International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 09 | Sep 2020 www.irjet.net p-ISSN: 2395-0072

A Review on Hybrid Vehicle

Nawaz Sharif[1], Bhupendra Kumar[2]

[1,2]Dept. of Electrical Engineering, Vishwavidyalaya Engineering College, Lakhanpur, C.G., India

---

Abstract: Electric vehicles (EVs) have recently attracted considerable attention and so did the development of the battery technologies. Although the battery technology has been significantly advanced, the available batteries do not entirely meet the energy demands of the EV power consumption. One of the key issues is non-monotonic consumption of energy accompanied by frequent changes during the battery discharging process. This is very harmful to the electrochemical process of the battery. A practical solution is to couple the battery with a super capacitor, which is basically an electrochemical cell with a similar architecture, but with a higher rate capability and better cyclability. In this design, the super capacitor can provide the excess energy required while the battery fails to do so. In addition to the battery and super capacitor as the individual units, designing the architecture of the corresponding hybrid system from an electrical engineering point of view is of utmost importance. The present manuscript reviews the recent works devoted to the application of various battery/super capacitor hybrid systems in EVs.

Keywords: Hybrid, Vehicle, Battery, Super Capacitor

I. Literature Survey:

M. A. Spina (2012) et al. proposed the conception and assembly of an experimental Hybrid Electric Vehicle based on the combination of human energy contribution and photovoltaic solar energy is presented in this manuscript. The vehicle has a battery for storing the energy provided by both systems. The application's aim is to achieve the lowest possible energy consumption for the vehicle's movement, with photovoltaic modules as the main electricity source. The development of the solar vehicle was motivated by a Latin-American solar vehicles race about 1000km across the Atacama Desert in Chile, South America. The main constructive aspects, energy issues and experimental results are presented.

Pierre-Olivier Logerais (2013) et al. proposed the storage of photovoltaic energy by supercapacitors is studied by using two approaches. An overview on the integration of supercapacitors in solar energy conversion systems is previously provided. First, a realized experimental setup of charge/discharge of supercapacitors fed by a photo voltaic array has been operated with fine data acquisition. These approach consists in simulating photovoltaic energy storage by supercapacitors with a faithful and accessible model composed of solar irradiance evaluation, equivalent electrical circuit for photovoltaic conversion, and a multi branch circuit for supercapacitor. Both the experimental and calculated results are confronted, and an error of 1% on the stored energy is found with a correction largely within ±10% of the transmission line capacitance according to temperature.

Karan C. Prajapati (2013) et al. proposed with the advancement in 21st Century, there has been increase in usage of Oil and Gas leading to problems like Global Warming, climate change, shortage of crude oil, etc. Due to these reasons Automobile Companies have started doing research for making Hybrid Techonolgy usable into the daily life. The Paper starts from brief history about Hybrid Technology and also some brief introduction on it. Paper will also discuss the technologies used in the making of Hybrid Cars such as "Hybrid Solar Vehicle", "Hybrid Electric Vehicle" and "Plug In hybrid electric vehicles". Our Paper is based on the explanation of such technologies, their function, drawback of this technology, efficiency of Hybrid Cars, Case studies on the present commercial hybrid cars such as Toyota Prius series, Astrolab etc and the fuels and raw materials used in the Hybrid Cars. Paper concludes on the advantages and dis-advantages of Hybrid Cars and how this technology will take over the world in future and would become the alternative for Petrol and Diesel Cars.

Thilo Bocklisch (2015) et al. proposed an overview of the innovative field of hybrid energy storage systems (HESS). An HESS is characterized by a beneficial coupling of two or more energy storage technologies with supplementary operating characteristics (such as energy and power density, self-discharge rate, efficiency, life-time, etc.). The paper briefly discusses typical HESS-applications, energy storage coupling architectures, basic energy management concepts and a principle approach for the power flow decomposition based on peak shaving and double low-pass filtering. Four HESS-configurations, suitable for the application in decentralized PVsystems: a) power-to-heat/battery, b) power-to-heat/battery/hydrogen, c) supercap/battery and d) battery/battery, are briefly discussed. The paper ends with a short description of the HESS-experimental test-bed at Chemnitz University of Technology.

S. Piriienko (2016) et al. presented improvement of efficiency of energy storage devices for electric vehicles. The benefits and features of the hybrid energy storage system based on the batteries and ultracapacitors are described. The possible topologies and common schematics of bi-directional DC/DC converters for energy storage are analyzed in terms of efficiency, reliability and battery

maintenance. An algorithm for optimization of its parameters is developed, analyzed, shown and explained in detail. The surfaces, which show the dependence between required battery and ultracapacitors' capacities, energy storage cost and battery discharge ratio are obtained and analyzed. Conclusions are drawn concerning optimization strategy and results of optimization with possible further improvements.

Vrinda Tibude (2016) et al. proposed a highly reliable, extended range power supply for an Electric Vehicle (EV). The power supply consists of solar PV source, a battery and Ultra capacitor (UC). Main source of power is battery, and is connected with super capacitor during transient phase like overloading and starting. Photovoltaic cell works for the steady condition. The total effect of such arrangement is to improve travel range, reduced size of battery , enhanced excellent response while the overloading condition and battery life . Improved performance which gives optimal use of energy, smooth ride and minimum size of sources of energy. Many stand-alone photovoltaic systems need storage device for providing steady state energy to the load when photovoltaic irradiation are not sufficient. Generally, Batteries are used for such application. Thus, providing a large peak current, like starting of motor, degrades plates of battery, results in devastation of battery. An alternate solution of providing heavy current have to connect battery with super capacitors forming an hybrid energy storage system, for which battery could provide steady state energy also the super capacitor can provide the peak power to connected load. A secondary source, solar panel module is available to charge battery and super capacitor.

K. Mohan (2018) et al. presented in the current scenario, global warming is a threat to the society. One of the major reasons is the release of carbon-di-oxide from an automobile exhaust due to the combustion of fossil fuels which pollutes the environment. One of the optimistic solutions for this problem is to use of hybrid vehicles. Generally, Hybrid vehicle involves a combination of transmission system driven through electrical, solar as well as internal combustion (IC) engine. This work involves hybridization with solar power and conventional power IC engine. Hence it is called a Hybrid Solar Vehicle (HSV). It can be driven both on internal combustion engines as well as on solar energy assisted with electrical motor. In real life applications using solar vehicle produces zero emissions. At present, hybrid electric vehicles are being developed and launched into the market. For long distance travelling its necessary of periodic charging of their batteries, so these vehicles are depends the electrical sources also leads to increase the cost of electricity. These kinds of problems will be solved by using hybrid solar vehicle also HSV supporting to the green environment.

Dr. K.V. Vidyanandan (2018) et al. proposed Introduction of electric vehicles (EVs) signal the beginning of the end for traditional engine vehicles. The major motivators for shifting to EVs are the need for reducing polluting engine emissions and reducing dependence on costly oil fuels. By the end of 2016, the global stock of EVs crossed the two million mark. The growing acceptance of EVs is the outcome of several factors: technological advancements, rising storage capacity of traction batteries coupled with their falling cost, increased public charging facilities and Govt. incentives. The two EV technologies currently remain at the top are the battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEV). This paper gives an overview of various EV technologies, their features, limitations and challenges in their bulk deployment as a replacement to conventional vehicles.

Joeri Van Mierlo (2018) et al. presented the World Electric VehicleJournal is the first peer-reviewed international scientific journal that covers all studies related to battery, hybrid, and fuel cell electric vehicles comprehensively. The gaining interest in e-mobility and related fast developments in electric vehicles has been leading to the need for the academic and industrial world, as well as the societal stakeholders, to have their own open-access journal in which they can share the latest developments and knowledge about electric vehicles. The journal accepts papers from all different disciplines, from new battery technologies, over propulsion system, and charging infrastructure to market developments and consumer behaviour. The World Electric Vehicle Journal is the primary scientific journal serving the interests of the international electric vehicle community. The World Electric Vehicle Journal has been managed by the World Electric Vehicle Association for the 10 years, with support from the Vrije Universiteit Brussel, and we have decided to further improve our professional approach by setting up the cooperation with MDPI as our professional publisher.

Joeri Van Mierlo (2019) et al. presented climate change, urban air quality, and dependency on crude oil are important societal challenges. In the transportation sector especially, clean and energy-efficient technologies must be developed. Electric vehicles (EVs) and plug-in hybrid electric vehicles (PHEVs) have gained a growing interest in the vehicle industry. Nowadays, the commercialization of EVs and PHEVs has been possible in different applications (i.e., light duty, medium duty, and heavy duty vehicles) thanks to the advances in energy-storage systems, power electronics converters (including DC/DC converters, DC/AC inverters, and battery charging systems), electric machines, and energy efficient power flow control strategies. This Special Issue is focused on the recent advances in electric vehicles and (plug-in) hybrid vehicles that address the new powertrain developments and go beyond the state-of-the-art (SOTA).

Krishna Veer Singh (2019) et al. presented the rapid consumption of fossil fuel and increased environmental damage caused by it have given a strong impetus to the growth and development of fuel-efficient vehicles. Hybrid electric vehicles (HEVs) have evolved from their inchoate state and are proving to be a promising solution to the

serious existential problem posed to the planet earth. Not only do HEVs provide better fuel economy and lower emissions satisfying environmental legislations, but also they dampen the effect of rising fuel prices on consumers. HEVs combine the drive powers of an internal combustion engine and an electrical machine. The main components of HEVs are energy storage system, motor, bidirectional converter and maximum power point trackers (MPPT, in case of solar-powered HEVs). The performance of HEVs greatly depends on these components and its architecture. This paper presents an extensive review on essential components used in HEVs such as their architectures with advantages and disadvantages, choice of bidirectional converter to obtain high efficiency, combining ultra capacitor with battery to extend the battery life, traction motors' role and their suitability for a particular application. Inclusion of photovoltaic cell in HEVs is a fairly new concept and has been discussed in detail. Various MPPT techniques used for solar-driven HEVs are also discussed in this paper with their suitability.

Yasmeen Malik (2019) et al. proposed with growing oil prices and escalating environment worries, cleaner and supportable energy solutions are demanded. Present transportation contributes large amount of energy consumption and emission of pollutants. In this paper, hybrid vehicle technology has been analyzed, with Power split configuration having internal combustion engine and battery as the power source. Initially the analysis of hybrid electric vehicle performance is done with battery of higher amp-hr capacity .In advanced state the converter circuit is implemented to reduce the battery rating. Different cases have been observed with different charging and discharging circuitry of battery. Hybrid electric vehicles are admired because of their ability to achieve related performance to a standard automobile while prominently improving fuel efficiency and tailpipe emissions. Having a great control of ANFIS controller in power system and machine rather than other controller, motivate us to interface this controller in hybrid electric vehicle. An improving effect can be visualized from the simulation results.

Marut Prasad (2019) et al. proposed most automobiles on the road currently run on fossil fuels in the form of petrol or diesel. Very few use Electric or Hybrid Electric Vehicles, which are a lot eco-friendlier due to their shortcomings in terms of power among other issues. Supercapacitors overcome some of these issues and their use in cars has become a major field of research in the automotive industry. This paper gives an introduction to supercapacitors and their advantages. It also talks of how they are being used currently in electric and hybrid vehicles along with a comparison between supercapacitors and conventional batteries that clearly shows the advantages of supercapacitors over existing batteries for powering EVs and HEVs.

Muhammad Khalid (2019) presented presents a comprehensive categorical review of the recent advances and past research development of the hybrid storage paradigm over the last two decades. The main intent of the study is to provide an application-focused survey where every category and sub-category herein is thoroughly and independently investigated. Implementation of energy storage systems is one of the most interestingly effective options for further progression in the field of alternative energy technology. Apart from a meticulous garnering of the energy resources regulated by the energy storage, the main concern is to optimize the characteristic integrity of the storage devices to achieve a practically techno-economic size and operation. In this paper, hybrid energy storage consisting of batteries and supercapacitors is studied. The fact that the characteristic of batteries is mostly complementary to that of supercapacitors, hybridizing these storage systems enhances their scope of application in various fields. Therefore, the objective of this paper is to present an inclusive review of these applications. Specifically, the application domain includes: (1) regulation of renewable energy sources, (2) contributions to grid regulation (voltage and frequency compensation, contribution to power system inertia), (3) energy storage enhancements (life cycle improvement, and size reduction), (4) regenerative braking in electric vehicles, (5) improvement in wireless power transfer technology. Further, this review also descriptively highlights the control strategies implemented in these domains of applications. The application-oriented review explicates the principle advantages with the hybridization of battery and supercapacitor energy storage systems that can be used as an insight for further development in the field of energy storage technology and its applications.

Nagesh B.K. (2019) et al. presented Plug-in Hybrid Electric Vehicles (PHEVs) have an excessive opportunity due to its charging facilities and charge storage system. Through appropriate design and development, Electric Vehicles (EVs) not only eliminate the pollution but also make the system more efficient over traditional vehicles. However, still it is in the progress of the investigation and has several unanswered issues. The performance of PHEV depends upon proper utilization of electric power which is solely affected by the battery State-Of-Charge (SOC). SOC determination becomes a vital problem in whole area where it comprises a battery storage; because it has several drawbacks such as weak power density, longevity, etc. one probable and favourable resolution for this issue is multi-source EV. Both the batteries and Ultra-Capacitors (UC) can reduce the aforementioned disadvantages in existing systems. This proposed work has more efficiency because of the combined design model of both battery and super-capacitor. Hence, in this work, the Particle Swarm Optimization (PSO) technique with Fuzzy Logic Controller (FLC) is implemented for optimal sharing of power between the battery and the super-capacitor.

II. Conclusion:

Both the environmental issues and the market demand have caused the popularity of the Electric Vehicles, but the electrochemical energy storage systems are still far behind the expectations to compete with the fuel-based vehicles. Although recent advancements in the battery technologies have provided excellent opportunities to produce Electric Vehicles, which can fairly compete in the market, the limitations in both the thermodynamics and kinetics of the electrochemical reactions involved in a battery do not fully meet the requirements of irregular energy consumption of vehicles. In this direction, employing a Super Capacitor along with the battery system can satisfy the need. In this hybrid design, the Super Capacitor can quickly (for a short period, few seconds), provide the energy when the battery system fails to do so. After that, the steady energy flow is supplied by the battery pack.

References:

1. Dr. K.V. Vidyanandan, "Overview of Electric and Hybrid Vehicles", International Energy Agency (IEA), March 2018.
2. Joeri Van Mierlo, "The World Electric Vehicle Journal, The Open Access Journal for the e-Mobility Scene", World Electric Vehicle Journal 2018, 9, 1.
3. Joeri Van Mierlo, "Special Issue "Plug-In Hybrid Electric Vehicle (PHEV)"", Applied Science 2019, 9, 2829.
4. K. Mohan, S. Sankaranarayanan, Shyam Sundar Devi Prasad, V. Sivasubramaniam and V. Sairam, "Solar powered Hybrid vehicle", The 3rd International Conference on Materials and Manufacturing Engineering 2018 IOP Publishing.
5. Karan C. Prajapati, Ravi Patel and Rachit Sagar, "Hybrid Vehicle: A Study on Technology", International Journal of Engineering Research & Technology (IJERT), Volume 3 Issue 12, December-2014.
6. Krishna Veer Singh, Hari Om Bansal, Dheerendra Singh, "A Comprehensive Review on Hybrid Electric Vehicles: Architectures and Components", Springer, 8 March 2019.
7. M. A. Spina, R. J. de la Vega, S. R. Rossi, G. Santillán, R. C. Leegstra, C. Verucchi, F. A. Gachen, R. E. Romero, G. G. Acosta, "Some Issues on the Design of a Solar Vehicle Based on Hybrid Energy System", International Journal of Energy Engineering 2012, 2(1): 15-21 DOI: 10.5923/j.ijee.20120201.03.
8. Marut Prasad, Mrudula Amirapu, Nesara B.E., Suhas M., "Usage of Energy Storing Supercapacitors in Body Panels of EV/HEVS", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Volume 8, Issue 6, June 2019.
9. Muhammad Khalid, "A Review on the Selected Applications of Battery-Supercapacitor Hybrid Energy Storage Systems for Microgrids", Energies 2019, 12, 4559; doi:10.3390/en12234559.
10. Nagesh B.K., B. R. Lakshmi Kantha, "Performance Evaluation of Battery and Super-Capacitor for Electric Vehicle with Hybrid Techniques", International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-8 Issue-10, August 2019.
11. Pierre-Olivier Logerais, Olivier Riou, Mohamed Ansoumane Camara, and Jean-Félix Durastanti, "Study of Photovoltaic Energy Storage by Supercapacitors through Both Experimental and Modelling Approaches", Hindawi Publishing Corporation Journal of Solar Energy Volume2013,ArticleID659014.
12. S. Piriienko, A. Balakhontsev, A. Beshta, A. Albu, S. Khudoliy, "Optimization of Hybrid Energy Storage System for Electric Vehicles", Power Electronics and Drives, Volume 1 (36), Number 2, 2016 DOI: 10.5277/PED160206.
13. Thilo Bocklisch, "Hybrid energy storage systems for renewable energy applications", Elsevier ScienceDirect 1876-6102 © 2015, 9th International Renewable Energy Storage Conference, IRES 2015.
14. Vrinda Tibude, Sneha Tibude, "Hybrid Energy Storage System consisting Solar Panel – Battery – Super capacitor for improving the performance of Electric Vehicles", IJISET - International Journal of Innovative Science, Engineering & Technology, Volume 3 Issue 1, January 2016.
15. Yasmeen Malik, Vikas Kumar, "A Review on Hybrid Electric Vehicle", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Volume 6, Issue 9, September 2017.