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Fuel Efficiency and Engine Power in Hybrid and Electric Vehicles - A Review Study

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Abstract: Globally, the rules and regulations concerning fuel consumption are turning strict more than ever due to the control of environmental pollution. Consequently, the car firms seemingly identify the broader portfolio in terms of component technologies that involve efficient fuel use, transmissions, electrification, and more engine power. As a result, numerous car manufacturers produce hybrid and electric vehicles with better fuel efficiency and engine power, hence this paper considers this concept and review the same. This paper reviews the previous studies that are in line with the concepts of fuel consumption, economy, and engine power in both hybrid and electric vehicles. Secondary data was collected with the help of peer-reviewed journals, websites, seminar papers, etc. The findings of the review confirmed that the hybrid and electric vehicles have an enormous quality of fuel consumption that drastically increases the economy of the fuel for vehicles and using strong engines helps the increasing fuel efficiency for both hybrid and electric vehicles. Therefore, this paper recommended manufacturers to increase production in India.

Keywords: Electric vehicles, hybrid vehicles, engine power, fuel efficiency, environmental pollution

I. INTRODUCTION

In recent times, environmental-related pollution, as well as the declining resources, has raised the level of demand for lesser pollution and better fuel economy for ground transportation. Pollution arises particularly from traditional combustion engines that include diesel, gasoline, and remaining heavy oils. When it comes to fossil fuels, petroleum is responsible for the whole energy consumption of nearly 10.51% in India [1]. Researchers have given supplementary solutions in the decades of recent times; electric & hybrid vehicles containing electric motor and internal combustion engine were regarded as something very promising in a very short period. EVs i.e. "Electrical vehicles" use electricity when it comes to vehicle power trains; it is either used as primary or else to assist the designs of the conventional vehicle. EVs are generally classified as BEVs (battery-only electric vehicles), PHEVs (plug-in hybrid electric vehicles), and HEVs. HEVs make use of both electric motor as well as the traditional engine. Anyway whilst PHEVs are capable of plugging into an electric source to get a battery charged; on the other hand, regenerative braking & internal combustion engine are used for charging HEVs yet can never be plugged into for charging the battery [2]. Compared to ICEVs (Internal combustion engine vehicles); HEVs are observed to be having more fuel efficiency and are generating lesser emissions of the tailpipe. In addition to that, they are generally simpler as well as cheaper for building than in the case of PHEVs. On considering the rising effect of hybrid & electric vehicles in India, the present paper aimed to show the importance of engine power and fuel efficiency in hybrid and electric vehicles and based on which, the study gives recommendations to policymakers to further improve the production of hybrid and electric vehicles in India.

II. FUEL EFFICIENCY OF HYBRID AND ELECTRIC VEHICLES

Fundamentally the term fuel-efficiency refers to none other than the potential a vehicle holds in extracting energy from the fuel. The vehicle is regarded to be higher fuel-efficient provided if it extracts more energy from itself. Similar to that a vehicle is considered to be lesser fuel-efficient if it extracts lesser energy. A vehicle is been named or defined as being "fuel-efficient" when they get listed containing <6 liters per 100 km distance (else <16.5km per liter). This standard helps prevent the car makers/manufacturers from tagging their vehicles as "fuel effective" suppose while they appear tangible or non-tangible. It means that a vehicle considerably needs about six liters or less fuel for covering 100km distance. It is based on the kind of engine as well. Drivers get more benefited by fuel-efficient cars as it saves much money for them for a longer duration of time [3].

Electric, as well as hybrid vehicles, can be certainly said of being truly a potential and promising solution when it's about the improvement of fuel economy. Enhancing the fuel economy of the vehicles like alleviating rolling resistance, downsizing the engine, down weighting the automobile, decreasing aerodynamic resistance, and more are suggested. These recommended practices contain its own merits and demerits might restrain it. The electric and hybrid vehicles are never new [4]–[6], whereas the advanced technology, on the other hand, is new.

Thus the total electric & hybrid vehicles are seemed to have increased quickly in automobile industries and markets [7]. Several types of research are there about the anticipated advantages of using electric & hybrid vehicles [8]. Fuel efficiency represents in two main forms, one is fuel economy and the other is fuel consumption. Therefore the following section will deeply review the fuel efficiency of hybrid and electric vehicles in these two perspectives:

Ahluwalia *et al.* [9] examined the capable improvement in terms of FCEV's fuel economy through hybridizing it with the help of ESSs (energy storage system). On taking a comparison of FCHEV's (fuel cell hybrid electric vehicles) fuel cell hybrid electric vehicles with various hybridization degrees it is noted that they show the same performance of acceleration through keeping the combined rated power of both ESS & FCS as constant. As a consequence; FCS has been downsized since the hybridization level is raised through making ESS bigger. Paykani and Shervani-Tabar [10] illustrated the vital parameters that lead to an optimum blend of hybrid power trains elements so that a finer fuel economy can be obtained in hybrid power trains. It involves various factors of hybridization and driven cycles and proved that hybrid power trains' fuel economy gets better and increases through lessening the average load of a test cycle. Along with that when the test cycle's average load gets decreased then the degree of best fuel economy for a (specific average load of the cycle) tends to direct towards greater hybridization factors. The study by Walton and Rousseau [11] studied the alleviation of fuel consumption via the gathering of advanced SI (spark ignition) engine technologies and through utilizing full-vehicle simulations. The results have disclosed that conventional types of vehicles were observed of reaching the greatest overall advantages whilst on the other hand full and mild hybrid vehicles have just achieved lesser advantages. The findings show a negative correlation between vehicle hybridization and engine technology advantage [12]. Pitanuwat and Sripakagorn [13] tried to research the hybrid vehicles' fuel economy performance based on real-time driving conditions followed in Bangkok. The impact created due to the driving behaviors or styles and the traffic conditions were taken to deeper note. The experimental outputs have shown that HEV was having the ability to lessen CVs' consumption of fuel in almost every kind of traffic conditions as well as driving styles enclosed by this research. That too in congested traffic happening in Bangkok, HEV is said to have considerably lessened the consumption of fuel by 47.3% to the maximum. More crucially, HEV is useful in alleviating the aggressive effect on excessive consumption of fuel in terms of practical driving practices despite their more sensitive behavior towards aggressiveness compared to CVs. Al-Samari [14] argued that FE (fuel economy) can be crucially enhanced to 68% regarding the case of the real-world driving cycle; this indeed is illustrated generally in the city activity. Anyway, the enhancement of FE was limited i.e. 10% when it comes to the highway driving cycle. This is anticipated right from the infrequent utilization of the brake process. Furthermore, parallel HEV emissions are noted to have decreased to nearly 40% and 11% in terms of real-world and highway driving cycle respectively. At last, the efficiency of the engine has risen to nearly 7% in the case of highway driving cycle and 12% in real time driving cycle. Ahn and Rakha [15] show a simple HEV (hybrid electric vehicle) fuel consumption model which is power-oriented. This is indeed for using it in microscopic traffic software & different connected as well as automated vehicle applications of CAV like eco-drive and eco-routing process. The proposed model of fuel consumption analyses the immediate rates of HEV's fuel consumption via immediate vehicle operational input variables. This includes even the acceleration of the vehicle, speed as well as roadway grade that can be obtained from the component of GPS (global positioning system) or remaining other types of sensors.

III. ENGINE POWER OF HYBRID AND ELECTRIC VEHICLES

The quick fossil fuel consumption coupled with the rising environmental damage caused due to the same has paved a way for the powerful stimulus of growth & development in terms of fuel-effective vehicles. HEVs also is known as Hybrid electric vehicles have developed right from the inchoate stage and now it's showing how promising is it to confront serious existential types of issues constituted to the whole planet. HEVs not merely give lesser emissions and better economy of fuel that in turn satisfies the laws relating environment' but it's even responsible for decreasing the impact caused due to the increasing cost of fuels on the customers [16]. Engine power is none other than the power which an engine can put out. It shall be expressed through power units to kilowatt in particular. Bennion and Thornton [17] defined that hybrid electric vehicles are the type that is growing, therefore, there is a necessity for the breakthrough of the next technology. It is suggested not only for improving the efficiency of the vehicle but even to enable the diversification of energy for transport of the vehicle. Through enhancing the efficiency of the vehicle along with enabling the diversification of energy, a country like the United States could certainly accomplish crucial reductions of fuel utilization for transport purposes. Kumar and Subramanian [18] assessed the advantages regarding fuel economy; in comparison with the conventional sort of vehicle (ICE-driven). The outcomes relating simulations prove that; there can be an improvement in the vehicle fuel economy until 32% in terms of Indian driving style/conditions than the conventional drive of ICE. In addition to that, the fuel economy shall be enhanced in the hybrid power train and in that the engine will be turned off whilst braking rather than trying to operate at an average speed.

IV. FINDINGS AND DISCUSSION

With the higher prices of fuel and stringent regulations for the environment, the efficiency of fuel and engine power for trucks and cars becomes highly significant. The chief method to deduct the consumption of fuel is the driving of an economy that is the velocity differs the way the consumption of fuel is reduced. In this aspect, there are some researchers earlier highlight fuel efficiency through fuel economy and consumption ways in varied approaches (Paykani and Shervani-Tabar, 2011; Al-Samari, 2017; Ahn and Rakha, 2020). Hybrid and electric vehicles are a distinct method to enhance the efficiency of fuel. Most of the car manufacturers are presently designed this kind of vehicles for energy-saving and increase fuel efficiency. Further internal combustion engine supports the fuel consumption of hybrid and electric vehicles. It acts as a good control strategy for energy sources that are necessary for less consumption of fuel. Building optimal strategies for fuel efficiency and engine power has been subject to research for any time. Some of the earlier research work on engine power on hybrid vehicles is Kumar and Subramanian [18] who assessed the importance and role of engine power for long-term use of hybrid vehicles in India. Similar to this, the study by Bennion and Thornton [17] also highlights the technological development of saving fuel and strengthen the engine power of hybrid vehicles. When compared to electric and hybrid vehicles, fuel efficiency, maintenance with relates to engine and rebates, etc. are better in hybrid than electric vehicles. Though there is a scanty of papers focused on the engine power of both hybrid and electric cars.

V. CONCLUSION

It is clear from the reviews; there is a lot of importance of using hybrid and electric vehicles to the society in terms of reducing pollution and also the benefits of high fuel economy and fuel consumption. The findings of this paper highlight that hybrid and electric vehicles enable high fuel efficiency than conventional vehicles. The chief potential for fuel efficiency and engine power lies in the torque split choice between the electric motor and internal combustion engine and the strategy of gear shifting. Considering the importance of fuel efficiency and engine power, nowadays there are numerous car manufacturers' give more attention to hybrid and electric vehicles in India.

VI. RECOMMENDATIONS

Both electric and hybrid cars have many advantages to society and also for car manufacturers with regards to fuel consumption and economy. However, the production of such kind of cars in India is less comparing to other countries because of less usage among people. Therefore, car manufacturers must conduct a campaign to increase awareness among people about the significance of fuel efficiency and the engine power of both hybrid and electric vehicles. This would lead to the productivity of the firms as well as increase the country's economy.

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