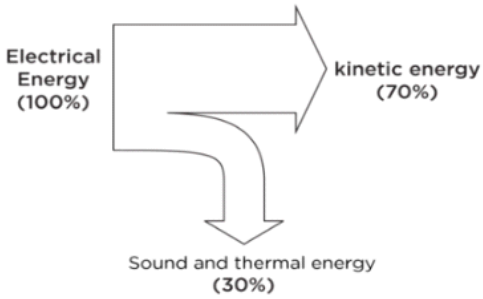


fig 1.1 Energy distribution in vehicles

In traditional braking systems, lots of energy wasted in the form of friction. If the car is brought to a complete from 300 km/hr in the shortest possible time, then it has been estimated that during the braking process, an average of 1 MW power is dissipated. The process involves conversion of kinetic energy of the car into heat energy through friction on the brake plates. As well as in drum brakes regular maintenance of liner is required because of friction. In disc brakes brake system, braking pad become thinner by the time. Also, in traditional brake system brakes are not efficiently working as well as lag in the braking leads to major accidents. In the recent search it is saw that 22% road accidents are caused due to faulty brakes. As accidents happens due to brake fluid leakage, overheating, driving through mud we can't reduce it because that systems are 100% mechanical system.

To overcome this problem electro-magnetic braking system is introduced. Electromagnetic brakes or EM brakes are used to decelerate or stop the vehicle using electromagnetic force applied to the mechanical resistance to the disc. EM braking is most efficient braking till date.

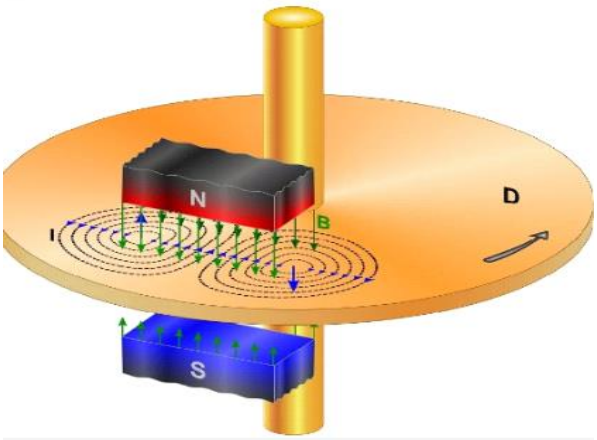


fig 1.2 Electromagnetic Braking

In advancement in EM braking we have discovered the system, that decelerate and stop vehicle and along with that also generate energy.

Methods

In invention approach of renewable energy source in automobile sector, we have taken consideration of various aspects like Rider's comfort, vehicle stability, maintaining center of gravity, efficiency of system, other environmental effects on system etc.

After lot of research and reading we arrived at two methods to achieve results for braking in automobile.

A. By changing commutation circuits in steps as per requirement

B. By constantly varying stators of motor for change in magnetic field

These two techniques are having retrofitted models that can be implemented in any automobile. We will discuss:

A. By changing commutation circuits in steps as per requirement

As we know change in timing of current in the coil leads to change in the power of DC machine. The major challenge was that how to control the power of DC machine. We have used coil changing principle in this models. The function of commutation circuit in controller is take energy from battery through the live

and ground wire and convert it in 3 phase supply for the motor. It energies the current coil in the motor as per power requirement of the motor. Multiple Commutation circuit is responsible for adjusting the timing of current's flow at different power in DC machine

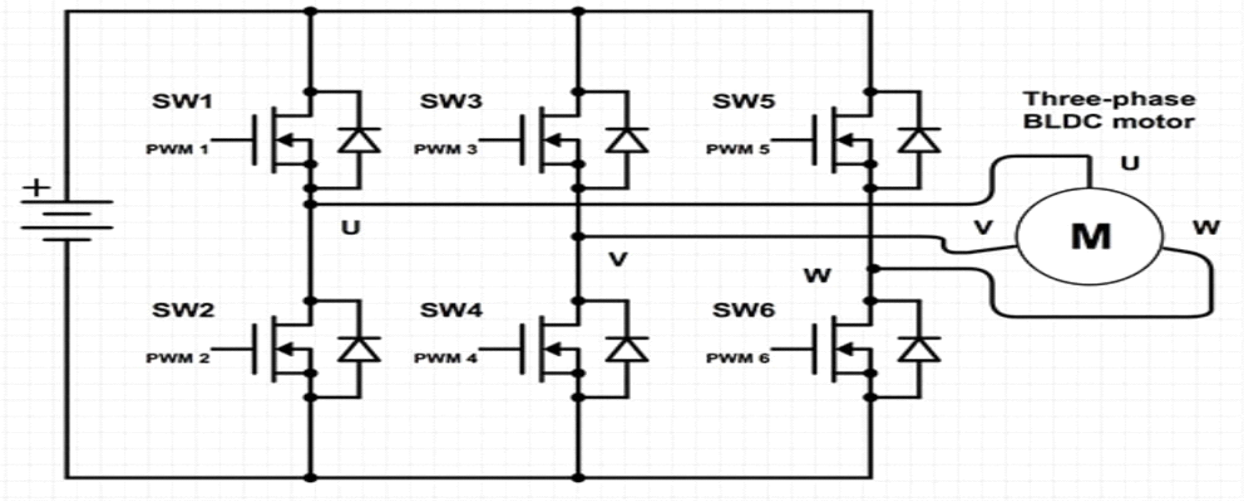


Fig. 2.1 Commutation circuit of BLDC motor

In this method we are going to use above commutation process in the reverse direction. The number of energising current coils are also different. In this model relay is used for efficient switching of different commutation circuits. LVDT sensor is located at brake lever for detecting position of lever. In between brake lever and the relay module we have used microcontroller like Arduino with trained algorithm for sending pulse to the relay module for switching.

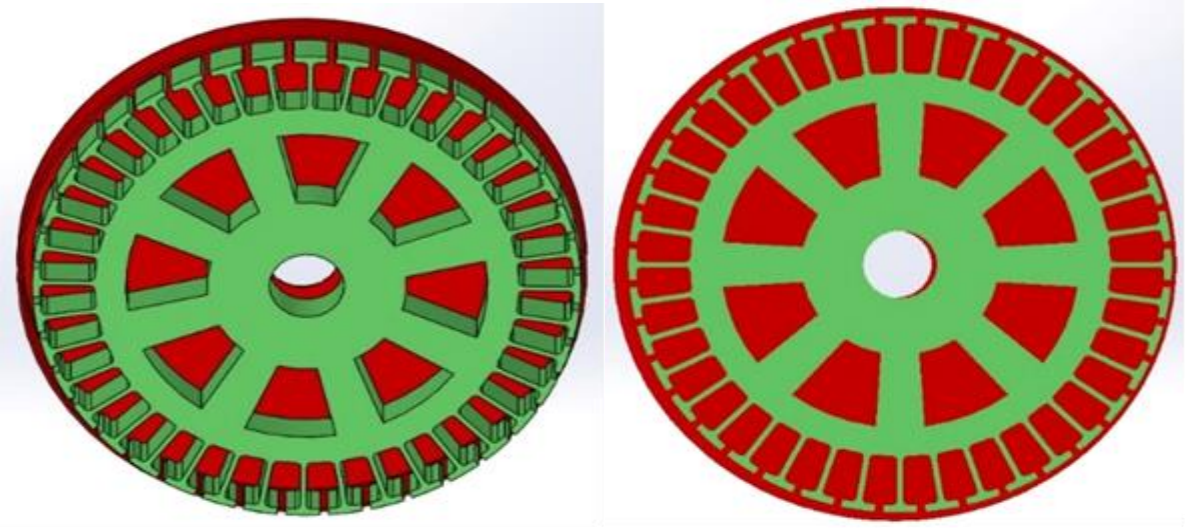


Fig 2.2 Designed Motor retrofitted to rear axle

In vehicles we will be using this retrofitted model instead of traditional disc brakes or drum brakes. In this we are using designed and optimized BLDC motor. This motor act as generator as having input of rotating force. As we know power of BLDC motor can be changed by changing direction and timing of the current in the coil. So, we are using 5 commutation circuits of different power and by switching that circuits we can get different power in output. In this mechanism as commutation circuit changes, power at the output changes resulting in change in force required to vehicle deceleration. We are taking input from brake lever using LVDT (Linear variable differential transformer) sensor. Then we divide sensors output in 5 steps. As the lever distance reached to predefined level, relay connects the particular switching circuits.

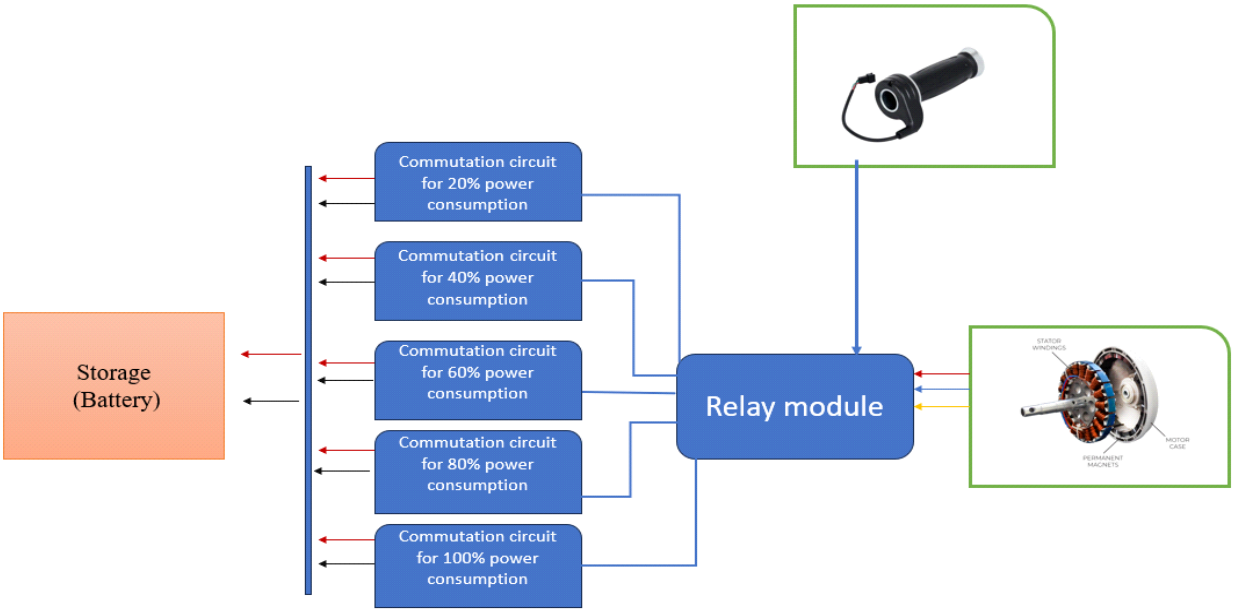


Fig 2.3 Step wise Distribution of braking load

Material – Designed BLDC motor (Permanent Magnet), LVDT sensor, Microcontroller, Designed reverse commutation circuits, Relay, Energy Storage devise (Battery)

B.By constantly varying stators of motor for change in magnetic field The power of DC machine is depended on the armature coil current as well as magnetic field intensity or flux density. In this we have used the principle of variable magnetic field for the changing corresponding power changes in output power. In this mechanism we are using motor having field winding. This method requires a variable voltage supply for the field circuit which is separated from the main power supply to which the armature is connected. We are using coiled motor to control the power of DC machine by changing the field winding. As same in method 1. LVDT sensor is located at brake lever used for positioning the lever distance. Along with that pre-programmed microcontroller and MOSFET (Voltage controlled switch) switch is placed for sending proportional pulse for external power source that is connected to the field winding.

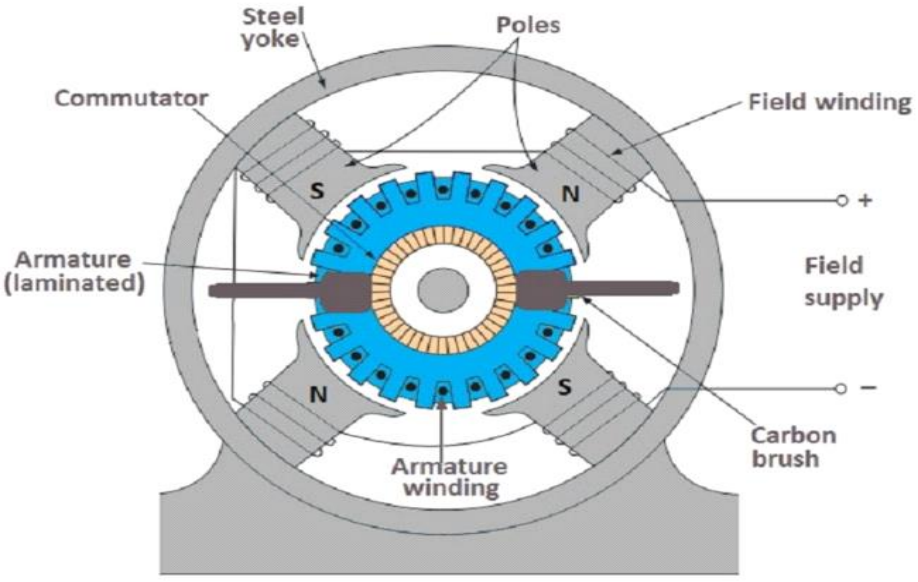


Fig 2.4 Wound motor (Retrofitted to rear axle)

As shown in Fig.2.1 external power source is connected to give supply to the field winding. LVDT (Linear Variable Differential Transformer) sensor gives output of position of brake lever in the form of variable voltage. Pre-programmed microcontroller takes voltage from sensor and give proportional pulses to the MOSFET (Voltage Controlled Switch).

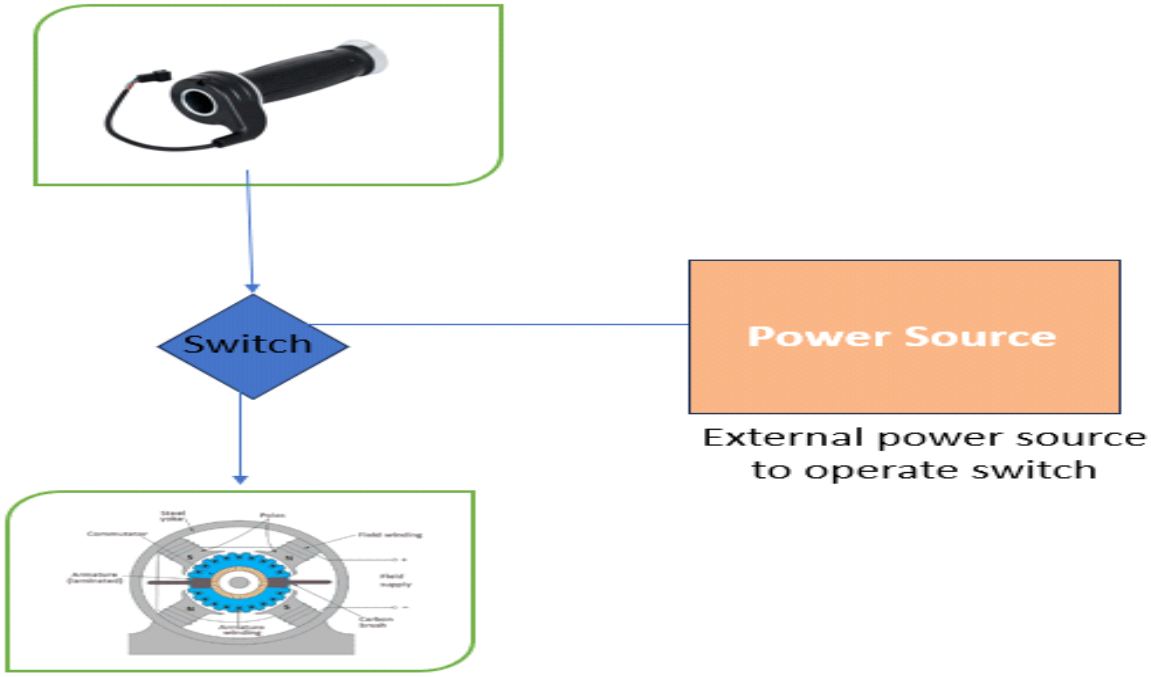


Fig 2.5 Analog braking load distribution
Material – Designed DC machine (field winding), LVDT sensor, power source, Microcontroller, MOSFET, Energy Storage devise (Battery)

CASE STUDIES:
Considering ground vehicles is classified it as two wheel drive, Four wheel drive and heavy weight transportation vehicle then Power required to drive, Mass of vehicle, Mechanical losses also changes and simultaneously energy required for applying brakes changes. For implement these systems on vehicle, power can be calculated with gross weight and taking average mass as:

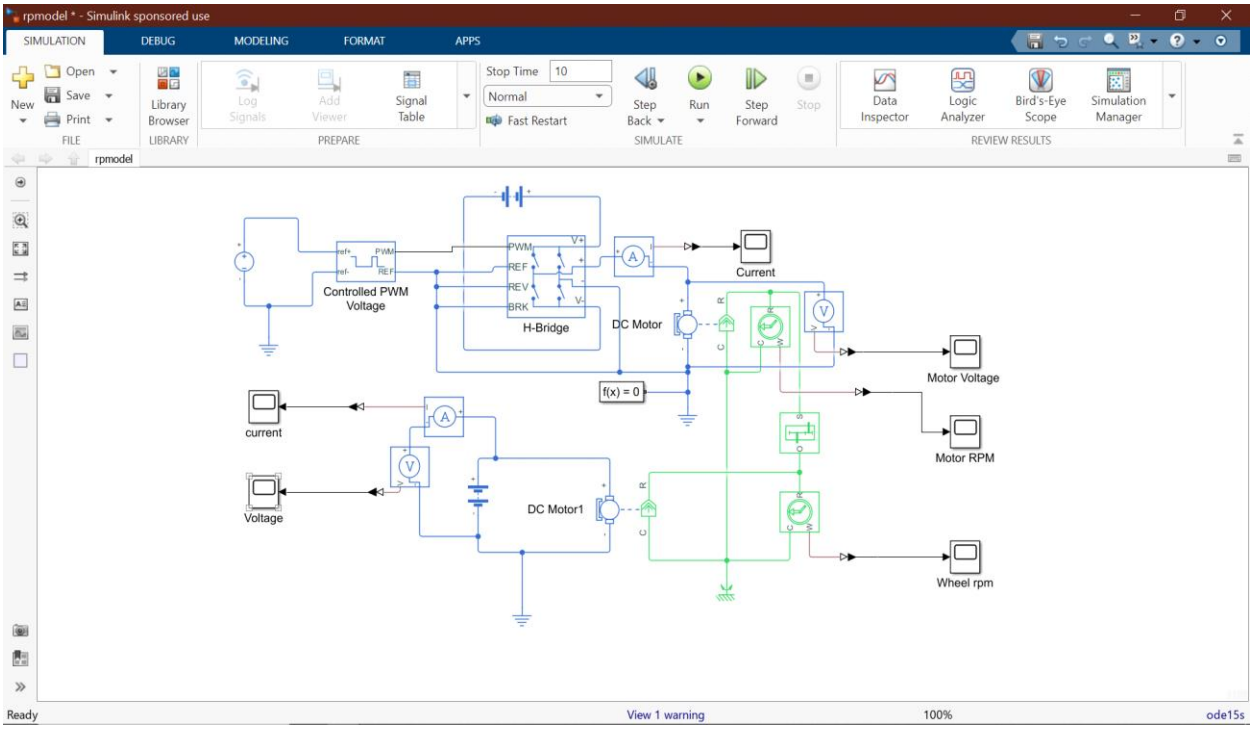
A. For two wheeler:
Assume gross weight(weight with driver) of normal two wheeler = 150 kg
Speed = 50 kmph = 13.8 m/s
Kinetic energy produced = (1/2) * m * v^2

As we know power can be changed by changing magnetic field of the DC machine. Magnet in the DC machine energise with externally controlled current source. So as we apply brakes by pulling brake lever magnets gets energise in that proportion. In this way we can decelerate as well as stop the vehicle by continuously changing the magnetic field in the DC machine.

= (1/2) * 150 * 13.8^2 = 14.28 kJ = 3.96 Whr
If we take brakes apply counting of normal driver is 200 per 100 kilometers.
Total Consumable energy 3.96 * 200 = 0.79 KWhr
Hence , Vehicle having driving power of 7.46 kW (125-150 cc) can drive upto 8 - 12 km per 100 km.

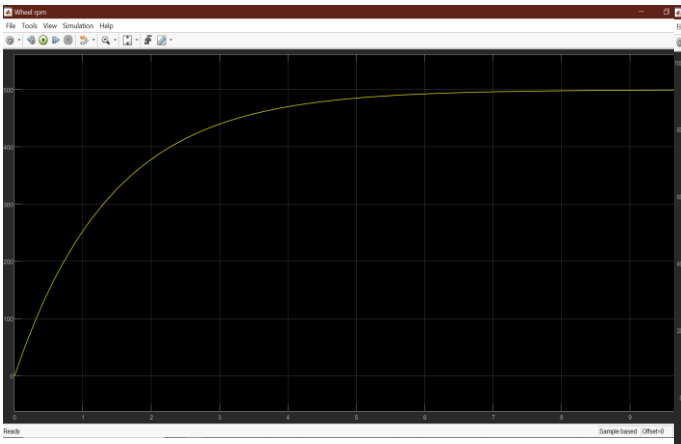
B. For Four Wheeler(Swift desire):
Assume gross weight(weight with driver) of average four wheeler = 900 kg
Speed = 50 kmph = 13.8 m/s
Kinetic energy produced = (1/2) * m * v^2
= (1/2) * 900 * 13.8^2 = 85.69 kJ = 23.8 Whr
If we take brakes apply counting of normal driver is 200 per 100 kilometers.
Total Consumable energy 23.8 * 200 = 4.76 K Whr
Hence, Vehicle having driving power of 61.17 kW (1197 cc) can drive upto 6 - 9 km per 100 km.

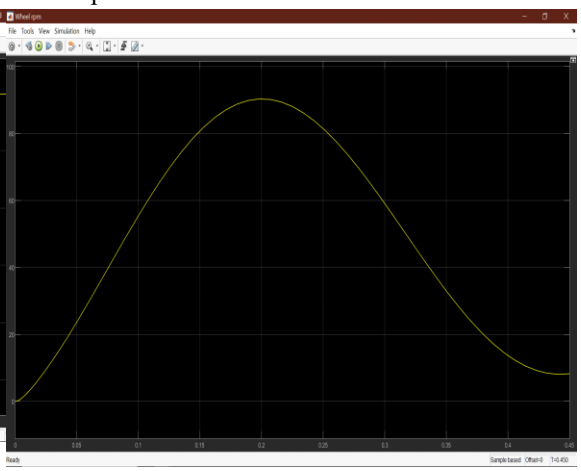
SIMULATION RESULT:



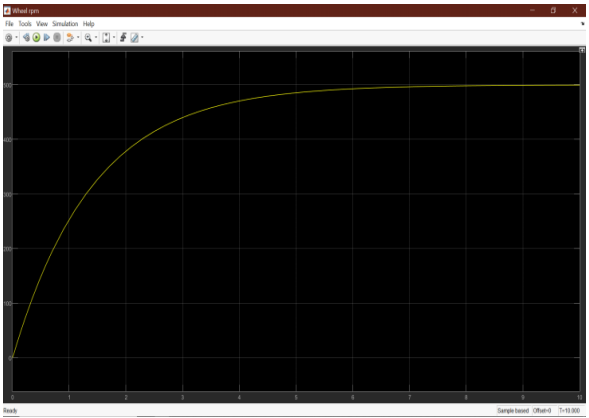
Model

Wheel rpm without brake





Motor rpm without brake



Wheel rpm after brake after sec.

In this way, case studies gives the theorical confirmation of average increment in milage. We consider the system efficiency for this system is 90%. We simulate this model in MATLAB SIMSCAPE software. For the simulation we have take driving power as 1 kW and continuously incrementing braking power. This simulation gives effective braking effect and makes vehicle stops when we apply brake by this system.

CONCLUSION

Energy produced through brakes have huge potential to drive any vehicle. It is the way to make driving energy source more efficient. As we know any energy source that drives the vehicle is not 100% efficient because of energy loss in mechanical system like Inertia, Friction, Thermal emission, etc. This “Renewable Energy generation in Automobile” is able to collect that lost energy in the form of friction in traditional braking system. Indirectly it is way to make driving power source more efficient by collecting and storing waste energy. Finally, the research conducted provides valuable insights into potential of renewable energy sources and increase the 10-15% vehicle milage as well as to make more responsive braking system.

REFERANCE

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[4] "STUDY AND FABRICATION OF ELECTROMAGNETIC BRAKING SYSTEM" by YV Nitesh & 4 others.

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