

ABSTRACT

The use of electric vehicles (EVs) has become a primary focus in efforts to reduce greenhouse gas emissions and dependence on fossil fuels. In this context, regenerative braking technology plays a crucial role in improving energy efficiency in electric vehicles. However, the use of regenerative braking systems also impacts battery degradation, which can affect the performance lifespan of the battery in electric vehicles. This study aims to analyze the effect of using fuzzy logic control, adaptive PID control, and hybrid Fuzzy-PID control on regenerative braking systems on the level of battery degradation in electric vehicles (EVs).

This research employs field experiments and statistical analysis to collect data from electric vehicles equipped with independent regenerative braking systems. Testing was conducted under various operational conditions, including variations in charging cycles and battery operating temperature. The test results were comprehensively analyzed to evaluate energy recovery efficiency, overall system performance, and the impact on battery degradation.

Based on the results, fuzzy control demonstrated the best performance in improving system efficiency, reducing charging cycles, and suppressing battery temperature increases, thereby minimizing battery degradation. Conversely, adaptive PID control and hybrid PID-Fuzzy control tended to produce unstable currents and increase charging cycles, even though they reduced battery temperature. These findings indicate that the application of fuzzy control in regenerative braking systems can optimize energy recovery and extend battery lifespan.

Keywords : Electric Vehicles (EVs), Regenerative Braking, Battery Degradation, Fuzzy Logic Control, Adaptive PID Control, Hybrid PID-Fuzzy Control.