PhD Thesis Title:

Experimental Investigation of Energy Consumption and Performance of an Electric Vehicle Powertrain on Different Laboratory and Real-World Driving Cycles and Drive Modes.

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Short Abstract

Over the last few years, the prospect of a rapid rise in global temperature and air pollution has created concerns (about global warming, health issues) and the need to reduce the use of fossil fuels and the associated emissions. Vehicle emissions and Green-House Gases (GHGs) can have adverse impacts on health (such as cardiopulmonary diseases), environmental damage, and contribution to global warming. Road transport is one of the major contributors to the growing air quality problems in Indian cities. There is a need for greener or alternative vehicle technologies to address the vehicle emissions issue. So, researchers are focused on developing alternative technologies such as hybrid electric, electric, fuel cell, and plug-in vehicles. Hence the necessity of Electric Vehicles (EVs) has been realized because of their substantial advantages over conventional Internal Combustion Engine (ICE) vehicles.

Presently, there are around 61 million in-use ICE vehicles in India, out of which passenger car contribution is 7 million. Some of them are between 6 and 10 years old; some are between 11 and 15 years old. Many owners are still operating these old vehicles and hatchback car models. The vehicle emissions from these old ICE vehicles are a major source of air pollution in Indian cities. Therefore, the country's Supreme Court has banned BS-IV & older vehicles' sales since 1st April 2020, and operation of ICE vehicles older than 15 years old.

Meanwhile, it is essential to provide a solution for old-vehicle owners. So, the Indian government has passed a legislative law, [G.S.R 167(E), 2019], which permits electric conversion of ICE vehicles into pure EVs. It paves the way for developing EV propulsion kits in the country. Therefore, there is a vast scope and potential for electric conversion of the old ICE vehicles (including the hatchback cars) into EVs. Hatchback car models are popularly used and have a significant population in India. Presently, indigenous EV kits for passenger cars are not available in India. Therefore, it is felt to develop a prototype EV propulsion kit for the hatchback car models. In this thesis, electric conversion of two old gasoline cars into EVs is described and presented in two separate case studies. It is an experimental attempt for faster vehicle electrification and adoption of EVs. The gasoline cars are namely Maruti-800 and Maruti-Zen. Both cars belong to the entry-level hatchback segment of the M1 vehicle category.

First, the EV conversion process is described, and the conversion is carried out using local subsystems such as a local make Induction Motor (IM) and Li-ion Battery (LiB) pack. The remaining electrical subsystems are off-the-shelf components available in the market. Secondly, evaluation tests for the converted EVs are carried out using three different driving cycles in a chassis dynamometer laboratory as per the test procedure of the prevailing Automotive Industry Standards (AIS). The laboratory study evaluates the EVs' Energy Consumption (EC) and performance using three driving cycles, and comparative analysis for the test data is performed. However, a laboratory test cannot emulate the real-world driving conditions, and it is different from a real-world test.

Finally, EV performance tests for one of the converted EVs are conducted in real-world conditions. The real-world tests are conducted on three selected traffic routes (representing low, medium, and congested traffic routes) of a Tier-II Indian city (Dehradun). The field study investigates the effect of real-world driving and drive-modes (idling, acceleration, deceleration, and cruising) on the EV's electrical parameters and performance. The distribution analysis of the drive-modes to the electrical parameters are evaluated using the driving cycle analysis. The statistical, uncertainty, comparative, and sensitivity analysis are performed for the laboratory data and real-world test data. The research study is a novel attempt to convert old hatchback cars into EVs and evaluate them as per the legislation and homologation requirement. Further, the research study attempts to develop and evaluate a low-cost, prototype Electric Power-Train (EPT). Such a study can help researchers develop local EPT and conversion kits for import substitution, transport sustainability, fossil-fuel saving, and vehicular pollution reduction.

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