RESEARCH ARTICLE OPEN ACCESS

Regenerative Braking Process & its Principle Working

Vedant A. Utikar*, Shraddha S. Jadhav**

*(Mechanical Engineering, JSPM's Rajashri Shahu College of Engineering, Tathwade, Pune
Email: vutikar@gmail.com)

**(Mechanical Engineering, JSPM's Rajashri Shahu College of Engineering, Tathwade, Pune
Email:jadhavshraddha863@gmail.com)

----------**********----------

Abstract:

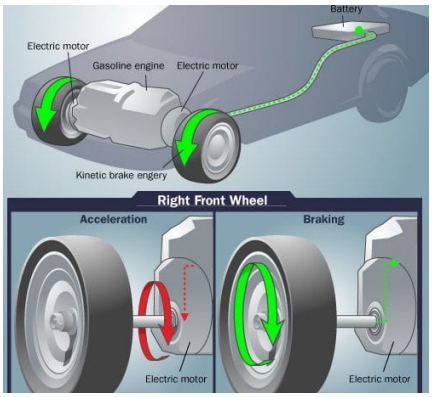
Through this research paper we should like to deliver some important information regarding Regenerative Braking. This is in contrast to conventional braking systems, where extra kinetic energy is converted to unwanted and wasted heat due to collision of brakes, or by rheostatic brakes, where power is obtained using electric motors as generators but dispersed rapidly as heat to resistors. The electric motor in your hybrid or electric car goes two ways - one to drive the wheels and move the car, and the other to recharge the battery. When you lift your foot off the accelerator pedal and enter the brake, the engine changes direction and begins to recharge the battery. Efficiency, on the other hand, refers to the greater the impact of regenerative brakes. The efficiency of the regenerative braking system varies with most cars, motors, batteries and batteries, controllers, but usually somewhere in the 60-70% effective area. Car size can be the biggest factor in the efficiency of re-braking due to the simple reason that heavy cars have great power and kinetic power. The fact of the matter is that in small and medium-sized electric cars, renewable brakes do not work as well as in electric cars, but there are still many benefits. It is then stored in the battery, to be returned to the electric motor if needed to drive car tires. It is estimated that the efficiency of a photocopying system can range from about 16 to 70 percent, and that is limited to the way a car is driven. And sometimes the power has to be wasted when the battery is fully charged, as it cannot be fully charged. In mixed settings, however, these types of brakes can only provide power to the part of the electric drive with a car battery. This slows the car down and helps to stop it. It is predicted that a system like this could keep up to 80% of the pressure lost when a car pulls up and uses it to get the car moving again.

Keywords **—braking, electric, car, brakes, power, regenerative, system, battery, energy, hybrid.**

----------**********----------

I. INTRODUCTION

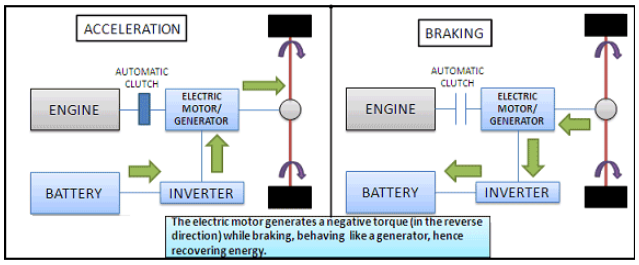
Regenerative braking is a machine used in a car that helps a moving car or object to slow down by converting its kinetic energy into a type of stored energy that can be used immediately or stored for future use. In this machine, the electric traction motor uses the force of the motor to obtain the energy that would be lost on the brake discs as heat.



This is in contrast to conventional braking systems, where extra kinetic energy is converted to unwanted and wasted heat due to collision of brakes, or by rheostatic brakes, where power is obtained using electric motors as generators but dispersed rapidly as heat to resistors. In addition to improving the overall performance of the car, the refurbishment can significantly extend the life of the braking system as the mechanical parts will not wear out very quickly.

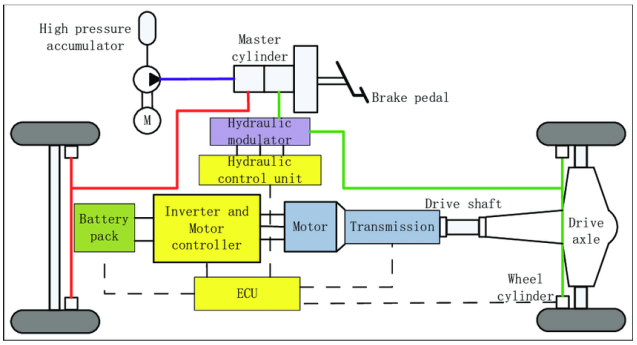
II. Standard Rule

The most common type of renewable brake involves the operation of an electric car as an electric generator. In the railway line, the electricity generated is converted into traction. In electric-powered and hybrid electric vehicles, energy is stored as a chemical in a battery, electrically in a capacitor bank, or mechanically in a rotating flywheel. Hydraulic hybrid motors use hydraulic motors to store energy in the form of compressed air. In a hydrogen fuel cell motor, the electric power generated by the engine is stored by battery chemicals, such as battery- and hybrid electric vehicles.



III. How does Regenerative Braking Work?

The electric motor in your hybrid or electric car goes two ways - one to drive the wheels and move the car, and the other to recharge the battery. When you lift your foot off the accelerator pedal and enter the brake, the engine changes direction and begins to recharge the battery.When this process starts, you can hear the car start to go down. It sounds different for every car that has this function, because manufacturers can adjust how much refresh braking happens when you lift the pedal.



All cars still have standard brakes, so if you push the pedal firmly enough the hydraulic system will kick in to stop quickly (depending on your speed). Also, different cars will have different power on the pedal needed to apply the brakes.

IV. How effective is a refreshing brake?

In order to test regenerative braking, we really need to look at two different parameters, efficiency and effectiveness. Despite the similarities, both are very different. Efficiency refers to how well the refreshing braking absorbs the 'lost' energy in braking. Does it waste a lot of energy like heat, or does it turn all that kinetic energy back into stored energy? Efficiency, on the other hand, refers to the greater the impact of regenerative brakes. Is it increasing your width in a balanced way, or will you not notice a big difference?

V. Efficiency

No machine can be 100% efficient (without violating the laws of physics), as any transfer of power will result in certain losses such as heat, light, sound, etc. The efficiency of the regenerative braking system varies with most cars, motors, batteries and batteries. controllers, but usually somewhere in the 60-70% effective area. Regen often loses about 10-20% of its grip power, and the car loses another 10-20% or more when it converts that power back to speed, according to Tesla. This is common to all electric vehicles including cars, trucks, electric bicycles, electric scooters, etc.

Keep in mind that this 70% does not mean that regenerative braking will increase by 70%. This will not reduce your distance from 100 miles to 170 miles. This means that 70% of the kinetic energy

lost during braking can be reversed and accelerated over time.

This is why reporting only system performance does not really mean anything. A person can be very good at working, but if he only works one hour a day, he probably doesn't accomplish much. What should interest us most is the effectiveness of regenerative braking.

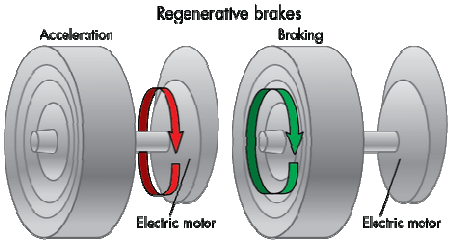
That's when things get really fun. The effectiveness of regenerative braking is a measure of how much it can increase your range. Does it make your theory level 5% higher? 50% more? Even more?

As you may have guessed, the effectiveness of regenerative braking varies greatly depending on factors including driving conditions, location and vehicle size.

Driving conditions have a huge impact. You will see the best effect of rebuilding the brakes in city traffic when you leave on the highway. This should make sense, as if you are braking repeatedly, you will be holding more power than if you were driving for hours without touching the brakes. The Terrain also plays a big role here too, as driving uphill does not give you a chance to brake, but driving downhill will rejuvenate you because of the longer braking. At long distances, the rechargeable brakes can be used almost consistently to control speed while continuously charging the battery.

Car size can be the biggest factor in the efficiency of re-braking due to the simple reason that heavy cars have great power and kinetic power. Like a large airplane wheel that works better than a small flywheel, a four-wheeled electric car has more kinetic power when traveling than an electric bike or scooter.

Comparative data can be difficult to obtain. Tesla cars show you regenerative braking power, such as 60 kW during heavy braking, but that doesn't answer the most interesting question. We want to know how much energy we are rebuilding in the journey, not how strong our brakes each time we press the pedal.



Fortunately, a number of Tesla drivers have reported power supply data back using different data tracking applications. Model S drivers reported re-recording about 32% of the total energy expenditure while driving up and down. This will effectively increase the car distance of 100 km to 132 miles, for example. The owner of the Model S P85D reported about 28% of the recapture of power (stadium in Danish) and others also reported that they recaptured between 15-20% of their total kWh consumption on average during normal travel.

For small EVs such as personal electric vehicles, the numbers are less promising. In most electric bikes with reusable braking options, I usually limit about 4-5% of the reusable, with a maximum of almost 8% in the hilly areas. Other personal electric vehicles including electric motorcycles and skateboards have similar effects, usually with a single lower digit. Also, keep in mind that this is not a system efficiency (such as how much braking power is lost in a power transfer), efficiency (such as how your range increases due to regenerative braking).

As I said above, this is mainly due to the low weight of human electric vehicles. They do not have as much power and thus have little power to turn back on the battery.

VI. DOES IT MATTER HOW WELL THE BRAKING BRAKES WORK?

In the EV industry, re-brakes can sometimes be used more as a marketing tool rather than as a feature. Because regenerative braking is usually only possible on electric bikes with large gearless gearboxes, such e-bike manufacturers will enhance the efficiency of their models. At the same time, manufacturers of e-bikes with mid-drive and other geared motors that can bind the regen will dispose of it as ineffective and unsuitable. The fact of the

matter is that in small and medium-sized electric cars, renewable brakes do not work as well as in electric cars, but there are still many benefits.

One of the major benefits of regenerative braking on small human EVs is the extra braking force. Some PEVs, such as the Xiaomi M365 electric scooter, use only the regen front braking of the front wheel, while relying on a standard rear-wheel drive brake. This means that the scooter has two independent brakes with only one lever to open them, which reduces costs, weight and complexity.

Regenerative braking also allows the introduction of brakes on electric skateboards - a function previously performed using the flexible braking feature of your shoe soles on the paved area. With popular electric skateboards such as the Boosted Board reaching speeds of more than 20 mph, the electric brake achieved by regen is a widely accepted safety feature.

Another benefit of regenerative braking is to extend the life of common brake parts such as cables and brake pads. This can be frustrating to maintain and replace; especially as electric bicycles and scooters travel much longer and faster than their non-electric counterparts and otherwise wear out the brake pads quickly. One of my e-bikes has no regen due to having a spare tire, and I seem to be constantly repairing and repairing the brakes. On re-enabled e-bikes, however, I find that I can rely almost entirely on regenerative brakes, which means my brakes see less use.

At the end of the day, regenerative braking will not work in small cars as it does in large ones due to physics. Because of this, the lack of regen in e-bikes and other PEVs is not something that breaks the agreement. However, the benefits of regenerative braking without a simple regenerative force cannot be ignored. And Hello, I will be taking a free 5% promotion for any day!

VII. TAKING KINETIC ENERGY FROM BRAKING

With an electric motor, the electric motorcycle drives the wheels, either in combination with a gasoline engine as a hybrid, or alone in an electric battery. As you drive forward, the motorcycle rides in that direction, providing electricity to the wheels. But if you slow down by removing your foot from the throttle, the electric motor stops giving you power to slow down. When the engine stops, it speeds up, and then it starts to slow down. The transmission is still in Drive, so it does not slow down the wheels; instead, it acts as a generator. It captures the kinetic energy from the wheels as it slows down, and converts them into electricity. It is then stored in the battery, to be returned to the electric motor if needed to drive car tires.

VIII. "DRIVING ONE PEDAL"

How much power is taken may depend on how the system is configured. For others, the driver may decide how much brakes to apply, usually by moving the gearshift lever while slowing down. If aggressive braking is selected, the system will absorb and retain more power, but the car will slow down faster, and in some cases, may stop completely.

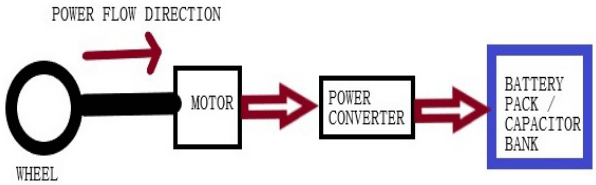
Automotive manufacturers often refer to this as the "single pedal". With practice, drivers can get into traffic jams using only the throttle, speeding up as fast as they can, and then lowering the pedal and allowing the brake pedal to stop.

But the refurbishment system is not enough to stop the car in all situations, especially if you are driving at high speed, and that is why every hybrid or battery-operated car also has regular hydraulic brakes. The good thing is that because the auto repair system also slows down the car, the brakes should not work too hard. Drivers often find their hybrids or EVs that require new brakes far fewer times than conventional vehicles.

IX. DRIVING BEHAVIOUR DETERMINES THE POWER TAKEN

Hybrids usually get better fuel savings in city traffic congestion than on a highway, and they do not last long. They need rechargeable brakes to recharge their batteries, but if you maintain a steady pace and do not slow down on the highway, the battery will supply the electric motor (which may add a gas engine, or drive itself, depending on driving conditions) without having to reload. When it drops too much, the battery loses its grip on the gas engine, and instead drains its power to recharge.

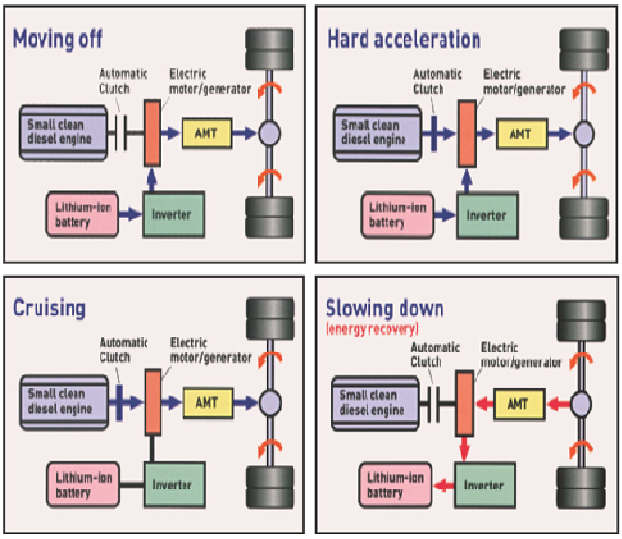
How much power the braking system relies on depends on a few factors - the driver is one of the most important. It is estimated that the efficiency of a photocopying system can range from about 16 to 70 percent, and that is limited to the way a car is driven.



Higher return levels are achieved when drivers slow down early, while those who stop and apply the brakes at the last minute see little efficiency, especially as they rely heavily on the normal car route brakes. You really need to adjust your drive in an electric vehicle if you are going to benefit the most from it.And that's just part of the big picture when designing EVs and hybrids to work as efficiently as possible. A bigger, heavier car will have more power, with more technical power to photograph - but it will take more power to move and when it stops in an area that a small car would not need. The renewal program adds weight and weight, which increases costs. And sometimes the power has to be wasted when the battery is fully charged, as it cannot be fully charged. It's all part of what keeps car engineers awake at night.

X. Hybrid Regenerative Braking

How is a hybrid car different from a completely electric car? However, hybrid electric vehicles use both an electric motor and an internal combustion engine to provide the best driving experience in the world. They include the driving range of the internal combustion engine and the efficiency of the fuel and the non-exhaust features of the electric car. If the hybrid is going to have a positive effect on fuel and produce as little carbon emissions as possible, it is important that the battery stays charged for as long as possible. If a hybrid car battery loses its charge, the internal combustion engine will be fully responsible for charging the car. At that time, this car no longer operates as a hybrid but as a natural gasoline.



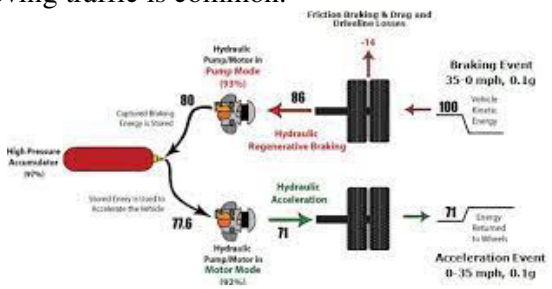
Automotive engineers have come up with innumerable downs and downs to improve the performance of high-performance hybrids, such as the simplification of aerodynamic systems and the use of lightweight, but unsurpassed, most importantly renewable brakes. In mixed settings, however, these types of brakes can only provide power to the part of the electric drive with a car battery. The internal combustion engine does not benefit from these types of brakes.

In part, this efficient operation is necessary because of the great difficulty in locating a hybrid recharge. This makes long journeys difficult without relying on the hybrid internal combustion engine, which actually cancels one of the benefits of having a hybrid.

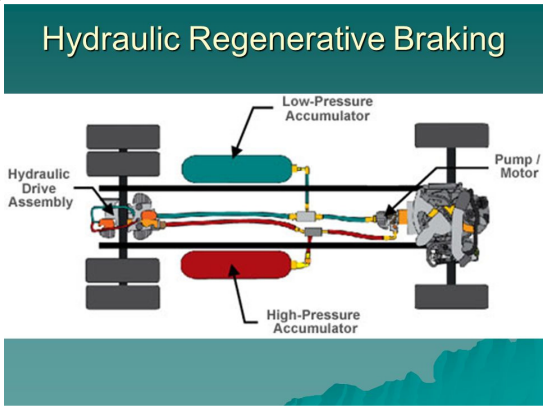
XI. Hydraulic Regenerative Braking

Another refreshing braking system is being developed by Ford Motor Company and the Eaton Association. It is called Hydraulic Power Assist or HPA. With HPA, when the driver presses the brakes, the kinetic energy of the car is used to power the receding pump, which sends the liquid fluid from the low-pressure accumulator (type of storage tank) inside the car into the high-pressure skin. The pressure is caused by the nitrogen gas in the accumulator, which is compressed as the liquid is pumped into the area where the gas once resided. This slows the car down and helps to stop it. The liquid remains under pressure in the accumulator

until the driver pushes the accelerator and, at the same time the pump is reloaded and the compressed fluid is used to accelerate the vehicle, effectively translating the kinetic energy the car had before breaking into rehabilitation. It is predicted that a system like this could keep up to 80% of the pressure lost when a car pulls up and uses it to get the car moving again. This percentage represents an even more impressive advantage than that produced by the brake systems. Like electronic regenerative braking, these types of brakes - HPA systems - are best used in city driving, where stopping and moving traffic is common.



To date, HPA systems have been used primarily as proof of concept and demonstration projects only. They are not ready for production models yet. At present, these electric brakes are noisy and often leak; However, once all the details have been released, such systems will be very useful for large trucks weighing 10,000 kilograms (4,536 kilograms) or more, where these types of brakes could be a much better system than electrically controlled upgrades. brakes.



Finally, this technology may be available in small vehicles. One company, Hybrid-Drive Systems, LLC, of Michigan, has relaunched the 1968 Volkswagen Beetle with a reusable electric braking system. However, accumulators take up a lot of space, and future production plans focus on applying technology to larger vehicles, such as vans. At the time, the U.S. The Environmental Protection Agency (EPA) has partnered with Eaton Corporation to install brake systems to regenerate electricity in UPS delivery trucks.

XII. Benefits of Regenerative Braking

1. Improves fuel economy.

The amount of fuel used can be greatly reduced with this type of braking system. The International Journal of Vehicle Design noted in 2011 that fuel consumption including the NEDC (New European Driving Cycle) improved by 25%.

2. Allows traditional friction-based brakes.

The friction braking system is fitted with a refurbishment system to ensure the vehicle is able to stop on time.

3. Extend battery charge.

Once the power is applied to the charging brakes, the power is used to recharge the car batteries. Because this power would often be lost, they allowed each car to be charged for a longer period of time while driving.

4. Reduce aging and depression in the braking system.

Because the electric train is part of this system, the high efficiency given to the brakes allows for a reduced level of aging on the car's brakes. With conventional collision brakes, there is no way to achieve this benefit.

XIII. Disadvantages of Regenerative Braking

1. It provides a smooth scale of benefits.

The results are slowing down. At low speeds, collision brakes are required to keep most vehicles in good condition. That means the power is still there.

2. Gives a different feel to the driver.

Regenerative braking systems feel different from drivers familiar with traditional systems. Car brakes often sound soft, which many drivers describe as “mushy”. Until you get used to the new system, some may not trust the skills of their brakes.

The pros and cons of a refreshing braking system give drivers new benefits and cost-saving opportunities. There is one main limitation requirement for brakes based on collision during low-speed conditions.

Like anything else, regenerative braking has its drawbacks. The most obvious is the decline in performance at low speeds. In slow-moving and off-road traffic, regenerative braking cannot take up too much energy and return it to the battery, greatly reducing system benefits for most riders during the race.

Another disadvantage of other regenerative braking systems is the way it changes the brake tone and modulation changes. Depending on the vehicle and the design, the brake brakes may feel temporarily unresponsive or difficult to change so that they are well-maintained, clean and standing. These feelings may not impel the driver to feel confident or comfortable.

Regenerating brakes may not have the same braking power as normal ones, requiring drivers to step on the brake pedal. Drivers should be aware of this possibility and adjust their driving style accordingly. Many new braking systems perform much better than earlier technical models, which feel natural to the driver and offer the same level of efficiency as a normal system. When inspecting mixed and electric vehicles, be sure to pay close attention to how the brakes feel and work. You may not notice the difference at all.

REFERENCES

[1] https://auto.howstuffworks.com/auto-parts/brakes/brake-types/regenerative-braking.htm
[2] https://www.jdpower.com/cars/shopping-guides/what-is-regenerative-braking
[3] https://www.autoexpress.co.uk/tips-advice/353643/regenerative-braking-what-it-and-how-does-it-work
[4] https://electrek.co/2018/04/24/regenerative-braking-how-it-works/
[5] https://driving.ca/column/how-it-works/how-it-works-regenerative-braking
[6] https://en.wikipedia.org/wiki/Regenerative_brake
[7] https://eprints.whiterose.ac.uk/2118/1/ITS105_WP471_uploadable.pdf
[8] https://www.researchgate.net/publication/344154270_Research_on_Regenerative_Braking_Systems_A_Review
[9] https://ieeexplore.ieee.org/document/6321173
[10] https://www.ijser.org/researchpaper/Regenerative-Braking-Systems-RBS.pdf
[11] http://www.aidic.it/cet/18/66/220.pdf
[12] https://iopscience.iop.org/article/10.1088/1757-899X/398/1/012013

