

Design, Analysis and Retrofitting of an Internal Combustion Engine Mini-Truck into an Electric Vehicle

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Abstract

The growing concerns over vehicular emissions and rising fuel consumption have accelerated the need for sustainable transportation solutions. Electric vehicle (EV) retrofitting has emerged as a cost-effective and practical alternative to the adoption of new EVs, particularly for small commercial vehicles widely used in urban transport. This study focuses on the conversion of a conventional internal combustion engine (ICE)-based mini-truck into a fully electric vehicle. The power and torque requirements under various driving conditions, including acceleration, steady-state motion, and inclined travel, are evaluated using analytical and numerical approaches. Standard vehicle dynamics equations are employed for theoretical analysis, while MATLAB Simulink is utilized to simulate realistic drive cycles and obtain dynamic performance characteristics. Based on the obtained results, suitable motor and battery specifications are identified, leading to the selection of a Permanent Magnet Synchronous Motor (PMSM) due to its high efficiency and superior performance. Furthermore, key mechanical components such as the motor mounting clamp, mounting plate, coupler, and fastening system are designed and modelled using CAD tools. Structural analysis is conducted using ANSYS to assess stress distribution, strain, and deformation under operational loading conditions. The results demonstrate that all designed components are structurally reliable, exhibiting minimal deformation and stress values well within permissible material limits. The study validates the feasibility of EV retrofitting as an efficient and sustainable solution for reducing emissions in urban transportation.

Index Terms

Retrofitting, Permanent Magnet Synchronous Motor (PMSM), ANSYS Structural Analysis, MATLAB Simulink Simulation