International Journal of Research
Available at https://edupediapublications.org/journals
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue 12
April 2018

Regenerative Braking System

K. SRIKAR REDDY

Department of Mechanical Engineering Velagapudi Ramakrishna Siddhartha Engineering College

srikarkoteru@gmail.com

Abstract:

Every time we step on our car's brakes, we are wasting energy. Physics tells us that energy cannot be destroyed. So when our car slows down, the kinetic energy that was propelling it forward has to go somewhere. Most of it simply dissipates as heat and becomes useless. That energy, which could have been used to do work, is essentially wasted. Is there anything that we, the driver, can do to stop wasting this energy? Not really. In most cars it's the inevitable byproduct of braking and there's no way you can drive a car without occasionally hitting the brakes. But automotive engineers have given this problem a lot of thought and have come up with a kind of braking system that can recapture much of the car's kinetic energy and convert it into electricity, so that it can be used to recharge the car's batteries. This system is called regenerative braking. In this project we are making an attempt of exploring the Regenerative Braking System which can save the energy which is being lost during braking as heat due to friction. A practical model is developed which is similar to that of the existent one and the working of the system is explained in detail.

INTRODUCTION

The issue of calculating the energy saving amount due to regenerative braking implementation in modern AC and DC drives is of great importance, since it will decide whether this feature is cost effective. However, as the increase of the electric energy cost at the industrial sector, the need for advanced energy saving techniques emerged in order to cut down operational costs. To this direction, this project presents a theoretical, simulation and experimental investigation on the quantization of energy recovery due to regenerative braking application in industrial rotating loads. Finally, a power conversion scheme is proposed for the storage/exploitation of the recovered energy amount. Fossil fuels become each time less abundant and expensive, and with the problems of worldwide pollution, they also become inadequate to be used in such a large scale. The automotive industry is one of the biggest spenders of this limited resource. This fact may be changed with the use of electronic propelling systems, such as the appliance

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue 12
April 2018

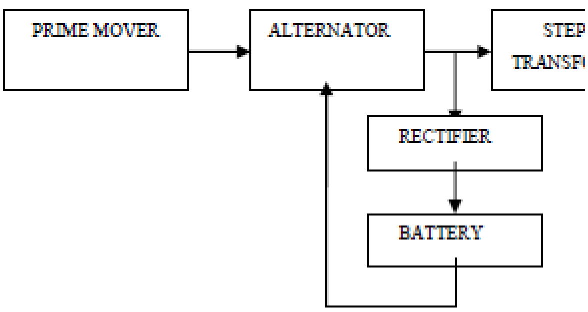
of a three-phase induction motor driven by a controlled inverter, replacing the internal combustion engine. The objective of this project is to research, design and implement the most effective regenerative system. The extra energy obtained from braking is used for light the bulb.

BRAKING SYSTEM

All electric machines have two mechanical operations, motoring and braking. The nature of braking can be regenerative, where the kinetic energy of the rotor is converted into electricity and sent back to the power source or non-regenerative, where the source supplies electric power to provide braking. This project investigates several critical issues related to regenerative braking in both DC and AC electric machines, including the re generative braking capability region and the evaluation of operating points within that capability region that result in maximum regenerative braking recharge current. Electric machines are used in the power trains of electric and hybrid-electric vehicles to provide motoring or braking torque in response to the driver's request and power management logic.

DESIGN AND METHODOLOGY:

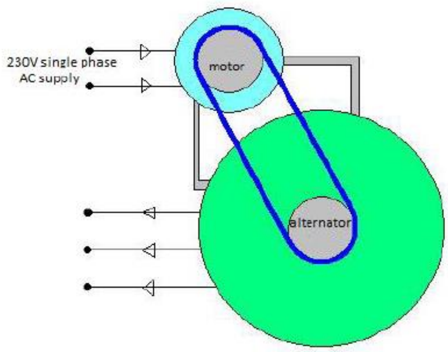
BLOCK DIAGRAM:



Block diagram of overall project design

In our project, we consider single phase induction motor as prime mover. Prime mover is directly coupled with an alternator by using belt and pulley arrangement. Output of the alternator is connected to a step-up transformer. The transformer step up into 230 V AC supply and this is fed into an incandescent lamp. While we applying the brake, giving DC supply to rotor. The rotor will produce flux. Due to the kinetic energy, the rotor will slowly rotate and come to rest. During this time an emf will produce in the stator winding and fed to the step-up transformer and then fed to the load

BELT AND PULLEY ARRANGMENT:



Belt and pulley arrangement

LITERATURE REVIEW

A BRIEF HISTORY OF REGENERATIVE BRAKING

Regenerative Braking for an Electric Vehicle Using Ultra capacitors and a Buck-Boost Converter: An ultra capacitor bank control system for an Electric Vehicle has been simulated. The purpose of this device is to allow higher

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue 12
April 2018

accelerations and decelerations of the vehicle with minimal loss of energy, and minimal degradation of the main battery pack. The system uses an IGBT Buck-Boost converter, which is connected to the ultra capacitor bank at the Boost side, and to the main battery at the Buck side. The control of the system measures the battery voltage, the battery state-of-charge, the car speed, the instantaneous currents in both the terminals (load and ultra capacitor), and the actual voltage of the ultra capacitor. This last indication allows to know the amount of energy stored in the ultra capacitor. A microcomputer control manipulates all the variables and generates the PWM switching pattern of the IGBTs. When the car runs at high speeds, the control keeps the capacitor discharged. If the car is not running, the capacitor bank remains charged at full voltage. Medium speeds keep the ultra capacitors at medium voltages, to allow future accelerations or decelerations. The battery voltage is an indication of the car instantaneous situation. When the vehicle is accelerating, the battery voltage goes down, which is an indication for the control to take energy from the ultra capacitor. In the opposite situation(regenerative braking), the battery voltage goes up, and then the control needs to activate the Buck converter to store the kinetic energy of the vehicle inside the ultra capacitor. The measurement of the currents in both sides allows to keep the current levels inside maximum ratings.

EXISTING SYSTEM

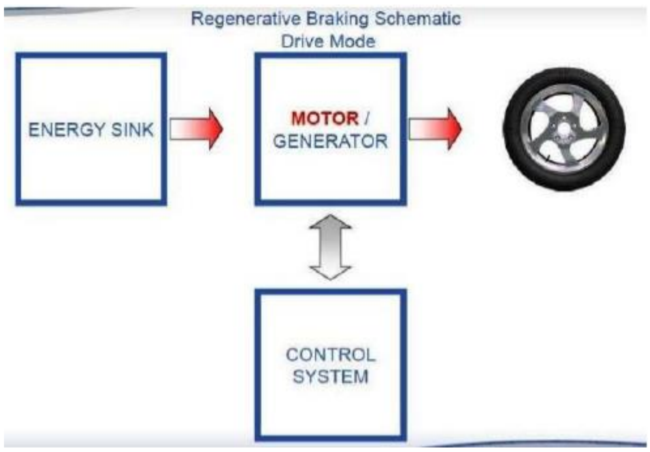
In the existing system it uses mechanical breaking and it also needs break shoes. In the existing system the wear and tear is more. The existing system consists of brake shoes, which is very costly. The noise produced is more in this system. In this system break shoes needs to be frequently changed due to the mechanical friction. In the existing system the energy during breaking is lost in the form of heat

PROPOSED SYSTEM

In the proposed system it uses electrical energy. In this system during the breaking time the electrical energy is produced. In this system the noise is less. Frequent replacement of brake shoes is not required in this system It is more advantageous than the existing system, it produces electrical energy during the breaking time. It is a cost effective system and it is a flexible system The energy during breaking is converted to electrical energy.

ANALYSIS AND RESULT

ELECTRICAL SCHEMATIC DIAGRAM



COMPARISON OF DYNAMIC BRAKING AND

REGENERATIVE BRAKING

Dynamic brakes unlike regenerative brakes, dissipate the electric energy as heat by passing the current through large banks of variable resistors. Vehicles that use Dynamic brakes ("rheostatic brakes" in the UK), unlike regenerative brakes, dissipate the electric dynamic brakes include forklifts, diesel-electrical locomotives, and streetcars. This heat can be used to warm the vehicle interior, or dissipated externally by large radiator-like cowls to house the resistor banks. The main disadvantage of regenerative brakes when compared with dynamic brakes is the need to closely match the generated current with the supply characteristics and increased maintenance cost of the lines. With DC supplies, this requires that the voltage be closely controlled.

EXPERIMENTAL WORK

In this experiment the apparatus vary from that of the actual setup. The design is done using almost the scrap material except for two or more components. A working model is made using the principle of Regenerative Braking. It uses a setup of sprocket and chain. A metallic frame is made so that the wheel to be powered up can be supported by it. A small wheel is used for the purpose of braking application. This wheel is brought in contact with the inner surface of the rim and as soon as they meet the small wheel starts rotating in the opposite direction thereby running a motor which is connected to it. An LED is connected which is used to know whether the power is being generated or not. A battery is connected to the motor and the power generated by motor is fed directly into the battery. The power is stored and used whenever needed.

FUTURE MARKET POTENTIAL

Regenerative braking is a mature technology. Within Europe, there is still a considerable difference between countries in the share of rolling stock that is equipped with regenerative braking, but the share is relatively high already. Regenerative breaking is relatively standard in new trains. It is also used in major new high-speed trains. However, friction brakes are still needed as backup in the case that the regenerative brakes fail. It is possible to use regenerative braking on these high speed trains because most cars have their own electric motors, this is in contrast to trains in which only the locomotive has electric motors. The fourth generation TGVs in France, which are expected to be commissioned in 2010, will also be equipped with regenerative brakes, as will the German ICE 3 trains which are to be commissioned in 2016.

ELEMENT SPECIFICATIONS FOR ACTUAL MODEL

General design will provide all of the following:

- Single Phase Induction Motor: 230V, ¼ HP Capacitor start- run single phase induction motor

- Belt and pulley arrangement

- Alternator: 120VA, 12V, 10A, 300 rpm alternator

- Voltage Regulator: Zener diode is used to regulate the output voltage

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue 12
April 2018

- Rectifier: Three phase bridge rectifier. Diode used IN4007

- Battery: 10Ah 12VDC deep cycle lead acid battery for compatibility, convenience, and cost.

- Relay: 12V single pole double throw.

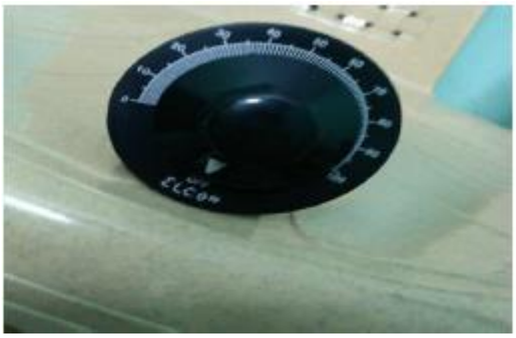
- Step-up transformer: 12V to 230V AC single phase transformer

- Load: 40W 230V incandescent bulb is connected as load.

ELEMENT SPECIFICATIONS FOR PRACTICAL MODEL:

Sewing Machine Motor: 220V, 230W, 7500 rpm

Chain and Sprocket arrangement



Voltage regulator

Dc motor

Led

We construct the regenerative braking system by using the induction motor, alternator, rectifier, battery, step-up transformer, relay and incandescent lamp. We successfully take the energy lost due to braking and convert to 230 V single phase 50 Hz output supply and it is fed to the load. Let us consider that the optimum speed for the above experiment is 33.4 kmph as the apparatus does work fine

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue 12
April 2018

under those conditions. When the brake is applied the braking effect is felt for almost around a time of 5 seconds. Hence the energy generated during the braking process is thus obtained by multiplying the value of power obtained with the time of braking.

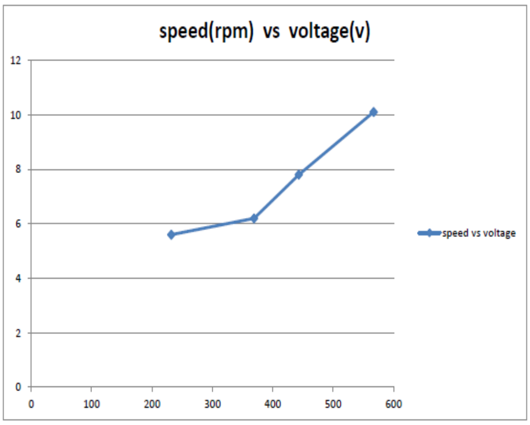
Braking time= 5 seconds

Power generated at the speed of 33.4 kmph = 1.9344 W

Energy generated for once during braking at the above conditions is therefore obtained as = 5*(1.9344) = 9.672J

Let us consider that the above equipment is used for a vehicle on one of the busy roads in a town. Let the distance to be covered be 1 km. Let us consider that the driver has to use the brake for at least 5 times during his travel of this 1 km.

Then the energy developed due to braking is = (5*9.672) = 48.36J/km



The above graph shows us the variation of the voltage whenever speed is regulated. The system is operated at different speeds and at each and every speed the readings of voltage obtained due to the braking are noted down. As can be seen from the graph the voltage is gradually increased with the increase in speed. This implies that as the speed is increased the braking effect needed to bring the system to halt increases as well. Hence when the brakes are applied, more voltage is applied every time the speed has been increased. And this is also an effect of time taken for braking. When the speed is high then the time required to bring the system to halt also increases. Hence as the braking is done for more time the voltage appears to be increased. Similarly the current and the power generated during the braking also have the same effect with increase in speed. i.e., With increase in speed the current and the power produced increased.

PHOTO GALLERY

ADVANTAGES AND DISADVANTAGES

ADVANTAGES:

• Increase of overall energy efficiency of a vehicle. The energy saved during the braking can be used in various forms. Many electric cars feed the energy back to batteries where the energy is stored and can be in turn used for various purposes.

This increases the overall efficiency of the system by using the braking energy which is wasted away in general braking systems.

• Improved Performance due to the introduction of this type of system. The usage of brake shoes and brake pads is reduced thereby reducing the chance of wear and as the system is anti friction type the material wear is negligible thereby improving the performance greatly.

DISADVANTAGES:

• Added Weight-Extra components can increase weight. As discussed above even though the weight of individual accessories is less, the more number of added components add extra weight to the system which may dampened by this method.

• Complexity-depends on control necessary for operation of regenerative braking system.

• Cost of components, engineering, manufacturing and installation is high.

CONCLUSION

In ordinary braking system there is a huge amount of energy wasted while braking. Generally we uses brake shoe and hydraulic systems are used in locomotives, so the maintenance cost is high and also those system will create noises and pollution. In our project we can reduce the wastage of energy during the braking time. This is simple and cost effective way of braking. It can perform a fast and controlled braking. The locomotives are normally designed for gradual braking. If we apply this mechanism in electrical locomotives, we can obtain very good braking with less maintenance cost and we gather electricity as by product from the system, then the electricity is fed into the bus. And electric is the future and there is no denying that fact. With the scope to the electric vehicles already wide spread the future is well set for regenerative braking system. May it be cars, trains or any other electric vehicles which we are about see a lot in the future, can use this braking system which is efficient and game changing.

REFERENCES

[1]. Chen, C.-H., Chi, W.-C., and Cheng, M.-Y., “Regenerative braking control for light electric vehicles,” in 2011 IEEE Ninth International Conference on Power Electronics and Drive Systems (PEDS), pp. 631 – 636, Dec 2011.

[2]. Cholula S, Claudio A, and Ruiz J, “Intelligent Control of the Regenerative Braking in an Induction Motor Drive”, Proceedings of the 2nd International Conference on Electrical and Electronics Engineering (ICEEE 2005), Mexico City, Mexico, pp. 302-308, 7-9 September 2005.

[3]. Cikanek, S. and Bailey, K., “Regenerative braking system for a hybrid electric vehicle,” in Proceedings of the 2002 American Control Conference, vol. 4,pp. 3129 – 3134, 2002.

[4]. Crombez, D. and Czubay, J., “Vehicle and method for controlling regenerative braking.” Patent, US 0303498 A1, Dec 2011.

[5]. Dubey, G. K., Fundamentals of Electrical Drives. Alpha Science International Ltd., 2002.

[6]. E.C. Ejiogu, and Y. Tanno, "Transient and Saturation Modeling of the Capacitor-Excitation and Magnetic Braking of the Induction Motor", Proceedings of IEEE International Symposium on Industrial Electronics (ISIE'93), Budapest, Hungary, pp. 316-320, 01-03 June 1993.

[7]. George A. Kaufman and Mark J. Kocher, "Fail-Safe Dynamic Brake for Three-Phase Induction Machines", IEEE Transactions on Industry Applications, Vol. IA-20, No. 3, pp. 1229-1237, September 1984.

[8]. Grantham C, "Zero-Sequence Dynamic Braking and Parameter Determination", Proceedings B of IEE Electric Power Applications 1983, Vol.130, No. 6, pp. 392-398, November 1983.

[9]. Hairik H.A, Thejel R.H, and Kadhem W.A, "Proposed Scheme for Plugging Three-Phase Induction Motor", Proceedings of 15th IEEE Mediterranean Electro technical Conference (MELECON 2010), Valletta, Malta, pp. 1-5, 26-28 April 2010.