International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 11 Issue: 04 | Apr 2024 www.irjet.net p-ISSN: 2395-0072

Regenerative Braking System with Power Monitor

Atharv Bhopale[1], Omkar Bhorade[2], Girish Chaudhari[3], Ganesh Tekale[4], Aniket Koli[5], Prof. Priyanka Barde[6]

[1]Atharv Bhopale SPPU (Jayawantrao sawant college of Engineering)
[2]Omkar Bhorade SPPU (Jayawantrao sawant college of Engineering)
[3]Girish Chaudhari SPPU (Jayawantrao sawant college of Engineering)
[4]Ganesh Tekale SPPU (Jayawantrao sawant college of Engineering)
[5]Aniket Koli SPPU (Jayawantrao sawant college of Engineering)
[6]Professor Priyanka Barde Dept. of Mechanical Engineering, JSCOE, Maharashtra, India

---***---

Abstract -

This study offers a thorough examination of Regenerative Braking systems, with a special emphasis on Power Monitoring. It begins by examining the fundamental principles of regenerative braking, a revolutionary technology that allows for the recovery and reuse of kinetic energy that is typically wasted during the braking process in conventional vehicles. The paper then delves into the intricacies of power monitoring, a critical aspect that ensures the systems' ideal functionality and effectiveness. Additionally, by highlighting the broader implications of this technology in promoting sustainable mobility and reducing the car industry's impact on the environment. It underscores the potential of regenerative braking systems in clearing the path for the creation of more environmentally friendly, efficient, and cost-effective transportation systems in the future. Through this research, it is hoped to contribute significantly to the existing body of knowledge in this field and inspire further innovations in energy-efficient automotive technologies. The results of this investigation have the potential to influence policy-making in the transportation sector and guide the development of future sustainable mobility solutions.

Keywords: Regenerative Braking, Kinetic Energy, Electrical Energy, etc.

I. INTRODUCTION

Regenerative braking is a cutting-edge energy recovery system that decelerates a vehicle or object by transforming its kinetic energy into a form that can be utilized immediately or stored for future use. [1] This stands in sharp contrast to conventional braking systems, which, because of friction in the brakes, waste away extra kinetic energy as heat. which, as a result of brake friction, turn extra kinetic energy into undesired and wasted heat Besides enhancing the vehicle's overall efficiency, [2] regenerative braking can significantly prolong the lifespan of the braking system, as its components do not wear out as rapidly. Brakes are devices that aid in slowing down a moving object; [3] they employ friction to transform kinetic energy into heat. This mechanism is utilized by traditional braking systems. When the brake pads come into contact with the vehicle's wheels, a substantial amount of heat energy is generated. This heat is then dissipated into the air, accounting for approximately 30% of the vehicle's generated power.

Instead of wasting the kinetic energy of a vehicle with brake pads, regenerative braking recovers it. This can result in an increase of 10 to 25% in a vehicle's range in urban settings where brakes are frequently used. [5] The least energy consumption is achieved when the loss during energy recovery is minimized, which implies that mechanical brakes should not be employed.

This study's main objective is to identify all practical regenerative braking methods for the recreational three-wheel rear-wheel drive hybrid car shown in Figure 1.

[6] A unique regenerative braking command, separate from the standard brake command, is employed to apply a regenerative torque to the electric motor, which is then transmitted to the rear wheel (Tregen). During deceleration, some of the rear-wheel weight is transferred to the front wheels, reducing the rear wheel's adherence.

If Tregen is set too high, [4] the rear wheel locks, making the vehicle unstable and reducing the regenerative performance. This indicates that the choice of strategy is a significant concern for rear-wheel regenerative braking. The primary regenerative braking strategies outlined in the literature aim to maximize the power extracted, the power incoming to the battery, or the electrical efficiency The impact of mechanical loss on energy regeneration and the road friction coefficient were not taken into account when developing these solutions.

II. TYPES OF REGENERATIVE BRAKING SYSTEM

Electric motor (RBS): This technique entails turning an electric motor into a generator. The regenerative brake system's operation is dependent on the operation of an motor electric. An electric motor has to have current flowing through it in order to operate. But, the motor acts like a generator and produces electricity when an outside force is supplied to activate it (during braking). The battery is subsequently recharged using this electricity.

Flywheel (KERS): A flywheel, which is coupled to the drive shaft via a gearbox and transmission, spins when the vehicle's kinetic energy is captured by the Flywheel Kinetic Energy Recovery System. The car will then gain power as a result of the flywheel's spinning ability to impart torque to the driving shaft. These kinds of technologies find application in Formula One cars due to their great efficiency and instantaneous energy supply.

Hydraulic (RBS): The car is slowed by the Hydraulic Regenerative Braking System, which compresses a fluid while producing electricity. A common choice for the working fluid is nitrogen gas. Because compressed fluid doesn't lose energy over time, hydraulic regenerative braking systems can store energy for the longest. But using an engine to compress gas is a laborious procedure that drastically reduces the hydraulic Regenerative Braking system's power.

RBS, or electromagnetic flywheel: The electro flywheel regenerative brake is a hybrid model that combines the electromagnetic system and fundamental power generation techniques; the energy is stored in a flywheel as opposed to batteries. The flywheel can be thought of as a mechanical battery that stores and releases electrical energy. The more economical way to store electricity is via an electric flywheel regenerative braking system since flywheel batteries have a longer lifespan than lithium-ion batteries.

III. LITERATURE REVIEW

"Regenerative Braking System: A Comprehensive Review" by Tanveer (2018). A test rig is developed to evaluate the regenerative braking capability of a Brushless DC Motor. The study emphasizes the importance of energy efficiency and conservation, concluding that regenerative braking systems perform optimally at higher speeds and cannot solely serve as the vehicle's braking system. The paper suggests that the adoption of this technology in future automobiles could contribute to a more energy-efficient world.

Tushar L. Patil, Rohit S. Yadav, Abhishek D. are, Mahesh Saggam, Ankul Pratap (2018) 'Performance Improvement of Regenerative braking system' (2018).

discusses various techniques to enhance the efficiency of the regenerative braking system. The paper suggests reducing the weight of the vehicle, using super capacitors to improve the energy conversion rate in regenerative braking systems, and compacting the automobile to increase system efficiency.

D. Mohan Kumar, Jagadeesh Vikram, and Dr. P. "'Fabrication of Regenerative Braking System', Naveen Chandra (2018)"There is a discussion and implementation of the Regenerative Braking System fabrication process. In light of the study's criteria, the report proposes future improvements for regenerative braking systems and highlights their significance in car mobility.

"Khushboo Rahim and Mohd. Tanveer, 'Regenerative Braking System: Review Paper 'The authors discuss the advantages of regenerative braking systems over conventional braking systems. Regenerative braking systems can operate at high temperature ranges and are highly efficient compared to conventional brakes. They are more effective at higher momentum. A car may get more use out of its braking system the more often it stops. Large and heavy vehicles that move at high speeds build up a lot of kinetic energy, so they conserve energy more efficiently. The paper concludes that there is a broad scope for further advancements and energy conservation in regenerative braking systems.

IV. WORKING PRINCIPLE

Regenerative braking alone is not adequate to safely halt a vehicle or decelerate it as necessary; it must operate alongside traditional friction-based braking systems.

- Speed Limitations: The efficacy of regenerative braking decreases at lower velocities and is unable to bring a vehicle to a complete stop swiftly.
- Stationary Vehicle Constraints: Regenerative brakes cannot secure a stationary vehicle; a mechanical lock

is needed, for instance, to prevent vehicles from rolling downhill.

- Drive Motor Restrictions: Regenerative braking typically only affects powered wheels; not all road vehicles with this feature have driven motors on every wheel (like in a two-wheel drive car).
- For safety, the capacity to break all wheels is mandatory.
- Effectiveness Limitations: The regenerative braking effect is finite and often inadequate, especially in urgent situations.
- Friction Brake Backup: The friction brake is an essential contingency in case the regenerative brake fails.

The vehicle's propulsion system predominantly manages the braking process. When the driver presses the brake pedal (in hybrid or electric vehicles), the brakes engage the motor in reverse, slowing the wheels. In reverse, the motor acts as a generator, channeling electricity back into the batteries. Most hybrid and electric vehicles on the market utilize this method to increase the battery pack's lifespan. Employing a regenerative mechanism is highly advantageous as it diminishes pollution and enhances engine longevity.

V. SYSTEM DESIGN

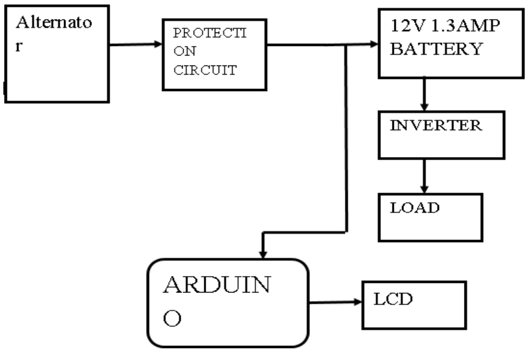


Figure 1: Block Diagram

Here, we use Regenerative charged battery systems provide continuous power delivery regardless of weather conditions. We can harvest a significant quantity of power from regenerative radiations by using technology appropriate for the geographical location. Furthermore, regeneration energy is thought to be the most promising alternative source of energy

DESIGN AND CALCULATIONS

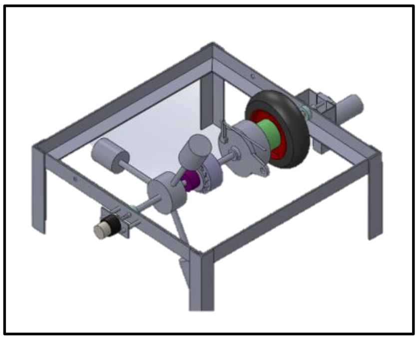
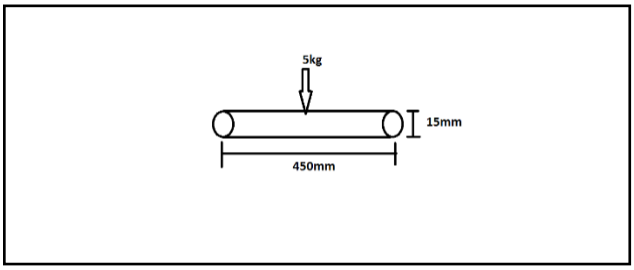


Figure 2: Proposed Model

Design of shaft:



$$\frac{M}{I} = \frac{\sigma b}{y} \quad (1)$$

Bending moment=force*perpendicular distance
Bending moment=5*9.81*400
Bending moment =19620Nmm

For diameter 15mm,

$$I = \frac{\pi d^4}{64}$$

$$I = \frac{\pi * 15^4}{64}$$

I=2483.78

Therefore,

$$\frac{19620}{2483.78} = \frac{\sigma b}{7.5}$$

σb=7.899*7.5=59.24Nmm

59<105Nmm

therefore, design is safe.

Power:

Output motor is 300rpm.

- $$\text{Power} = \frac{\text{force} * \text{displacement}}{\text{time}}$$

$$\text{Power} = \frac{1.5 * 9.81 * 10 * 0.05}{1}$$

power=7.35

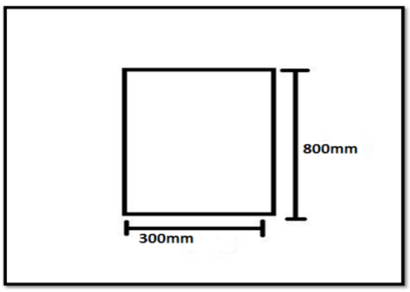
- $$\text{Power} = \frac{2\pi NT}{60}$$

$$T = \frac{7.35 * 60}{60 * 300}$$

=0.23Nm

T=2.34kg-cm

Design of Frame:



$$\frac{M}{I}=\frac{\sigma b}{y} \quad (1)$$

Bending moment (M) =force *perpendicular distance

=30*800*9.81

Bending moment (M) =235440Nmm

$$I=\frac{(b(h^3))}{12}$$

$$=\frac{(25(25^3))}{12}$$

=32552.08mm4

$$Y=\frac{25}{2}$$

=12.5

Therefore above value use in equation no(1).

$$\frac{235440}{32552.08}=\frac{\sigma b}{12.5}$$

Therefore, σ_b=90.40Nmm

90.40<105

Hence design is safe.

VI. CONCLUSION

This project is designed with the ARDUINO controller. In this project, we utilized a hybrid system that integrated regeneration and wind energy. It is a productive method of producing electricity. Hence This project develops a hybrid power generation system capable of driving a load using regenerative panels and windmills as energy sources. To meet the increasing need for electricity, a clean hybrid power station based on regenerative wind can be deployed. In addition, this approach decreases reliance on a single supplier while increasing reliability. This technology has already contributed to the development of vehicles such as the Tesla Roadster, which runs solely on batteries. Sure, these automobiles may use fossil fuels during the recharging stage that is, if the power source is a fossil fuel such as coal but once on the road, they can operate without using any fossil fuels, which is a significant step forward. When you consider the energy losses experienced by battery-electric hybrid systems, it seems reasonable to expect that efficient flywheel hybrids will soon become the standard. However, it is not quite so black and white, and more investigation suggests that a combination of battery-electric and flywheel energy storage is most likely the optimal.

VII. FUTURE SCOPE

Even though regenerative braking is more effective than conventional braking, electric and hybrid vehicles are still in the development or design review stages, so regenerative braking is still uncommon and unpopular. Batteries are used to store energy for a variety of electrical appliances, including lights, air conditioning, mobile phones, and other devices.

Regenerative braking makes a car more efficient, but it also makes it heavier, which is a big issue. It can be solved by researching material sciences and employing lighter materials for regenerative circuit components. The adoption of more effective methods may result in significant cost savings for the auto industry, which would inevitably benefit the national economy.

Losses incurred throughout the generating process should be decreased to increase its efficiency, and the upkeep needed for this method should be considered for use in the future. This regenerative braking technology is going to be revolutionary since electrical and hybrid vehicles are the way of the future for the automobile industry.

VIII. REFERENCES

[1] "Design, Fabrication and Testing of Regenerative Braking Test Rig for BLDC Motor," Avinash Srivastava, Shaikh Farhan, Sayed Nashit, Sufiyan Adhikari, Amruta Gambhire, and others, 2016.

[2] Performance Improvement of Regenerative Braking System, International, Tushar L. Patil, Rohit S. Yadav, Abhishek D. Mandhare, Mahesh Saggam, Ankul Pratap.

[3] The international journal of advanced research and innovative ideas in education published an article titled "Design and Fabrication of Regenerative Braking System," written by A. Eswaran, S. Ajith, V. Karthikeyan, P. Kavin, and S. Loganandh (2018).

[4] Ketan Warake, Dr. S. R. Bhahulikar, Dr. N. V. Satpute, 'Design & Development of Regenerative Braking System at Rear Axle', International Journal of Advanced Mechanical Engineering.Volume 8, Number 2 (2018).

[5] In the International Journal of Creative Research Thoughts, Volume 6, Issue 1 (2018), Siddharth K. Sheladia, Karan K. Patel, Vraj D. Savalia, and Rutvik G. Savaliya present "A Review on Regenerative Braking Methodology in Electric Vehicle."

[6] "Design, Fabrication and Testing of Regenerative Braking Test Rig for BLDC Motor," Avinash Srivastava, Shaikh Farhan, Sayed Nashit, Sufiyan Adhikari, Amruta Gambhire, along with others, 2016.

IX. ACKNOWLEDGEMENT

We extend our heartfelt gratitude to all those who We extend our heartfelt gratitude to all those who contributed to the successful completion of our research paper titled 'Regenerative Braking System with Power Monitor.' First and foremost, we express our appreciation to Prof. Priyanka Barde, our research supervisor, for their invaluable guidance, unwavering support, and expertise throughout the research process. Their insightful feedback and encouragement significantly shaped the direction and quality of our study.

We also acknowledge Dr. Pradeep A. Patil, Head of the Mechanical Engineering Department at JSCOE, for his valuable advice and counsel during the writing phase. His insights enriched our work and ensured its depth and relevance.

Furthermore, we extend our profound gratitude to Dr. R. D. Kanphade, Principal of JSPM's Jayawantrao Sawant College of Engineering, Hadapsar, Pune. His constant encouragement and unwavering support, along with providing necessary lab and library space, were pivotal to our progress.

Lastly, we sincerely thank Dr. Mahesh Gaikwad, Project Coordinator, for his technical assistance and efforts in preparing this study. His contributions were invaluable, and we truly appreciate his dedication.