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Electric Vehicle Technology Battery Management - Review

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Abstract: *In a day today life there is a tremendous development in Electric vehicle technology. Amount of energy stored in EVT vehicle is one of the important issues regarding it. Energy density is the amount of energy that can be stored in a battery per unit of weight or volume. Higher energy density means that an EV can travel further on a single charge, making it more convenient for drivers. The transportation sector is generally thought to be contributing up to 25% of all greenhouse gases (GHG) emissions globally. Hence, reducing the usage of fossil fuels by the introduction of electrified powertrain technologies such as hybrid electric vehicle (HEV), battery electric vehicle (BEV) and Fuel Cell Electric Vehicle (FCEV) is perceived as a way towards a more sustainable future. When we use IC engine, there is a large amount of pollution, At a time when the fuel prices are rocketing sky high, the daily running cost of a vehicle and its cost of ownership are hitting the roof and there is a dire need to protect our environment, alternative means of transport are few. Electric vehicle are slow expensive with limited range the solution comes in the form of electrical vehicle.*

Keywords: EVT, HEV, BEV

I. INTRODUCTION

India is one of the top ten automotive markets in the world today and having highly increasing middle class population with buying potential and the steady economic growth. But petrol price has increased more than 50% in 13 different steps in last two years. Here comes the potential need for alternative technologies in automobiles such as electric vehicles (EV) in India. Although the initial investment is around 1.5 times than conventional IC engine, but time has come when cost of environment is now more concern than the cost of vehicle. The purpose of this report is to describe the technology used to produce an electric vehicle and explain why the electric engine is better than the internal combustion engine. It includes reasons why the electric vehicle grew rapidly and the reason it is a necessity to better the world today. The report describes the most important parts in an electric vehicle and hybrid vehicle. It compares the electric to the hybrid and internal combustion engine vehicle. It also includes the future of the electric vehicle. The overall impact of the electric vehicle ultimately benefits the people. Compared to gasoline powered vehicles, electric vehicles are considered to be ninety-seven percent cleaner, producing no tailpipe emissions that can place particulate matter into the air.

Electric vehicles (EVs) are universally recognized as an incredibly effective method of lowering gas emissions and dependence on oil for transportation. Electricity, rather than more traditional fuels like gasoline or diesel, is used as the main source of energy to recharge the batteries in EVs. Future oil demand should decline as a result of the predicted rise in the number of EVs on the road[1]. The charging infrastructure is considered as a key element of EV technology where the recent research is mostly focused. A strong charging infrastructure that serves both urban and rural areas, especially those with an unstable or nonexistent electrical supply, is essential in promoting the global adoption of EVs. Followed by different EV structures such as fuel-cell- and battery-integrated EVs, the charging infrastructures are thoroughly reviewed in three modes, specifically—off-grid (standalone), grid-connected, and hybrid modes (capable of both standalone and grid-connected operations.

The government, industry, and academia are actively promoting the development of an electric vehicle (EV)-based transportation system. This system utilizes renewable energy or the electric grid for charging purposes. The primary objective is to address the increasing environmental concerns associated with daily transportation, which currently

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contributes to 25–30% of India's greenhouse gas emissions. By adopting EVs, there is a significant reduction in the consumption of fossil fuels. Worldwide governments are actively promoting the EV industry by implementing subsidies and legislation. This is in response to consumer demand for low-emission transportation options as a viable alternative to conventional fossil-fuel-powered vehicles. The motivation behind this shift is the recognition that fossil-fuel-based transportation poses significant risks to the environment and the planet. EVs offer several positive societal consequences, including enhanced safety, improved public health, a thriving domestic economy, and a cleaner and safer environment. Many nations are transitioning to renewable energy sources due to the advantages they offer in terms of both environmental sustainability and economic viability. Fossil fuels, due to their significant contribution to carbon dioxide (CO2) emissions, present a substantial risk to the Earth's ecosystem. Figure 1 depicts the proportional distribution of CO2 emissions contributed by different sectors, as classified by the International Energy Agency (IEA).The sectors encompassed are the electricity and heat sector, the industry sector, the residential sector, and various other areas.[1,2,3,4].stakeholders that need to visualize before they plan to invest in the implementation of electric fleets, there are still certain reservations associated to such fresh ideas, despite such encouraging proof.

Due to a lack of charging stations [3],long charging times, utility grid pressure, and—most importantly—the problem of intrinsic EV range anxiety (EVRA), existing EV users may experience social difficulties. The conductive EV charging (flow of power between EV supply equipment (EVSE) and EV battery through conductive link), inductive charging (flow of power between EVSE and EV battery wirelessly through induction principle), and the EV battery swapping system are the notable andpromisingchargingtechniques(wherethedischargedbatteryisreplacedbyafullychargedone.

The battery switching system, or third option, is still not available as a commercially viable alternative despite fastprogressinthefieldsofconductivechargingandwireless(inductive)charging.Amongallpotentialsolutions,switching batteries seems to be the most suitable for the current situation. The switching of the EV battery offers one major advantage over the conductive way of charging via EVSE, namely rapid recharging of the EVs. The task is simple; the driver just drives to a battery swap station (BSS), parks in a designated spot, and the battery swap is completed automatically. The driver then drives away after paying. It is possible to use computer vision here also [4].

Even faster than recharging an automobile with an internal combustion engine, Tesla has been in the business for more than three years. The entire process takes less than two minutes. Additionally, the range that these services offer is comparable to the proverbial "holygrail" of electric mobility.

Two areas of significant importance in automotive engineering are improvement in fuel economy and reduction of emissions, [1]. The automotive industry and governments in the United States, Europe, and Japan have formed strategic initiatives with the aim of cooperating in the development of new vehicle technologies, [5]. During years several "nontraditional" solutions has been presented: Electric Vehicles (EV), Hybrid Electric Vehicles (HEV), Fuel Cell Vehicles (FCV), [3]. Actually, HEV seems the only promising technology able to satisfy the market requests, since they match good performances in terms of both consumption and reliability.

In a 2015 china developed three vertical & horizontal electrical vehicles. Problem coming in that vehicle was battery and their backup, for that they have research on it & find solution on it.

II. METHODOLOGY

2.1 Survey Methodology

Survey Methodology to sample the population, The GfK Group (GfK) sampled households from its Knowledge Panel, a probability-based web panel designed to be representative of the United States [1]. To qualify for the main survey, a panel member must have been: (a) 18 years or older (b) vehicle driver and (c) live in California or in one of the following NE states: CT, ME, MA, NH, RI, VT NJ, NY, PA. Of the 1,213 cases completing the main survey, all cases were determined to be valid cases to be included in the final analyses. Documentation regarding Knowledge Panel sampling, data collection procedures, weighting, and IRB-bearing issues are available at the below online resources. This is a A system for contactless scanning also used [6].

The flow of technical knowledge leads to trans disciplinary integration of technology, thus technological boundaries have become blurred, and outstanding inventions do not appear within a single technological field anymore but rather between technological fields [5] In order to capture the characteristics of trans disciplinary integration in research, patent data are used because patents are generally considered up-to-date and reliable knowledge sources that reflect the rapidly evolving Technological advancement [7].

Patents are classified in different sectors by the International Patent Classification (IPC) which is a standard taxonomy developed and administered by the World Intellectual Property Organization (WIPO). A patent may contain several technical objects and therefore be allocated to several classification codes. Those IPC codes are classified into two categories: the main classification code and supplementary classification code.

A patent can have a main classification code and multiple supplementary classification codes. Invention patents focus on the former one, and involve the latter one. Based on the premise of knowledge flowing from the main IPC to supplementary IPC, we use Sterling's framework [8] to investigate Tran's disciplinary characteristics of PEV technology through the following steps:

1) The IPC codes were allocated into 35 technology classes according to the technology classificationwhich was published by the world intellectual property organization (WIPO)[9].

2) We measure the variety of PEV technology in China through the number of main IPC code. All else being equal, the greater the variety, the greater the Trans disciplinary.

3) The balance of PEV technology in China is measured by the share of the number of supplementary IPC code in a certain field accounting for total amount of supplementary IPC code, the closer the proportion in different technical fields, the more even is the balance, the greater the trans disciplinary.

4) The disparity is measured by the equation that 1 minus similarity of different technical fields which calculated by Jaccard index. All else being equal, the greater the disparity, the greater the Trans disciplinary.

The formula of Jaccard index is shown as the following:

$$s(i,j)=\frac{coo(i,j)}{occ(i)+occ(j)-coo(i,j)}, \ (i,j=1,2,\ldots\ldots,35)$$

At present, there are many platforms provide patent search service, such as patent search platform of State Intellectual Property Office (SIPO), China Intellectual Property Network (CNIPR), SooPat website. However, CNIPR is more accuracy and more comprehensive, so this paper uses CNIPR to collect data. By consulting a plenty of information and data, we summarized the basic composition of power battery technology: (a) The power battery (Lead-Acid battery, Lithium Ion battery, Nickel Metal Hydride battery, Fuel cells, etc.); (b) The battery management system (Battery Management, Charge Control, SOC test, etc.); (c) Power battery recycling and other supporting facilities [7].Therefore, through a comprehensive analysis, the final data search expression is equal to /TI= (Lead-acid Battery or Nickel Cadmium Battery or Nickel Metal Hydride Battery or Nickel Iron Battery or Lithium Ion Batteries or Fuel Cells or Air Cell or Sodium Chloride Nickel Battery or Sodium Sulfur Battery or Silver-Zinc Battery or Solar Cell[8] or Flywheel Battery or Power Battery or Battery Management or state-of-charge(SOC) or Thermal Management or CAN or Safety Management or Equalizing Charge) and /AB = ((Pure Electric or Electric or Hybrid or Fuel Battery or Super Capacitor) and (Car or Motor Vehicle or Vehicles).

III. ANALYSIS OF OVERALL TREND OF R&D IN EVS BATTERY TECHNOLOGY

From CNIPR retrieval platform, we got 2061 patents totally from Jan.1992 to Jun.2016, among them, the number of the invention patent is 1219, accounting for 59%; utility model is 803 (39%); appearance design is 40 (2%). It shows that R&D of EVs battery patent technology mainly focuses on the patent of invention and utility model patents in China [9].It is possible to use PLC for this application [10].

3.1. Analysis of the distribution of different types on battery technology

Based on the analysis of application data of results of the distribution of different types on battery technology is shown in figure 3. The amount of the application of a certain patent represents the degree of social concern for the battery technology to some extent. It can be found that the R&D activities of the battery technology in current are mainly concentrated in three areas: fuel batteries, lead-acid batteries, lithium ion batteries [11].

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, (i,j=1,2,……,35) (1)
Where i is main IPC, j is supplementary IPC, s ,(i j) is the similar of i and j, coo(i, j) is the
Frequency of how many times i and j are co-occurrence in same patent, occ(i) is the frequency of i ,
occ(j) is the frequency of j , The value of s ,(i j) ranges from 0 to 1.
5) Based on the previous analysis, we get the formula of integration is:
I=1- i ij j
i j
r s r¦ (2)
Where ir and jr are proportion of elements i and j in the balance, ijs is a matrix where uses main
IPC i as rows, supplementary IPC j as columns and frequency as matrix elements.

IV. SELECTION OF PATENT DATA

This study collects patent data from the China's Intellectual Property right.

Component of Electric Vehicle Technology

A cheap open source IOT platform is Node MCU. Initially, it contained hardware based on the ESP-12 module and firmware that runs on the ESP8266 Wi-Fi SoC from Espresso if Systems. Support for the 32-bit ESP32 MCU was later added. The Node MCU serves as the project's brain and heart, constantly monitoring the input from the sensors, acting on the output side, and sending data to the internet. The suggested solution relies heavily on the Raspberry Pi 3. A mouse, keyboard, and pen drive can be connected to its four USB ports. Additionally, an Ethernet cable can be connected to it via an Ethernet compatible connector. We can connect a range of sensors, including ultrasonic, air, temperature, and moisture sensors, to the 40 GPIO pins of the Raspberry Pi 3. The touch screen display and Pi camera can be mounted in the Raspberry Pi's two specials lots analyze the range, price and charging time of vehicles. An advancement in EV technology [12], It could help us to improve the features of the vehicle and analyze the improving field. Then in section 3, the design
of the battery pack for EVs is discussed. The aim is to develop a battery for EV with high energy density and focusing on lightweight, high energy efficiency, practical usability, and excellent performance. In sections 4, various tests are discussed regarding the driving range of battery and various mechanical, electrical and environment battery tests for vehicles.

Lastly in section 5, paper summarizes with the help of concluding flow charts and remarks given with some future development of EVs. 1.1. Factors affecting the EVThere are two types of factors that affect the adoption of EVs, i.e., internal factors and external factor (Young et al., 2013). 1.1.1. Internal factors there are certain characteristics of an electric vehicle such as their driving range, charging time and cost which makes them less convenient in today's world. EVs are more expensive than conventional engine vehicles (Coffman et al., 2017). Carley et al. (2013) found that the cost of the EVs is more dominant as compared to another traditional vehicle. Graham-Rowe et al. (2012) also concluded that

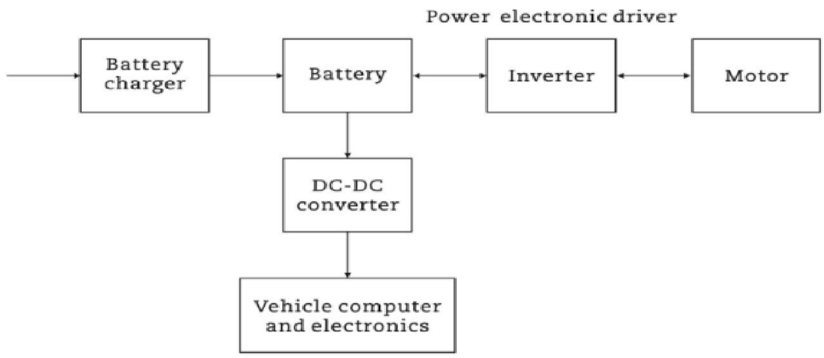

Fig. 1 Key component of an electric vehicle (Diamond, 2009).

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People were not willing to pay the high cost as demanded by EVs. As an industrial survey reviewed by Tran et al. (2013)shows that more than 63% of buyers refused to adopt the EVs because of the high price. The purchase costs of EVs should decline rapidly and quickly render the studies regarding the purchase price of the EVs (Hawkins et al., 2013). Wu et al. (2015) found that plug-in hybrid EV (PHEV) and battery operated EV (BEV) may be competitive with internal combustion engine vehicles (ICEV) in Germany by 2025. The rapid downfall in the price of EVs suggests the on-going studies on various parameters such as driving cost, purchase price and ownership costs on EV (Wu et al., 2015; Young et al., 2013; Zhang et al., 2017). No valid explanation is found that's why the purchase price fell more rapidly than the other EV models. More investigation needs to be done to relate the cost of the vehicle's performance. Human are able to detect visually distinctive parts [13]. One of the main obstacles in the way of EVs is their driving range which is less than other vehicles.

Egbue and Long (2012) proposed that 33% of the consumers identified that battery range was the most prominent concern with EVs. Axsen and Kurani (2013) suggested that consumers most often switch to PHEV because BEVs were the least favorite, even though it could drive up to 149 miles approximately in the range at no additional cost. Tamor et al. (2013) concluded that PHEVs may be more acceptable than BEVs. On the other hand, Tran et al. (2013) support that BEVs are more preferred over PHEVs because of their enhancing charging infrastructure. Now, the other major issue in the adaptation of EV's is charging time. Although, it is potentially less severe in comparison to the driving range. Carley et al. (2013), noted that a majority of consumers conclude that it was a disadvantage, but they all were willing to pay for immediate charging. Hidrue et al. (2011) suggest that most of the consumers are willing to pay nearly \$30 to \$70 for the added driving range (Axsen and Kurani, 2013; Tamor et al., 2013). 1.1.2.

External factors Certain external factors may also affect the adoption of EVs like consumer characteristics, fuel prices and the availability of charging stations. The hikes in fuel prices are caused due to the burning of fossil fuel in the combustion engine of vehicles. According to Tseng et al. (2013) and Wu et al. (2014, 2015), the petroleum-fuel prices depend directly on the EVs adoption. Sierzchula et al. (2014) studied vehicles survey of 30 countries and found that fuel price is not a significant analyzer of EV market share, fuel prices are very important factor of HEV adoption (Diamond, 2009; Gallagher and Muehlegger, 2011; Li et al., 2011). As consumers have different types of interest and the adoption of an EVdepends on different consumer characteristics such as education, income, level of environmentalism, number and/ or type of car owned and love for technology [14]. (Kettles, 2015). Several studies found that consumers having higher education are more likely to consider the adoption of Fig. 1.

Comparison of Primary Battery

i. Primary battery- The first primary battery was intro-duced more than 100 years ago, zinc-carbon was the only battery used in 1940 (Conway, 2013). After that, many advancements take place in primary cells regarding its capacity, operating temperature, life cycle, etc., hence, there are many primary cells designed using various anode- cathode combinations some of them are discussed in the following subsections (Elliott and Cook, 2018; Shen et al., 2016; Xia et al., 2015). There are a variety of batteries explained below and summarized in Table 2.

ii. Zinc-Carbon and alkaline manganese dioxide batteries Zinc-Carbon (Zn-C or Zn-MnO_2) batteries were the most popular battery for more than 100 years (Xia et al., 2015). It is also known as “dry battery”. In this, Zn is anode material while the carbon and MnO_2 are used as a cathode material (Jom et al., 1981). The cathode material is based on electrolytic MnO_2, which gives high power and long life. The theoretical capacity of the primary battery, i.e., Zn-C is 225 A\$h/kg, synthesized on both types of cathode material and this value is based on simplified cells (Xia et al., 2015). As on apractical basis, the obtained specific capacity of the battery is 97 A\$h/kg, and till now, this is the optimum specific capacity for a cell (Xia et al., 2015). The operating voltage/current of the primary battery is in the range of 0.16e44 A in prismatic battery design and button cells 25e60 mA. These batteries are having a low-temperature range, i.e., 10.C (Bockris, 1981; Wendt and Kreysa, 2013).

iii. Zinc-air battery

The zinc-air battery consists mainly of three components: a catalytic cathode, aqueous alkaline electrolyte, and zinc powder anode (Xia et al., 2015). In this, O 2 is utilized from the air as an active cathode, and due to this, the capacity of Zn-air is double than that of primary batteries. The gravimetric and volumetric size of a cell is very high. In the construction of the button cell, the capacity range is 40e600 mA$h (Xia et al., 2015). It has an advantage over another cell that it.

iv. Silver-oxide battery

Silver-oxide battery was first synthesized in the early 1960s for various applications such as a pocket calculator, watches, etc., as this battery offers certain advantages over other bat- teries named as high capacity, excellent storage capacity retention and a constant discharge voltage (Xia et al., 2015). The theoretical energy storage capacity of Zn-Ag2O is 231 Ash/kg, and it shows a steady discharge voltage profile between 1.5 and 1.6 V at low and high discharge rates (Xia et al., 2015). Its main advantage is long storage life up to one year at room temperature, and its performance deteriorates at low temperatures [13].

v. Magnesium/manganese dioxide battery

As in other batteries, now magnesium is considered as an anode material [14]. It has a low atomic weight and a high standard of potential [15]. for battery analysis computer vision may use [16].The main advantage of Mg battery over theother is its low operating temperature.[17],i.e.,20 C and below (Xia et al., 2015). However, the low-temperature affects the performance of heat generation during discharge and is dependent on the discharge rate, battery configurations, battery size and many other factors (Xia et al., 2015). For a next generation communication we need more powerful battery [18]. There is a evolution in battery technology in a china [19]. For battery charging we use the devices such as IGBT[20].

Table 2 — Comparison of primary batteries (Xia et al., 2015).

Primary battery	Cathode material	Anode material	Electrolyte/reaction	Nominal voltage /current	Practical capacity
Zinc-carbon and alkaline manganese	MnO_2	Zn	Aqueous KOH/NH_4Cl $Zn + 2MnO_2 + 2H_2O \rightarrow 2MnOOH + Zn(OH)_2$ $Zn + 2MnO_2 \rightarrow ZnO + Mn_2O_3$	0.16–44 A	75–35 A·h/kg
Zinc-air	O_2	Zn	Alkaline electrolyte $Zn + 2OH^- \rightarrow Zn(OH)_2 + 2e^-$ (anode) $O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$ (cathode) $Zn + \frac{1}{2}O_2 \rightarrow ZnO$ (overall reaction)	0.4–2 mA	40–600 mA·h
Silver-oxide	Zn	Ag_2O	KOH or NaOH aqueous electrolyte $Zn + Ag_2O \rightarrow ZnO + 2Ag$ (overall reaction)	1.5–1.6 V	165 mA·h
Lithium-sulfur dioxide	Teflon-bonded acetylene black	Li	$2Li + 2SO_2 \rightarrow Li_2S_2O_4$ (overall reaction)	2.7–2.9 V	~260 W·h/kg
Lithium-thionyl chloride	Porous carbon	Li	$4Li + 2SOCl_2 \rightarrow 4LiCl + S + SO_2$ (overall reaction)		450–600 W·h/kg
Lithium-manganese dioxide	MnO_2	Li	Ion conducting organics $Li \rightarrow Li^+ + e^-$ (anode) $2MnO_2 + Li^+ + e^- \rightarrow MnO_2^-(Li^+)$ (cathode) $MnO_2 + Li \rightarrow MnO_2^-(Li^+)$ (overall reaction)	3.60 V	200 W·h/kg
Lithium-carbon monofluoride	Polycarbon fluoride	Li	$xLi + CFx \rightarrow xLiF + xC$ (overall reaction)	2.8 V	200–600 W·h/kg

Fig.1 Comparison of Battery

V. DISCUSSION

EVT Power's technology can provide significant improved performance to conventional lead acid batteries without losing their cost advantage. SNAPPER can be applied to every market segment of the entire lead acid battery market (autos, micro-hybrid, electric bikes, boats, transportation, backup power, etc.). we know chandrayan-3, their also use of high power battery.

VI. CONCLUSION

Currently, electric batteries are not the most popular choice for a battery nor are they anywhere near being the most common used in cars on the road. However, as they continue to get more efficient, cheaper, and easier but it is tedious to dispose it.

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