International Journal of Interdisciplinary Innovative Research &Development (IJIIRD)
ISSN: 2456-236X
Vol. **06** Special Issue **01** | **2021**

Review on Regenerative Braking strategy In Electric Vehicle.

Ms.Anita R Hole1, Prof.Saurabh.H.Thakare[2], Prof.Yogesh.P.Sushir[3]

M.E.Scholar, Dept of Electrical Engineering,VBKCOE ,Malkapur (MH) India[1]
Assistant Professor .Dept of Electrical Engineering,VBKCOE, Malkapur(MH) India[2,3]

ABSTRACT

Traditional braking system causes a lot of energy wastage that produces unwanted heat during braking. To overcome this problem regenerative braking is invented. It save energy and increase the efficiency of electric vehicle. In electric vehicle regenerative braking is an effective approach to extend the driving range ,also improve the driving distance of vehicle. In this paper there are described some control strategy of regenerative braking system. Fuzzy logic control-with analyzing the characteristics and control factors of regenerative braking. The strategy dispense the regenerative braking force and frictional braking force during braking to braking safety and stability. By using the regenerative braking characteristics of motor kinetic energy can be converted into electric energy and store in battery. other control is by using flywheel to raise the regenerative performance. That promote the efficiency and energy saving in electric vehicle. A novel control strategy of regenerative braking based on a novel definition method of braking intensity caused to all braking condition.by slope information

Keywords: - Regenerative braking, fuzzy logic control, flywheel, the down slope driving , braking stability.

1. INTRODUCTION:-

Electric vehicle is well known as green vehicle because it produces zero emission to the air that there are no toxic gasses release from the vehicle that causes the environment polluted. Now the demand of electric vehicle is start increasing .in world all over eager to save the Mother nature from the excessive air pollution and recession on the natural resources and natural gasses In vehicular technology such as control technology and integrating technology has been develop aggressively .But the limitation of driving mileage becomes the problem for development of electric vehicle It had been solve by using regenerative braking it has become one way to improve the driving range This technology has mostly replace the traditional braking system always utilizes mechanical friction method to dissipate kinetic energy as heat energy to achieve the effect of stopping .The kinetic energy is a excess energy when the electric motor is in the braking state since it dissipated the energy as heat and cause loss of energy .This wasted energy can be converted to usable energy for electric vehicle. So the regenerated braking system has been invented to use the wasted energy. To enhance the performance of regenerative braking we discussed some previous control strategy .Regenerative braking force based on fuzzy logic control is tested with the state of charge and breaking energy recovery. This experiment carried out with different driving cycle and result is feasible and effective. Another is by using flywheel it enhance the performance of regenerative braking ,also energy conservation wear reduction and fuel consumption. Next is novel control strategy based on novel definition method of braking intensity,slope information and lgic threshold control algorithm.

In this work some control strategy of regenerative braking has been reviewed.

1.1 The Principle Of Regenerative braking :-

During braking regenerative braking converts mechanical energy into electric energy. The principle of that when braking is done the motor works as a generator , converting kinetic energy and potential energy into electric energy and storing in energy storage device. After that when vehicle starts or accelerates ,the driving motor is driven by electric energy stored in energy storage device. Fig shows the simplified schematic for regenerative braking.[1]

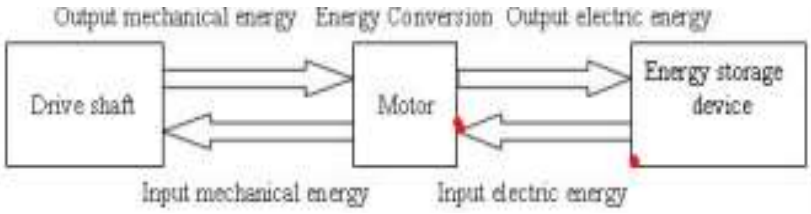


Fig 1-The simplified schematic schematic for regenerative braking.

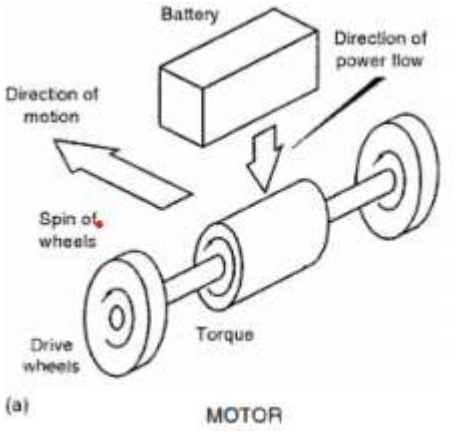


Fig 2 : Normal forward driving condition

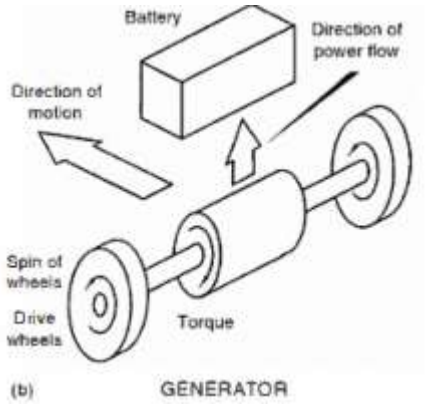


Fig 3 : Regeneration action during braking

In regenerative braking mode, it uses the motor to slow down the car when the driver applies force to the brake pedal then the electric motor works in reverse direction thus slowing the car. While running backwards, the motor acts as the generator and recharge the batteries as shown in figure 3. Meanwhile in figure 2 shows the car in normal running condition whereas the motor turning forward and taken energy from the battery.

By using regenerative braking, it vastly reduces the reliance on fuel, boosting fuel economy and lowering emissions (1, 2]. These types of brakes work effectively in driving environment such as stop-and-go driving situations especially in urban city. The regenerative braking system provides the majority of the total braking force during lowspeed and stop-and-go traffic where most of deceleration is required.

2 FUZZY LOGIC CONTOL IN REGENERATIVE BRAKING :-

Regenerative braking is the technology of electric vehicle which have braking safety and stability. During regenerative breaking convert portion of mechanical energy into electric energy. It reducing the energy consumption of electric vehicle. Increase driving range. A regenerative braking system is an system which deals with nonlinear parameter perturbation and serious external disturbances. Other literatures have not consider the SOC of energy storage devices hence . we design a regenerative braking force controller based on fuzzy logic . There is sugeno fuzzy logic controller, having high operational efficiency, coordinates with linear control theory. employs adaptive technology and ensures output plane continuity. The FLC system basically contains three main subsystem i.e. FLC input fuzzy variables. output fuzzy variables and the fuzzy logic rules , according to the influence factors of regenerative braking. The input variables are the driver's required braking force ,vehicle speed and batteries' SOC Output variable is the ratio between the regenerative braking force and total braking force [6].simulation Fuzzy logic control strategy can get more regenerative braking energy energy and efficient increases, is also feasible and effective. Fig shows the structure of FLC

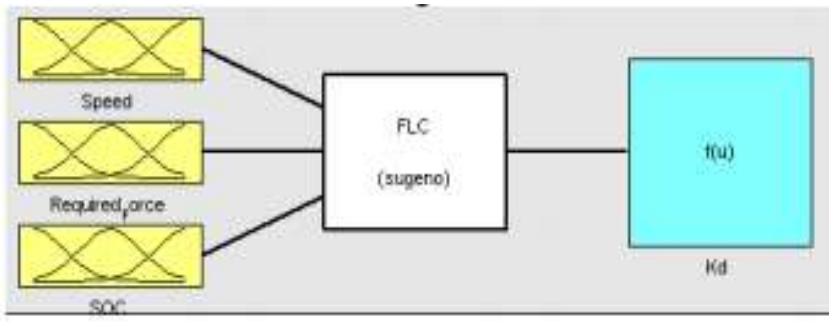


Fig4-Strcture of Fuzzy Logic Control.

3 . REGENERATIVE BRAKING USING FLYWHEEL :-

Regenerative braking is a braking method that utilizes the mechanical energy from motor by converting kinetic energy into electrical energy and fed back into the battery. In regenerative braking system the braking controller is the main part of the system because it control the overall process of the motor .Brake controller basically monitor the speed of the wheel, calculate the torque, rotational force and generated energy to be fed back to the batteries[2]

A flywheel is known as electromechanical battery. It is an inertia storage device .Flywheel is device which is supported by magnet floating bear in vacuum. It convert electric energy into kinetic energy and also kinetic energy into electric energy by the same motor or generator. Its function is to store energy when the supply of energy is more than the requirement and release it during the period when the requirement of energy is more than the supply.

In regenerative braking system , flywheel ,heavy wheel attached to a rotating shaft so as to smooth out variations in the speed of a shaft caused by torque fluctuations. The inertia of the flywheel opposes and moderates fluctuations in the speed of the motor and stores the excess energy for intermittent use. It functions when the driving and load torque is fluctuating Flywheel design can be improve by increasing angular velocity and delivers the stored energy of flywheel increase as the weight of rotational material is reduced., when compares it terms of equal mechanical strength of the flywheel.[7]

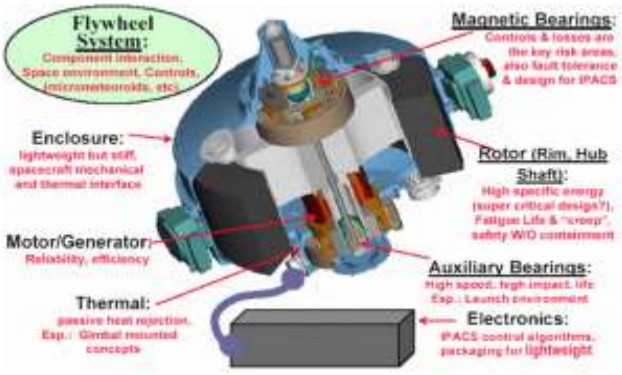


Fig 5-Flywheel system

4. NOVEL CONTROL STRATEGY IN REGENERATIVE BRAKING:-

The growing shortage of fuel fossils and environment pollution ,electric vehicle are taking responsibilities to ease the problem of harsh environment and energy depletion.[4].power management technology is to improve the performances of EV. Regenerative braking system transform the kinetic and potential energy into electric energy by generator and restores it in energy storage device. There are many researches in the subject. In order to to improve the efficiency of energy recovery braking safety and stability ,it is necessary to regenerating braking considering in down slope diving and braking stability.[5]

A single shaft electric vehicle driven by front axle is used here in fig 6. There is electric motor with two braking system pneumatic braking system and other is electric braking system composed of battery management system, motor controller and brake controller.

4.1 Basic theoretical analysis based on downhill braking:-

A) **Vehicle dynamic model**

According to the structure of vehicle drive system, vehicle dynamic model in braking process of downhill is built considering load transfer. The inertia force moment of rolling resistance ,air resistance and rotation mass is ignored. Neglecting braking process of rolling and sliding .adhesive coefficient is only definite value. The horizontal force equations along the ramp are given by

$$F_{xb} = F_{xb1} + F_{xb2} = mg[\, z_a + \sin\alpha]$$

When the wheels are locked, the maximum braking force on the ground is expressed as

$$F_{xbmax} = \varphi mg \cos\alpha$$

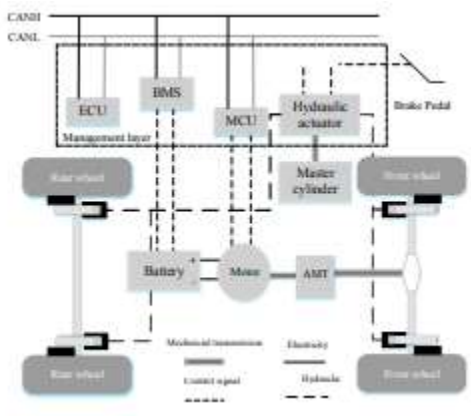


Fig 6-The configuration of RBS

B) **A novel definition of braking intensity**

Compared to the process of brake on horizontal road ,the driver should increase the brake pedal force or part the auxiliary braking device to keep steady running on the slope road and then prevent the traffic accident caused by rear end collision. Braking intensity in define as z=a/g is not suitable for cruising downhill regenerative braking.so redefine the braking intensity as $z=a/g+\sin\alpha$ .only when the wheel is locked ,the braking intensity is equal to $\varphi\cos\alpha$

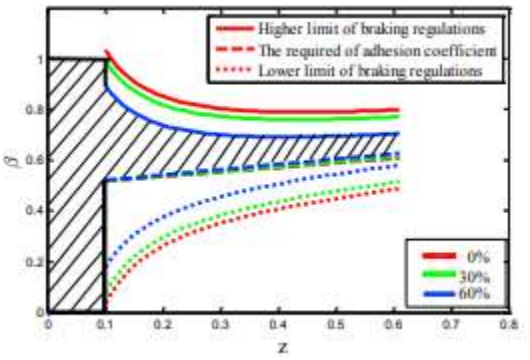
4.2 Control strategy of regenerative braking

4.2.1 The principle of upper braking force distribution

To ensure the directional stability and enough efficiency in braking process ECE R13 braking regulation for front and rear braking force of dual –shaft vehicle. Under various loading conditions braking strength is satisfied .Here apply the new definition of braking intensity to explore ECE R13 braking regulation

When the braking intensity is less than 0.1, the distribution coefficient of braking force can obtain any value between 0 and 1. With the increase of the pavement slope, when the braking intensity is between 0.1 and 0.61, the range of the braking distribution coefficient is gradually narrowed. Therefore, we need to strictly control the braking distribution coefficient within an inexpensive range to make sure the braking safety and therefore the efficiency of energy recovery. Because the front wheels, which are played by the motor, are adopted to recover energy, braking force distribution coefficient would be carried out in accordance with the upper limit of braking regulations, braking force distribution in front and rear wheels is shown in Fig.7.

we can obtain the maximum dynamic distribution function of the front braking force on braking intensity. According to the above study, the distribution relationship of the front and rear wheels is shown in Fig. 8. Due to the difference of the braking control lines between the flat road and slope road, A, B and C are dynamically moved to A', B' and C'. Therefore, the dynamic threshold value of the top-level braking force distribution needs to be transformed in the BCU controller according to the gradient information returned in vehicle-mounted GPS or main parameters of vehicle estimator to make sure the braking security



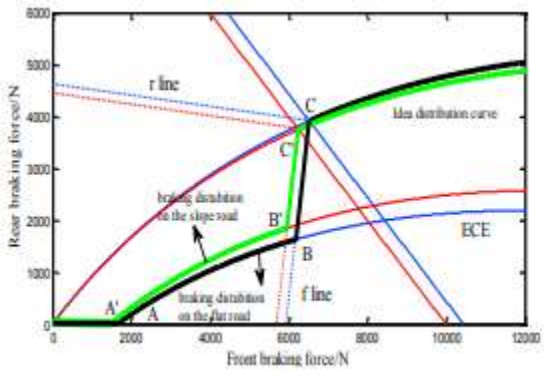


Fig 7-the range of brakeing distribution coefficients. ***Fig 8-The principle of braking distribution***

4.2. 2 The control strategy of bottom distribution based on logic threshold

The application of novel definition method can extend the adaptive scope of conventional regenerative braking control strategy and recover more energy. The variation of braking intensity is merely associated with slope when the vehicle is on the cruise downhill. According to the maximum longitudinal gradient of highway grade, the range of slope is 3~9%.

The electric braking torque generated by the motor is applied to the front wheels. When z is less than 0.1, the braking system enters the pure electric braking mode. When z is between 0.1 and 0.7, the braking system enters the composite braking mode. However, if the entire required torque can't be satisfied by regenerative braking torque, the motor would provide its max regenerative torque, and therefore the remaining torque would be compensated by the mechanical braking system. When z is more than 0.7, RBS shifts to the mechanical braking mode to ensure the braking safety

5. CONCLUSION:-

This paper summarizes how the regenerative braking technique employed for electric vehicle helps in improving the efficiency and driving range. The use of different control strategy in regenerative braking helps in improving the efficiency of conversion. The improvement in system can be done by using flywheel . The regenerative braking improves the driving range..Fuzzy logic control is feaisible and effective. This paper also discusses the need of boosting the voltage when back emf is not sufficient to provide reverse current to battery, especially at lower speeds. The advance control algorithms like fuzzy logic improves the energy savings in electric vehicle.

6. FUTURE SCOPE :-

Further research is required in regenerative braking to make far better system for extracting more energy and reduce the braking time. Researchers are working on this work on regenerative braking system with alternate energy source. In which advancement will possible so we studied further for better reliability as well as best working system.

7. REFERENCES:-

[1]. Hao Zhang, Guoqing Xu, Weimin Li, Meilan Zhou, Fuzzy Logic Control in Regenerative Braking System for Electric Vehicle, IEEE International Conference on Information and Automation, pp. 588-591, June 2012.
[2] M.K Yoong, Y.H Gan, G.D Gan, C.K Leong, Z.Y Phuan, B.K Cheah. K.W Chew, Studies of Regenerative Braking in Electric Vehicle, IEEE Conference on Sustainable Utilization and Development in Engineering and Technology Universiti Tunku Abdul Rahman, pp. 40- 45, November 2010.. Reference 2
[3]. Gang wan, Xinbo Chen, Guobao Ning, Journal of Asian Electric Vehicles, 2009 Reference 3
[4]. J Wu, Z Luo, N Zhang N. A new uncertain analysis method and its application in vehicle dynamics. Mechanical Systems & Signal Processing, 2017, 50–51:659-675 Reference 4
[5] Gao Y, Chen L, Ehsani M. Investigation of the effectiveness of regenerative braking for EV and HEV. Hydroelectric Energy, 1999
[6]] Yimin Zhao and Yu Wang, "Simulation and Fuzzy Logic analysis on an Off-road HEV," Consumer Electronics, Communications and Networke, pp.710-714, 16-18 April 2011.
[7]Dixon, J. (2010). Energy Storage for Electric Vehicles. Industrial Technology (ICIT), 2010 IEEE International Conference, (pp. 20 - 26)