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A Review of Self-Charging System for Electric Vehicles Innovative Systems Design and Engineering

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Abstract *– The development of electric vehicle technology is being pushed forward by a rising awareness of environmental preservation and energy conservation issues. Electricity is more than simply a technique of supplying energy to the vehicle's engine. It is necessary for the EV to have an energy storage system, which is one of the main challenges with today's EV technology. There are many research studies are reviewed related to the EV technology.*

Keywords*: Electric Vehicles, Hybrid Energy Storage System, Energy Management Strategy*

I. Introduction

An energy storage system (ESS) is a kind of battery that is frequently utilised in electric cars (EVs) nowadays. Electric vehicles (EVs) must be able to complete a complex driving cycle that includes starting, acceleration, cruising, and deceleration modes while also achieving a high driving mileage per charge. The energy storage system (ESS) must fulfill both the power and energy density criteria. Each ESS, on the other hand, has certain intrinsic disadvantages. When compared to supercapacitor, batteries have a significantly lower power density, a significantly shorter cycle life, a significantly longer charging time, and a significantly worse starting performance at low temperatures, whereas supercapacitor have a significantly lower energy density when compared to batteries. At the moment, there is no one ESS that can match both the power density and the energy density needs of electric vehicles. A hybrid energy storage system (HESS), in which a battery serves as the primary energy storage system and a supercapacitor serves as the auxiliary energy storage system, is capable of solving problems by combining the energy density superiority of the battery with the power density superiority of the supercapacitor. It is recommended that the HESS be used in conjunction with an energy management strategy (EMS) in order to allocate the entire amount of power necessary between the two ESSs in an acceptable manner, otherwise the energy may be squandered.

The EMSs for HESS for EVs have been classified into two categories: heuristic concept based EMSs [1,2,3,4,5,6,7,8,9,10] and optimum control theory-based EMSs[3, 9, 11]. Heuristic concept-based EMSs [1,2,3,4,5,6,7,8,9,10] are the most common form of EMSs.

The former EMS is formed by a set of rules or fuzzy logics that are based on expert knowledge and are applied to a given situation. This sort of EMS is straightforward, and the logic relationships between its components are obvious, making it easy to construct. An EMS based on simple principles, which takes use of the high power density of the supercapacitor and avoids overstressing of the battery, was suggested in research [1. It was discovered in [2] that a unique rule-based EMS was developed by taking into account two objectives: enhancing the efficiency of the vehicle and minimising peak battery currents in order to extend the battery life. When compared to the single battery configuration, several heuristic concept-based EMSs were proposed and tested for bus applications in research [3, including a rule-based EMS and a fuzzy logic-based EMS]. The comparison results revealed that the rule-based and fuzzy logic-based EMSs reduce more than 50% of the battery capacity loss along the China Bus Driving Cycle. The development of a rule-based energy management system (EMS) with the goal of exploiting the supercapacitor characteristics and increasing the battery lifetime and system efficiency was demonstrated in research [4]. Experiments demonstrated that the integration of the supercapacitor allows the battery to share low frequency load current, which would be extremely beneficial in extending battery lifetime and increasing system efficiency. Along with the previously mentioned rule-based EMSs, there is a completely different concept of rule-based EMS known as the frequency-based strategy [7,8,9,10], the main idea of which is to allocate the low and high frequency contents of the demanded power into the battery and supercapacitor on the basis of Wavelet

Transform.

II. Literature Review

X. Xia et al. [1] (2018) "Energy Management Strategy for the Advanced Energy Storage System of Pure Electric Vehicle Considering Traffic Information" In this research, a novel hybrid energy storage system for electric cars is proposed in order to give long-distance endurance while also ensuring the reduction of a cost function for electric vehicles. The research provides an optimum control method for the hybrid energy storage system, which is constructed utilising a Li-ion battery power dynamic limitation rule-based control based on the SOC of the super-capacitor and a Li-ion battery power dynamic limitation rule-based control. At the same time, DC-DC converters for electric cars are being equipped with magnetic integration technology that includes a second-order Bessel low-pass filter. Because of this, the battery's size is lowered, and the power quality of the hybrid energy storage system is improved. Finally, simulation and experimentation are used to demonstrate the usefulness of the suggested methodology.

Mohamed et al. [2] (2019) "Wireless Charging System for a Mobile Hybrid Electric Vehicle" In this study, we examine and explore the significance of applying recharge systems to electric vehicles, as well as the challenges that may arise. In addition to its critical function in providing vehicles with the necessary power, recharge systems are available in a variety of configurations, the most essential of which is the wireless charge system, which delivers electricity from transmitter to receiver without the need for physical contact. It goes without saying that this power is varied in response to the speed and that its primary duty is to charge the battery. It is our primary goal in this study, using Matlab Simulink, to investigate the change in SOC as a consequence of changing the car's speed and so obtaining the required conclusions and findings.

Terzi et al. [3] (2020) "A Review of Commercial Electric Vehicle Charging Methods" Electric vehicles (EVs) are quickly gaining prominence as the technological forerunners of the automobile industry. For the most part, early electric cars were disregarded due to their insufficient battery capacity and the poor efficiency of their electric motors, among other reasons. The advancement of semiconductor and battery technology has heightened interest in electric vehicles. Despite this, modern batteries continue to be insufficiently capacitative. As a consequence, automobiles must be recharged at small distances as a result of this (approximately 150 km). Because of the predetermined departure and arrival times, electric vehicles (EVs) seem to be more suited for city buses than for normal cars. The utilization of appropriate charging technologies and the availability of renewable energy for electric buses has resulted in reduced noise and CO_2 emissions in urban areas. Internal combustion engines use more energy than electric motors, which is why they are more efficient. It will be discussed in this article how research on commercial electric car charging techniques have been conducted, as well as how the plug-in charging procedures have been explained in depth. This research aims to provide answers to the issues of how communication during the plug-in charging process has performed between the electric vehicle and the Electric Vehicle Supply Equipment.

Al-Otaibi et al. [4] (2020) "Self-Charging System for Electric Vehicles. Innovative Systems Design and Engineering" This research article examines a technology that is employed in the charging of electric automobiles, which is described in detail. It is represented by the addition of electric generators to provide the electric vehicle with a part of the energy that it requires. This technology has been filed as a patent. This technique has been investigated in this research paper, and a number of important factors must be taken into consideration when dealing with this subject. The most significant factors that have been investigated are the effects on the speed of the electric vehicle, the regenerative braking, and the amount of energy that can be generated as a result of this innovation. Among the topics covered in this research study are the designs of a DC-DC Boost converter with two loops of PID controllers, as well as the design of a Field Oriented Control (FOC) of electric alternating current motors.

Younghyun Kim et al. [5] (2013) "Computer-Aided Design and Optimization of Advanced Energy Storage Systems" The book Computer-Aided Design and Optimization of Hybrid Energy Storage Systems covers a broad variety of subjects relating to the computer-aided design and runtime management of Hybrid Energy Storage Systems, including but not limited to (HESS). Energy storage systems (ESS) are becoming more important as electrical energy demand rises and power generating operational reserve margins grows more constrained. High performance but cost-effective energy storage systems are becoming increasingly important. Hybrid energy storage systems (HESS) are a new technology that combines already existing energy storage element technologies to create a high-performance and cost-effective energy storage system. Because of the heterogeneity of the energy storage components, the design and operation of the HESS are much more complicated than those of the homogeneous ESS. The many advantages of HESS, including as high power/energy density, low cost, high cycle efficiency, and extended cycle life, cannot be realized unless intelligent optimizations are carried out throughout the design and operating phases of the system. In Computer-Aided Design and Optimization of Hybrid Energy Storage Systems, the authors present a comprehensive assessment of research effort and findings on major areas of HESS, including system architecture, design optimization, and applications, among other topics. It discusses the fundamentals of HESS, beginning with energy storage element technologies and homogeneous ESS and progressing through the architecture, optimization strategies, and applications of HESS in contrast to homogeneous ESS, among other topics. The book Computer-Aided Design and Optimization of Hybrid Energy Storage Systems offers the reader with a complete primer on the vast array of technologies, metrics, and systems connected to hybrid energy storage systems (HESS).

Karl BA et al. [6] (2010) ""Design and Evaluation of Advanced Energy Storage Systems for Electric Power trains" One of the most challenging aspects of electric propulsion is the supply of portable electricity storage or generation. The issues are twofold: (1) providing sufficient energy capacity for long distance driving and (2) ensuring enough power delivery to meet peak driving requirements. Given the high energy density of gasoline, which allows it to be burnt at almost any rate, storing vast volumes of electrical energy and providing high-speed delivery is challenging. Furthermore, the requirements of regenerative braking need frequent current reversals in the storage system, which shortens the service life of certain electric storage systems.

S. Piriienko et al. [7] (2016) "Optimization of Advanced Energy Storage System for Electric Vehicles" One of the most challenging aspects of electric propulsion is the supply of portable electricity storage or generation. The issues are twofold:

(1) Providing sufficient energy capacity for long distance driving

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Given the high energy density of gasoline, which allows it to be burnt at almost any rate, storing vast volumes of electrical energy and providing high-speed delivery is challenging. Furthermore, the requirements of regenerative braking need frequent current reversals in the storage system, which shortens the service life of certain electric storage systems.

Tobias Anderssona et al. [8] (1992) "Alternative Energy Storage System for Hybrid Electric Vehicles" This paper describes an energy storage system that may be used to improve the performance of hybrid electric vehicles (HEVs). The batteries and supercapacitor that make up the hybrid power system are used to generate electricity. In electric cars, the supercapacitor helps to both the quick energy recovery associated with regenerative braking and the rapid energy consumption connected with acceleration by storing excess energy in the battery. Because it reduces high power demands away from the main batteries, this power system enables the vehicle to accelerate and decelerate with minimum energy loss and reduces the stress on the main batteries by allowing the vehicle to accelerate and decelerate with minimal energy loss. It also results in a longer battery life since the energy is extracted at a slower average rate. Because the entire weight of the hybrid system is less than the whole weight of the vehicle when just batteries are used, the efficiency of the vehicle is boosted.

III. Energy Storage System

The relative growth of the electric car: a used electric vehicle rising in value may be more or less costly than a new electric vehicle of equivalent value.

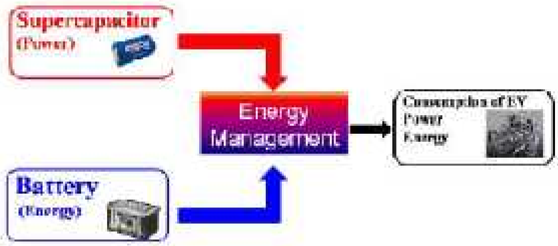

Fig.1: Hybrid storage system (Battery/Supercapacitors) for electric vehicles

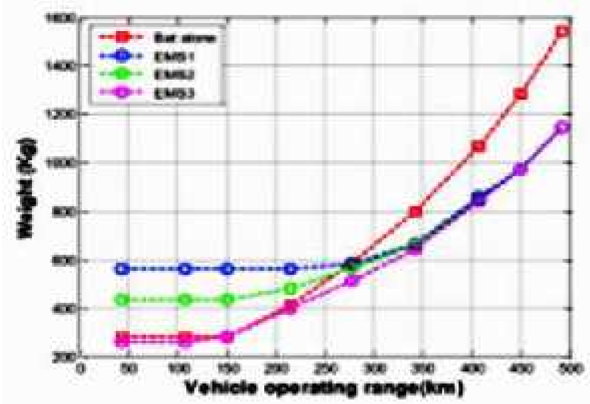

Fig.2: Weight of the hybrid embedded power

Following the completion of a simulation (Fig. 3.2), it has become clear that the half-bred EMS3-expandable power supply weighs less than the whole-mercule power supply throughout the vehicle's range of motion. There are two time periods for both activities, and whether they are taken or not taken, there are two stages from which the weight of evidence may be pushed in either direction. When you have a set weight, the weight expansion rate is one percent per working degree, and when you raise the vehicle weight by one percent when the vehicle is driven, the weight expansion rate is one percent per working degree. This process explains how the coherent and more strict half and one-power principle theory measured under discharge is present while charging, although the less severe charge and half-power schemes are utilised with vitality at different points in the cycle. The degree of energy at which the vehicle may grow energetically is also dependent on the initial feasibility of the expansion possibilities in the second stage, as previously stated. Many of the important forces and functions were put on the final scale of the supply.

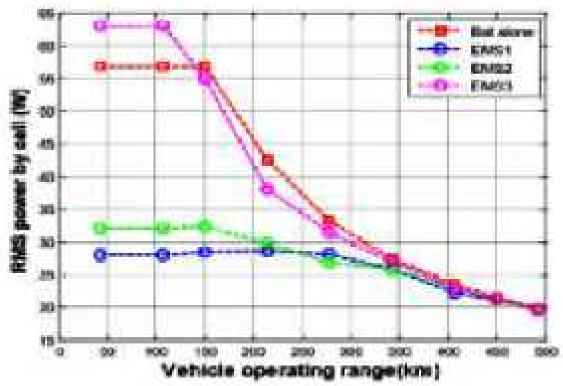

Fig.3: RMS power stress applied to battery cell

The weight applied to one cell in each arrangement is shown in Figure 3 as an enlarged RMS weight, which is displayed in Figure 3. We will be able to begin the first battery expansion process as soon as you provide us with this item, this inspection. Because battery voltage imbalances are one of the most common causes of controller failures, we avoid using the battery management system in order to prevent it from being influenced when the cells in a controller have voltage disparities amongst themselves. Furthermore, it is projected that the support provided throughout the charging and discharging phases would be consistent as a result of the presence of the BMS. The link between E-RMS need and RMS power consumption, as well as the use of half and half power supply in the intense operation of unyielding weight, results in a large quantity of RMS being created during the period of relentless weight operation. This turned out to be a lot more enjoyable approach for establishing the car on a single HP (kind of battery), rather than making a costly compromise on an uneven arrangement, as a result of underestimating the vehicle's power needs. It is specified that the half-and-half power supply, designated as EMS1 and EMS2, have RMS amplitude equal to the working degree, thereby providing low RMS amplitude for engine operating tension. Because the battery pack itself is claimed to contain an endless amount of electrons, it is possible to draw these conclusions.

HEC model (Figure 4) was developed in the context of the growth of the kinds of materials used in the experiment (Figure 1), and it will serve as the basis for the limited power flow guideline that will be implemented. In diverse industrial environment ranges of size and scope, diversification prior to commercial scale for simple and economical ebikes was examined in different industrial environment ranges of size and scope. In accordance with the findings of this model, the quantity of charge cycles and/or expansions performed on the Li-part battery and supercapacitor was shown to have an influence on their longevity.

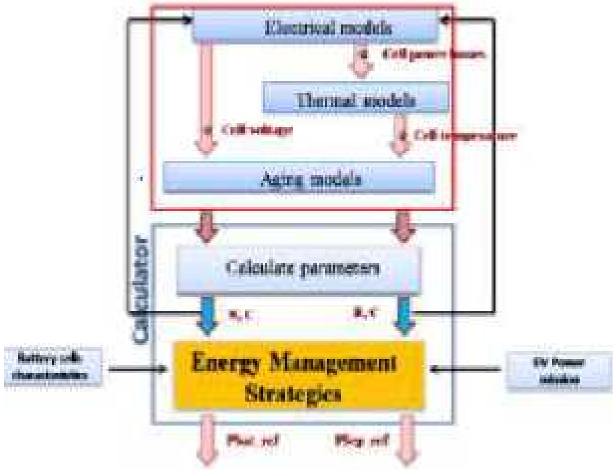

Fig.4: Multiphysics model of the Advanced Energy Storage system

IV. Conclusion

Because of the simple working principle and great controllability of the electric loading equipment, this is advantageous for enhancing the accuracy of the driving cycle modelling, as well as for lowering the risk and expense associated with validation. The efficacy of the HESS with the EMS as compared to the single battery case is primarily measured in terms of battery lifespan extension, battery energy savings, and life cycle cost reduction, according to this study's findings. The economic efficacy of the HESS is shown via the use of a dynamic battery deterioration model and a comparison of the life cycle costs between the HESS and the single battery case configurations.

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