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Overview of Plug-In Hybrid Electric Vehicles

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Abstract: Plug-in electric vehicles play a vital role in the extended range and potential for refueling of conventional hybrids. PHEV can be a good option, provides a backup of a fuel engine for longer runs. The hybrid vehicles are the combinations of internal combustion engine and electric motors that use energy stored in batteries.

Keywords: Plug-in HEV, Battery, Charge depletion, SoC, Internal combustion engine, Energy storage system.

I. INTRODUCTION

In 1834, tricycle is the first vehicle, it is powered by battery was developed. But with the improvement in the Internal combustion engine. In the market, the ICE vehicles have occupied an absolute share since 1930's, the PEV's have almost disappeared.

The global vehicles will increase from 700 million to 2.5 billion consequently and the global population will increase from 6 billion in 2000 to 10 billion in 2050. Before 30-40 years, the fossil fuel engines were good enough for us. But now they are one of the sources of contributor of global warming and pollution with fossil fuel crises. HEV is a combination of conventional internal combustion engine and an electric propulsion system. Compare to the similar sized gasoline car. HEV produces less emissions. The Hybridization of vehicles can reduce CO2 emissions and also the fuel cost.

At present hybrid electric vehicles are widely available in commercial vehicles, passenger cars and military vehicles. The technologies which will change the face of automobile sector would be "Hydrogen fuel cell" etc. In most application of HEV, a single charger is used for entire battery pack. HEV's have been in production for several years and now reached a level of maturity.

In charge depleting mode, plug-in hybrid electric vehicles (PHEVs) utilize battery packs which must provide the energy and peak power of drivetrain to drive between 20 and 80km. For hybrid operation, plug -in hybrid electric vehicles (PHEV) require high power density energy storage system (ESS) as well as for electric vehicle (EV) mode range, the plug-in hybrid electric vehicle (PHEV) require high energy density energy storage system (ESS). However, the technology of ESS, which is to maximize the density of power and energy simultaneously are not commercially feasible.

In hybrid energy storage system, the battery pack of lithium-ion with high energy density, it is used to provide the needed energy inthe mode of electric vehicle with charge depleting strategy. This is known as the energy module of the hybrid energy storage system and it is denoted by E-ESS.

II. HISTORY

In the early 1889 a patent of gasoline-electric hybrid rail-car propulsion system was filed by William H. Paton. Also, prototype was built in 1889 followed by experimental tram car in the year 1891. Later Harry E. Dey developed Armstrong Phaeton in 1896. Armstrong was gasoline powered 6.5 litres, two-cylinder engine but also a dynamo flywheel connected to battery.

The invention carried out and in the year 1905 Henri Pieper used electric motor to charge the batteries. Erich Gaichen invented 1/2 horsepower electric car with features which was incorporated has hybrid car. Modern production of HEVs was developed in 1967 with regenerative braking system for American Motors Amitron Regenerative braking concept was further modified and developed in 1980's by David Arthurs with fuel efficiency of 75 miles per US gallon (3.1L/100Km;90 mpg). In 1989 Audi manufacturers its first Audi Duo, plug in parallel hybrid vehicle. The United States National Research Council (USNRC) take a move to produce HEVs.

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III. LITERATURE REVIEW

Ancy Sara Varghese et al [1] gives the context of battery embedded on to the vehicle internally. The processor for onboard charger converts the AC power into DC power. They are usually limited by weight and size. Whereas specified off-board chargers can be larger and powerful. Also, high speed chargers are shared by the multiple vehicles. AC to DC power conversions happens with the electric motors invests which allows the motor windings to set up transformer coils and the existing high-power.

Peng-Yong Kong et al [2] PHEV's plays a very important role in reducing greenhouse gases. However, their lower fuel consumption as well for limited battery capacity they must be recharged. Charging the battery efficiently makes the effective PHEV. Hence there are different scheme of charging identified namely uncontrolled, indirectly controlled, smart and bidirectional charging schemes. In uncontrolled charging the variable has been added to charging load on the smart grid. In indirectly controlled charging scheme have been proposed to cost reduction purpose. In smart scheme its main objective is to achieve various parameters like profit, power loss, fairness etc. Bidirectional allow PHEV to discharge its energy to a smart grid. The standardization of PHEV is to ensure retractability and reusability. Making PHEV chargeable and reusable to improve level performance makes the cost-efficient manner. Sometimes the ideal charging scheme may not practically work. Hence practically research should be made for renewable power output and drivers' behavior, variable load.

Yap Wee Leong et al [3] PHEV can be charged using regenerative braking function. The function is active only when the vehicle goes to slow down or by stepping the brake foot pedal. The electricity recharging system is inconsistent, non-continuous and geography dependent. Another generator has to be applied in order to improve regenerative braking system which making the system to charge continuously. Applying of ironless electricity generator parallel to regenerative braking system is another manner to create sustainable charging system. Charging of an any hybrid or vehicle is very important factor. The electricity generation within a vehicle only improves its performance, which is only effective when the battery has slowed down. This can be overcome when it is attached with the parallel generator which makes the continuous charging whenever required. Thus, a good charging and sustainable vehicle. The electricity generator used type is coreless electricity generator which has no logging torques more CEMF.

C. Polini et al [4] Power generating system for an hybrid vehicle based on internal combustion engine coupled to a permanent magnate synchronous motor. The combination of batteries and ultracapacitors to improve the battery life is one of the factors. The key development factor is to reduce the environmental pollution and ecofriendly on making PHEV and EV effective dragging system. When the storage system is fully charged the vehicle take a help of CDM. There are different hoist prototype modes of operation and two types of ICE to reduce emissions and fuel consumption.
Anders Nordelof et al [5] In this, may be recycling avoids the future constraints on the resource of key and also reduce the production of energy demand. But one is remains as the future challenge that is the realization of efficient recycling of electrified vehicle. For toxic emissions the leakage of substances from the mine-tailing poses are risk in mining. It can be observed that the environmental impact assessment is coupled to obtaining the resources with the knowledge in the final remark on methodology.

Murat Yilmaz et al [6] the unidirectional charging limits hardware requirements and simplifies connection issues. Bidirectional charging supports battery energy injection back to the grid. The charging infrastructure reduces on board energy storage requirements and costs.
The charger systems are categorized into two types : there are off-board and on-board. Battery performance depends not only on types and design of the batteries but also in the charges characteristics and charging infrastructure. The paper reviews implementation of battery charges charging power levels and infrastructure for plug- in electric vehicles and hybrids. Typically, on board charges restrict power because of weight, space and cost constraints. They can be integrated with the electric drive to avoid these problems. On-board charger systems can be conductive or inductive. An off-board charger can be designed for high charging rates and is less constrained by size and weight. Various power level charges and infrastructure configurations are presented, compared and evaluated based on amount of power, charging time and location, cost, equipment and other factors. Battery infrastructure charging power levels Categorized into 3 types - level-1, level-2 and level-3.

Alan Millner et al [7] Enhanced plug-in hybrid electric vehicle. PHEV have the potential to reduce fossil fuel use, for decrease pollution and to allow renewable energy sources for transportation but, presently the lithium-ion battery subsystems are too expensive. To improve the economics, PHEV are proposed three enhancements. For PHEV operation the models are developed both on the road and it used while parked as a vehicle to building a peaklevel system. Using the weather and electric rate data for each location, the total subsystem cost includes battery, gasoline and electricity were compared for a baseline vehicle in Boston and Dallas. The aging model predicts that the cost up to

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7V2B cycles a month on the battery of vehicles. It will be less than $7 per month of added battery replacement cost; comfortably less than the projected $158 per month of potential revenue from the V2B operations. Therefore, the V2B has the potential to provide for more value than the cost of battery aging.

G. Ombach et al [8] Design considerations for wireless charging system for electric and plug-in hybrid vehicles. It is about wireless charging technology developed for electric and plug inhybrid vehicles. It includes power transfer, foreign object detection, live objects protection and required communication capabilities developed technology is very flexible. It's easy to use and can be easily adopted for various cars.eg: during public trails. car producers OEMs strive to reduce fuel consumption and pollution. In order to fulfill these aims new technologies have been launched and rolled out like plugin hybrid vehicles (PHEV) and electric vehicles (EV). There are two key areas of compliance they are foreign object detection (FOD) and living object protection (LOP). Development of complete wireless charging solution requires company to be able and willing to invest long term in WEVC technology and to support a range of diverse customers with varying needs. The comprehensive knowledge design, power electronic design, communication compliance and regulatory for automotive is required. There is limited number of companies that can deliver in WEVC vision and Qualcomm is one of those that has the knowledge, history and experience.

Amir Rezaei et al [9] Catch Energy Saving Opportunity in Charge-Depletion Mode, A Real- Time Controller for Plug-in Hybrid Electric Vehicles. ECMS-CESO is a new adaptive ECMS algorithm for HEV of both the types which is meant to design and optimize the energy consumption particularly in charge sustaining mode. It is a form of adaptive equivalent consumption minimization Strategy. It defines the soft bounds on the battery SDC and is penalized. The EM strategy allows SOC to exceed the soft bounds arrange for the ECMS optimal equivalent factor is proposed for series HEV's. The range is used to calculate the equivalent factor EM Strategy helps to achieve close to optimal fuel economy without the necessity for predicting future driver demand. Also, implementation of ECMS-CESO is easily feasible for real time application.

Phillip kollmever et al [10] Optimal Performance of a Full-Scale Li-ion Battery and Li-ion Capacitor Hybrid Energy Storage System for a Plug-in Hybrid Vehicle. In semi-active hybrid

energy storage system. It consisting Li-ion battery pack, DC to DC converter and Li-ion capacitor pack developed for a range extended plug-in vehicle application. The vehicle has a series-parallel Drivetrain with two electric motors, a gas engine, gearbox and a clutch to allow the engine to run. It is developed from the gear box. The peak DC electrical requirement of the electric drivetrain is about 17kw. A model of the prototype hybrid energy storage system which has the Li-ion capacitor pack connected directly to the motor drives DC bus and the battery pack connected to the Li-ion capacitor packs DC/DC converter. It is developed and used to determine the optimal power split between the battery and Li-ion capacitor packs. The hybridized system is shown to reduce battery pack loses and increase vehicle range compared to a system utilizing the battery pack. Plug-in electric vehicles utilize battery packs which must produce the Drivetrain peak power as well as the energy drive between

20 to 80 km in charge depleting mode. The developed HESS utilizes a semi-active topology with the Li-ion capacitor connected to the inverter DC bus and the battery pack connected a DC/DC converter. The hybrid energy storage system capable of providing more than 175kw. The optimal power split b/w the battery and Li- ion capacitor pack was calculated using dynamic programming for a range of drive cycles. The developed HESS is shown to be a promising solution to high performance applications and the concept could be applied to boast the power capability of any battery pack.

IV. WORKING

Plug in hybrid vehicles operates in two different modes such as charge depleting mode andcharge sustaining modes. For the enhanced performance the combination of these two is implemented referred as mixed mode. Such modes operate and manages the vehicles battery discharge strategy. Hence the vehicles can be designed to drive for extended range in every aspect either at low speed or at all speeds. The battery is maintained at a constant SoC with the amount of energy discharged during power assist operations being balanced. Most of plug-in hybrid operate in charge depleting mode in the beginning later switches to the charge sustaining mode after the battery reaches to a threshold limit. Another strategy for the depleting mode is referred as blinded mode which provides an opportunity to use a smaller battery with sufficient capacity. It supplements the during the heavy and medium load. Fuel consumption is comparatively low in blended or mixed mode as compared to the either (2 types) modes.

Initially in depleting mode the battery continuous discharging, we express in terms of CD range. After the end of its CD range where it switches to the sustaining mode and behave like a HEV which uses regenerative braking system and power to maintain constant SoC (In the charge depleting mode the battery is discharged continuously during an entire journey). The most important difference between PHEV and a standard full hybrid system remains only their size of the battery. In depletion mode it is designed in such a way that it supports aselectric range. In blended mode a combination of depletion mode and sustaining mode is designed where a vehicle can operate in such a way that initially beginning with low-speed charge depleting mode, then stepping into the freeway and operate in blended mode, the driver can go

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with either option, exiting the freeway and operate in blended mode or can reverting back to the sustaining mode till the final destination.

V. ADVANTAGE

1. The PHEV with the extra batteries has the ability to use all elective mode for an extended range (30 miles or more) most of the journey falls below the 30 miles which means a destination is reached without a drop of fuel consumption. The miles per gallon on a plug-in vehicle are often amazing.
2. The cost of a plug-in hybrid electricity is relatively chapter when compared to fuel and could easily charge at home or even in a gas station

VI. DISADVANTAGES

1. The batteries costs is more than normal hybrid batteries. Sometimes the batteries cost evenmore than the gasoline. The batteries do have lifespan. The no. of charges may be the same, but since the range is less than other electric cars, it causes less distance.
2. The combination of flammable gasoline and changed batteries sometimes results in potential charges.
3. The PHEV still carrying a gasoline gives the sense of normal car with checkups, oil charges and so on.

VII. CONCLUSION

In summary, to have a long life the batteries are being engineered. When the hybrid cars become more widespread, recycling of battery will become economically possible. There is a need to development of general analytic results and PHEV charging performance planning in an cost-effective manner. There is also a need to consider that realistic communication network model in charging scheme designs and evolutions. The paper shows that the conductive AC charging protocols for charging the plug in hybrid electric vehicles. These theories are expected to reduce the need of expensive computation in performance evolution. Comparing to the other energy sources make the future look brilliant for hybrid vehicles.

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