International Journal of Electrical and Electronics Engineers
Vol. No. 9, Issue No. 01, January-June 2017
ISSN (O) 2321-2055
ISSN (P) 2321-2045

A REVIEW ON ELECTRIC VEHICLE REGENERATIVE BRAKING SYSTEM AND ENERGY RECOVERY

Kritika Prakash[1], Aashutosh Khasdeo[2], Dr. Syed Uvaid Ullah[3]

[1,2,3]*Electrical Engineering Department, Laxmi Narain College Of Technology,Bhopa (INDIA)*

ABSTRACT

The issues of global warming and depletion of fossil fuels have paved opportunities to electric vehicle (EV) [2]. Moreover, the fast development of power electronics technologies has even accomplished high energy-efficient vehicles. Electrical vehicle as a brand new means that of transport, with its clean energy source pollution, diversification and energy driven higher efficiency become the development trend of the automobile business. The definition of the automobile's braking system is that the electrical vehicle converts components of kinetic energies of vehicle as electrical power whereas decelerating; the electrical power of converting is stored in the saving device, in order to extend the mileage of electric vehicles. Regenerative braking can improve energy usage efficiency and may prolong the driving distance of electrical vehicles (EVs) [4]. Center of attention of this paper is Review on Electric Vehicle Regenerative Braking System and Energy Recovery and related work.

Keywords: Energy management, energy storage, vehicles, energy recovery control strategy

I. INTRODUCTION

An electric vehicle can be described as a vehicle which runs using an onboard electric generator like electric battery or a hydrogen fuel cell as its primary source of energy. Electric vehicles provide a smoother operation, stronger acceleration and are quieter as compared to conventional vehicles with Internal Combustion Engine (ICE) [2]. In an age where fossil fuels like petrol, diesel are diminishing as well as getting costlier, Electric Vehicles hold a lot of importance today. An Electric vehicle can be operated by using only an electric source like battery or it can also have a structure of a combustion engine parallel to the electric motor. Such a type of vehicle is known as Hybrid Electric Vehicle. Either the battery or the gasoline engine runs the transmission and operates the motors of the vehicle [4]. An electric vehicle can have either ac or dc motors. The gear structure of an electric vehicle remains same as a conventional vehicle to provide both variable speed and variable torque to the vehicle. For ac motors, an inverter changes dc voltage of the battery to ac voltage before giving it to the motor. Charge in the battery determines the travelling distance and hence the mileage of the electric vehicle. This involves changing the engine from ICE to an electric motor to run the vehicle [2]. Though the initial conversion cost may be incurred, it is beneficial and cost effective to the user and better for the environment. Brake Systems in electric vehicles can be of different types. In some vehicles, conventional friction brakes are used. Brake Systems in electric vehicles can be of different types.

International Journal of Electrical and Electronics Engineers
Vol. No. 9, Issue No. 01, January-June 2017
ISSN (O) 2321-2055
ISSN (P) 2321-2045

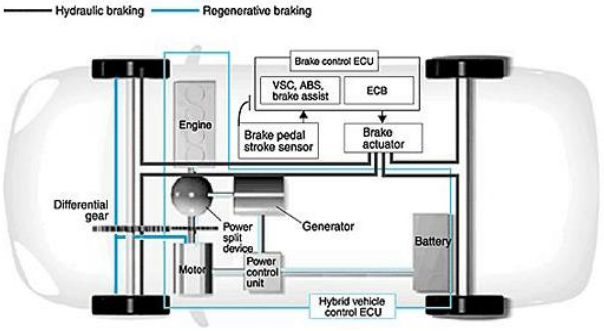

Fig.1 Regenerative Braking System (RBS)

In some vehicles, conventional friction brakes are used. In such method, continuous braking is useful which make friction and stops the wheels from rotate, thus slowing down the vehicle. In such brake systems, the brake pads heat up and this results in energy wastage within the type of heat. Another type of brakes is that the Anti-Lock brakes. Here, continuous braking isn't applied. Instead, a non-continuous braking pattern is applied that slows or stops the vehicle as required. Such a system is more efficient than the conventional braking system and gives a superior performance. A different type of brake method is the regenerative braking system [3]. In such a system, the motor itself or any other circuit works to apply the brakes by controlling the current in the motor circuit. If an ac motor is used, then during braking it works as a generator and gives back energy to the battery and slows down the vehicle at the same time. Any other circuit can also be used to divert the motor current during braking so that the vehicle slows down. Such types of systems also recharge the battery and help in braking. But such brake systems cannot be used solely as they can slow down the vehicle but generally do not bring it to a complete stop. Nevertheless, pure electrical vehicles (EVs) still haven't achieved ranges nearly as good as gas-powered typical vehicles. This drawback, because of the low-energy density and specific energy contained in most electrical batteries compared to it of gasoline, is resolved in hybrid vehicles by combining high-energy density of gas or hydrogen, with high efficiency of electric-drive systems [6].

II. LITERATURE SURVEY

GouYanan [1] "Research on Electric Vehicle Regenerative Braking System and Energy Recovery" in this paper to improve driving ability of electric vehicle, a braking regenerative energy recovery of electric vehicle was designed and the structure of it was introduced. The improvement effectiveness of the method was up to 60%, the electric vehicle energy recovery efficiency was effectively improved. In this paper, the design of the electric vehicle energy recovery system converts the braking energy into electric energy which charges for the battery. By simulating in MATLAB environment, we get the diagram about time-velocity, time-motor speed, time-motor torque, time-charging current and time-power.

Siang Fui Tie et. al. [2] "A review of energy sources and energy management system in electric vehicles" This paper analysis state-of-the-art of the energy sources, storage devices, power converters, low-level management energy management methods and high supervisor control algorithms utilized in ev. The rapid growth of ev has LED to the combination of different resources to the utility grid and hence sensible grid control plays a crucial role in managing the demand. This paper reviews the drive trains architectures on HEV and AEV with current

technology on energy storage unit and energy genera- tion unit. The power energy management at low-level component control and high-level supervisory control among the HEV and AEV are also reviewed.

Zhang Guirong [3] "Research of the Regenerative Braking and Energy Recovery System for Electric Vehicle" Electric automobile as a latest way of transportation, by means of its clean energy source pollution, diversification and energy driven higher efficiency become the development trend of the auto industry. Meanwhile, the power produced during the motor braking torque can be exerted through the transmission of the driving wheel brake, resulting in braking force. At present, the electric vehicle development and research process, how to improve their driving range is a more critical issue. Current technology is more mature as a super capacitor electric vehicle auxiliary power source, which can greatly enhance the energy recovery, further improving the electric vehicle's driving range on one charge. Regenerative braking is a unique electric vehicle that can achieve vehicle braking energy recycling, improve energy efficiency of the vehicle.

Fei Peng et. al. [4] "Regenerative Braking System of Electric Vehicle Driven by Brushless DC Motor" In this paper, BLDC motor {control|control} utilizes the standard proportional–integral–derivative (PID) control, and therefore the distribution of braking force adopts fuzzy logic management. The simulation results show that the fuzzy logic and PID management will realize the regenerative braking and may prolong the driving distance of EVs under the condition of ensuring braking quality. This paper has given the RBS of EVs that are driven by the BLDC motor. The performance of the EVs' regenerative brake system has been realized by our control scheme which has been implemented both in the simulation and in the experiments.

Junping Wang et. al. [5] "Regenerative Braking Strategy for Electric Vehicles" the most important property that have control on brake energy regeneration are analyzed. Mathematical model of brake energy create electrical vehicles is established. The strategy takes the braking force required, the motor accessible braking torque, and therefore the braking torque limit into consideration, and it will create the simplest use of the motor braking torque. The mathematical model of brake energy create EVs is established. By analyzing the charge and discharge characteristics of the battery and motor, an easy regenerative braking strategy is projected. The strategy takes advantage of the motor torque and may acquire maximum energy recovery.

III. METHOD

An electric vehicle provides a clear alternative to the internal combustion engine vehicles which run on fossil fuels like petrol and diesel. The fuels are depleting fast and alternative energy resources must be used as the consumption of fossil fuels goes on increasing every year due to usage of more vehicle but the production of these fuels is not keeping pace with the increasing demand.

3.1 Anti-Lock Braking System (ABS)

When a vehicle is travelling at a high speed, breaking the vehicle causes the wheels to slow down. But the vehicle body itself is travelling at a high speed and has its own momentum which does not slow down as fast as the wheels. Anti-lock braking is preferred over conventional braking. Anti-lock brake systems address two conditions related to break application; vehicle directional control and wheel lockup. When brakes are applied, friction is generated between the brake pads and the disc attached to the wheels. This causes the wheels to lock up. A locked up wheel has no traction with the road surface and hence the direction of the vehicle cannot be

International Journal of Electrical and Electronics Engineers
Vol. No. 9, Issue No. 01, January-June 2017
ISSN (O) 2321-2055
ISSN (P) 2321-2045

controlled or changed. When brakes are applied, friction is generated between the brake pads and the disc attached to the wheels. This friction causes the wheels to slow down and finally come to a halt. But at the same time, a lot of heat is generated in the brake pads as the kinetic energy of the wheels is converted into heat energy. Hence, it is vital to control the braking applied to the electric vehicle so that the wheels do not cease rotation and the vehicle directionality can be controlled at all times.

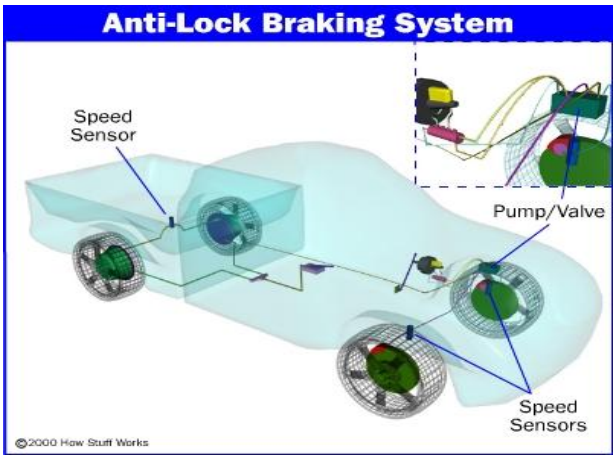

Fig.2 Anti-lock Breaking System

3.2 Regenerative Braking

Regenerative Braking is an energy recovery mechanism which saves energy which would have been otherwise wasted as heat due to friction while braking, and stores it in a capacitor bank or a flywheel setup temporarily. In Regenerative braking, an electric vehicles uses the motor as a generator when the brakes are applied, to transfer kinetic energy from the wheels which is wasted during braking into an energy storage device like capacitor bank. This energy is then given back to the battery thereby charging it. The energy wasted as heat can be up to 30% of the total energy and even if some portion of this energy is saved then it can be utilized to run the electric vehicle further.

IV. CONCLUSION

In this we review on Research on Electric Vehicle Regenerative Braking System and Energy Recovery and related work which gives some conclusion on behalf of other authors. In paper [2] reviews the drive trains architectures on HEV and AEV with current technology on energy storage unit and energy genera- tion unit. The power energy management at low-level component control and high-level supervisory control among the HEV and AEV are also reviewed. A conventional ICE vehicle contributes high GHG emission, and low efficiency drive train causes vehicle transforming to electric vehicle as an alternative solution. In [3] Regenerative braking is a unique electric vehicle that can achieve vehicle braking energy recycling, improve energy efficiency of the vehicle. At present, the electric vehicle development and research process, how to improve their driving range is a more critical issue.

REFERENCES

[1] Gou Yanan "Research on Electric Vehicle Regenerative Braking System and Energy Recovery" International Jour. of Hybrid Infor. Techn. Vol.9, No.1 (2016), pp. 81-90.

[2] Siang FuiTie, Chee Wei Tan "A review of energy sources and energy management system in electric vehicles" Renew. & Sust. Energy 20(2013)82–102

[3] Guirong, Zhang. "Research of the regenerative braking and energy recovery system for electric vehicle" *World Automa. Cong. (WAC), 2012*. IEEE

[4] Xiaohong Nian, Fei Peng, and Hang Zhang "Regenerative Braking System of Electric Vehicle Driven by Brushless DC Motor" IEEE Trans. On Indu. Electro., Vol. 61, No. 10, October 2014

[5] Jingang Guo, Junping Wang and Binggang Cao "Regenerative Braking Strategy for Electric Vehicles" Intelli. Vehicles Symp., 2009 IEEE.

[6] O. Fuji, "The development and application of hybrid vehicles," in *Proc. 19th Int. Electr. Vehicle Symp.*, Busan, Korea, Oct. 19–23, 2002,

[7] Xue X, Cheng K; "Selection of Electric Motor Drives for Electric Vehicles", Aus. Univ. Power Eng. Con. 2008, Volume 1, pp. 1 - 6.

[8] Zhang Z, Li W, Zheng L; "Regenerative Braking for Electric Vehicle based on Fuzzy Logic Control Strategy", Intern. Conf. on Mechanical and Electronics Engineering 2010, 319 - 323.

[9] Sudeendra Kumar, Verghese L, Mahapatra K.K., "Fuzzy Logic based Integrated Control of Anti-lock Brake System and Collision Avoidance System using CAN for Electric Vehicles", Indus. Techn. IEEE Conf. 2009, Volume 1, pp. 1–5.

[10] Tur O, Ustun O, Tuncay R, "An Introduction to Regenerative Braking of Electric Vehicles as Anti-Lock Braking System", Intel. Vehi. Symp. 2007, Volume 1, pp. 944 – 948.

[11] Ozdalyan B, Blundell M, "Anti-lock Braking Systems Simulation and Modelling in ADAMS", Intern. Conf. on Simulation 1998, pp. 140 – 144.

[12] Lu B, Wu J, Li J, "ABS System Design Based on Improved Fuzzy PID Control", 6th Intern. Conf. on Natural Computation 2010, Volume 1, pp. 62 -65.

[13] Naderi P, Farhadi A, "Anti-Lock and Anti-Slip Braking System using Fuzzy Logic and Sliding Mode Controllers", Vehicle power and prop. Conference 2010, pp. 1 – 6.

[14] Wang R, Sun H, "Development of a Single Wheel Test Bench for Anti-lock Brake System", Intern. Conf. on Optoelectronics and Image Proc. 2010, Volume 1, pp. 429 – 431.

[15] Darko B, Stanisa L, Dragan S, "Digital Sliding Mode Control of Anti-Lock Braking System", Adv. in Electrical and Computer. 2013, Volume 13, pp. 33 – 40.