International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

A Review of Electric Vehicle Technology Development

Chebodula Vighnesh[1], Vasupalli Manoj[2], Behara Bhuvaneswara Rao[3]

[1,3]B.Tech Student, Department of Electrical and Electronics Engineering, GMR Institute of Technology, Vizianagaram District, A.P, India

[2]Assistant Professor, Department of Electrical and Electronics Engineering, GMR Institute of Technology, Vizianagaram District, A.P, India.

A B S T R A C T

To reduce their reliance on oil and their impact on the environment, many countries have encouraged the development of electric vehicles. Some people believe that EVs, and especially battery EVs, are the key to solving the world's energy and environmental crises. This study presents an in-depth analysis of the current state of electric vehicle (EV) technology and the state of new technologies that will be employed in the industry in the future. Brief discussions are held on the EV charging infrastructure, electric motors, batteries, and electric motor and control systems. This research adds to that by outlining the technical challenges and state-of-the-art technologies that need to be conquered in order for EVs to increase in reliability, safety, and efficiency in the near future. Major developments in the electric vehicle (EV) charging infrastructure, battery technology, electronic motor technology, and new technologies are discussed. Improvements in battery technology are critical for EV uptake.

Keywords: Electric Vehicle (EV) Technology, Battery technology, Chargingtechnology

1.Introduction

Growing numbers of cars, trucks, and SUVs powered by internal combustion engines and fuels by conventional, nonrenewable fuels have exacerbated energy and environmental problems. New Energy Vehicles (NEVs) have been adopted by several nations in an effort to lessen their reliance on oil and the pollution it generates. China, which has the biggest market for cars in the world, has promised to use more NEVs to reduce its reliance on imported oil. Through the usage of one million electric vehicles (EVs) by 2020, Germany hopes to reduce CO2 emissions in Europe. Standard vehicles may be banned from sale throughout France and the United Kingdom by the year 2040. Most NEVs that rely on unconventional energy sources include electric cars (EVs), hydrogen vehicles, natural gas vehicles, and methanol and ethanol vehicles. When compared to other NEVs, electric vehicles are seen as having the most potential for positive social and environmental impact.

Thomas Parker built the first reliable electric vehicle in 1884. Another well-known early electric vehicle was the Ferdinand Porsche electric car, which was made in Germany and came out in 1899. Unlike their steam and gasoline-powered counterparts, early electric automobiles were almost quiet in operation, had few moving parts, and produced no noxious fumes. In the 1920s, 28% of the cars made in the US were electric, and electric vehicle makers did pretty well until Henry Ford built the revolutionary Model T with his mass production system.

Research on EVs has picked up steam in the twenty-first century in response to rising concerns about pollution and energy consumption. Thanks to efforts by both governments and private companies, the infrastructure for and capabilities of electric vehicles have advanced. In 2016, over a million electric cars were sold globally, and in 2018, over five million light-duty electric vehicles and plug-in hybrid electric vehicles will be sold. Popular automakers including VW, Mercedes-Benz, and Ford have all shown interest in expanding the market for electric cars. Fully electric vehicles (PEV), hybrid vehicles (HEV), and fuel cell vehicles (FCV) are the three primary types of EVs (FCEV). In a pure electric automobile, sometimes called a battery electric vehicle, the traction battery is the only source of power (BEV). A basic electric vehicle, or BEV, is shown in the diagram. A hybrid vehicle gets its power from both a gas-powered engine and an electric motor.

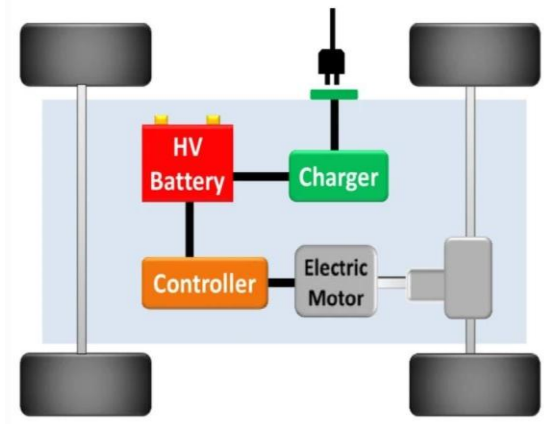

Fig 1: Simple design of a HEV

2.Methodology

Battery Technology in EVs

Innovations in traction battery technology have a significant effect on the electric vehicle industry as a whole since they are used to power the propulsion systems of electric cars. Electric vehicles (EVs) might benefit from the introduction of the rechargeable lead acid battery. Recent advances in battery technology have resulted in the introduction of several new battery types. Lead-acid, nickel-metal hydride (Ni-MH), and lithium-ion batteries are the most common types of rechargeable batteries used in electric cars today.

LEAD ACID BATTERIES

French scientist Gaston Plante invented the lead-acid battery in 1860; it can be recharged. The positive plate is formed of brown lead dioxide, while the negative plate is made of lead metal; both are immersed in an electrolyte of diluted sulfuric acid. A lead-acid battery may store and release electrical energy by converting chemical energy. The following are the reversible reactions that occur in a lead-acid battery.

Positive electrode reaction:

$$PbSO4 + 2H2O \leftrightarrow PbO2 + 3H+ + HSO4 - + 2e$$

Negative electrode reaction:

$$H+ + PbSO4 + 2e- \leftrightarrow Pb + HSO4$$

Net reaction:

$$2PbSO4 + 2H2O \leftrightarrow PbO2 + Pb + 2H+ + 2HSO4$$

Lead-acid batteries were selected by certain EVs because of their great availability, cheap price, and good dependability. One of the biggest problems with lead-acid batteries has always been the damage they do to the environment through manufacturing, use, disposal, and recycling. Lead is quite dangerous to people's health. In contrast to nickel-cadmium batteries, lead-acid batteries have a lower specific energy and energy density, which means they are not widely used in EVs. When compared to lithium-ion batteries, lead-acid batteries have a lower energy density per unit mass or volume. Lead-acid batteries are used in most electric cars on the road today because most of them are driven at slow speeds.

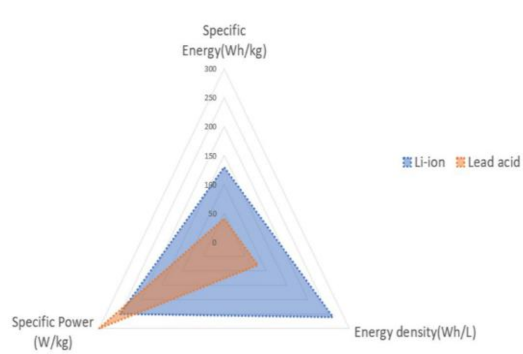

Fig 2: Comparison of lithium-ion and lead-acid batteries

Nickel Metal Hybrid Batteries

Usually, a solution of potassium hydroxide is used as the electrolyte in nickel-metal hydride batteries. Nickel hydroxide is used as the positive electrode, and another material is used as the negative electrode.

$$X + 2NiO(OH) + 2H_2O \leftrightarrow 2Ni(OH)_2 + X(OH)_2$$

$$M(H) + 2NiO(OH) \leftrightarrow M + Ni(OH)_2$$

$$H_2 + NiO(OH) \leftrightarrow Ni(OH)_2$$

The energy density and specific energy of a Ni-MH battery may be up to double that of a lead-acid battery. It's important to be aware that Ni-MH batteries have certain downsides, including lower charging efficiencies and increased self-discharge at warm temperatures. Since Ni-MH batteries for big vehicles are patented, their use in EVs has stayed the same over the past few years.

Lithium-ion Batteries

After Sony Corporation released the first mass-produced lithium-ion battery in 1991, it swiftly replaced nickel-cadmium batteries as the industry standard for portable devices and energy storage. They can store a lot of energy, weigh almost nothing, and take up very little space. Lithium-ion batteries are the main way that electric vehicles store energy. They are more efficient, don't have a noticeable memory effect, last longer, and have a highpower density.

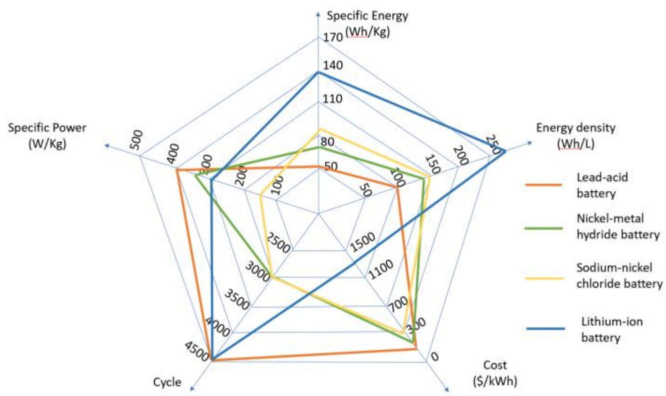

Fig 3: Comparison of the characteristics of various power batteries.

Batteries used to provide juice to electric vehicles (EVs) must meet certain criteria in order to function effectively. These include a high energy density, a highpower density, and a high energy efficiency. The table below compares the most popular batteries and details the benefits and drawbacks of each. Batteries designed for EVs take into account a number of factors, including the ability to reduce self-discharge while still being compact, having a long lifetime, and requiring little in the way of maintenance. As a result, the concept of hybrid energy storage systems was proposed, suggesting that electric vehicles may use a combination of different battery technologies. That's why there are always new developments in battery technology, whether it's improved materials, energy management, reduced size, lower cost, or more safety.

Table 1: Comparison of the most commonly used batteries

Cathode Material	Specific Energy (Wh/kg)	Cycle	Optimal Working Temp (°C)	Efficiency (%)	Advantages	Disadvantages
Lead acid	30–50	2000–4500	−20–60	70–90	High specific power at low cost and using a well-established technology	Disadvantages include a low specific energy, a limited lifespan, and extensive upkeep.
Ni-Fe	30–55	1200–4000	−10–45	75	Excellent potential for use in traction systems	High self discharge, hydrogen evolution, and acquisition and maintenance costs; low specific energy, power, and energy density
Ni-Zn	60–65	100–300	−10–50	76	High specific energy	Low efficiency and high price

Ni-Cd	40–50	2000–3000 −	−40–60	60–90	High specific energy	Costly cadmium toxicity testing and recycling problems
Ni-MH	50–70	500–3000	−40–50	50–80	Excellent particular energy, security, and durability	Conspicuous in its expense, discharge, and memory impact,

Charging Technology

The other issue with BEVs is the time it takes to charge the battery. Batteries and charging systems are two sides of the same technological coin. Reduced "range anxiety" among EV drivers is a major market opportunity for the charging technology industry. As the infrastructure for charging grows and charging technologies improve quickly, charging is becoming easier and faster.

Pulse charging refers to the practise of supplying charge current in intermittent bursts. In several studies, pulse charging was found to be faster than conventional charging methods for batteries. This process relies heavily on accurate pulse control. During this time, different chemical processes would keep thecharging process going.

Fewer gases would be produced at the electrode surface between successive charging pulses than would be the case with a single pulse. When used in conjunction with pulse charging, negative pulse charging can be extremely effective. A very While the electrode is resting during charging, a brief discharge pulse is used to flush out any trapped gas bubbles.

Conductive Charging

A physical connection between the charger and vehicle is made possible by the conductive charging technique. Transferring energy from the power source to the battery happens through direct contact. It may be either an on-board or an off-board charger, and is made up of AC/DC and DC/DC converters with power factor correction (PFC) . Transmission of power occurs through the charger. The term "charging" refers to the action of moving energy from the power grid into the EV's battery. Batteries in EVs can only accept DC current, thus a charger is needed to convert the alternating current (AC) from the power grid into the direct current (DC) needed to charge the batteries.

Battery Charger

Power transfer might be one way or two ways, hence charging systems are categorised as either off-board or on-board. Chargers with a one-way power flow reduce necessary hardware and facilitate connecting. Power may be sent in both ways using a two-way charger. Charging using an on-board charger is done from inside the EV and is often slower. Built-in charging solutions for electric vehicles have the advantage of requiring much less outside infrastructure for recharging. Increases in EVs' mass, size, and price are the primary downsides of on-board chargers. The ideal on-board chargers will be lightweight, compact, highly efficient, and easy to use.

Inductive Charger

Interest has grown in inductive charging, sometimes known as wireless charging, as a convenient alternative to traditional corded outlets. The wireless connection, as opposed to a direct cable connection, efficiently prevents sparking, which may be produced by plugging and unplugging, and minimises the constraints of EV applications in certain settings, such as near petrol stations and in airports. Furthermore, inductive charging may allow for dynamic charging, or charging while in motion.

In the 19th century, the concept of wireless power transmission (WPT) emerged. There are two primary types of wireless power transfer (WPT) systems: inductive power transfer (IPT) and capacitive power transfer (CPT). While conventional CPT is limited to applications requiring less than 10 kW of output power and air gaps of only 104 to 103 m, IPT may be employed with air gaps of several metres.

Comparison of Charging Technology

Three different charging methods are available for BEVs: conductive charging, inductive charging, and battery swapping. The benefits and drawbacks of the system parameters are laid forth in T. The most common of these three charging methods is conductive charging. It's easy to use and inexpensive, however it might give electric shocks due to worn parts. Similarly, automatic operation cannot be used for conductive charging. Conductive charging may be dangerous under extreme conditions, such as when submerged in water or exposed to a lot of dust. The inductive charging method is safer than the conventional one. With no metal to metal contact between the charging unit and vehicle assembly, there is no chance of a spark. Vehicles using inductive charging must be parked in a certain location inside a charging zone, and their exact orientation must be guaranteed. Friendly to users. Lower charging efficiency and higher cost are the primary drawbacks of inductive charging. However, inductive charging takes more time and requires circuitry to drive the coils on both ends. Since a fully charged battery is used to replace the drained one, the battery swap method results in the quickest time to full batteries. There are still many obstacles to overcome before the system can be considered economically viable, including how many charging bays should be set up in the facility, how many batteries should be used in the system, how many batteries should be recharged at different times, how to move the batteries between stations, and how to return and recover the swapped batteries. It's also a regular technical issue to not know how to switch out large batteries.

Heavy-duty battery swaps have benefited from the use of sophisticated equipment like robotic arms and control systems to combat this problem. The absence of a universal battery standard also prevents a public battery swap station from being built to charge all EVs.

Electric Motors

The electric motor is the heart of an electric vehicle's propulsion system, transforming the energy stored in the battery into the mechanical energy needed to move the vehicle forward. The propulsion motors mentioned in should be long-lasting, strong, powerful, efficient, versatile, simple to operate, inexpensive, quiet, small in size, and have a wide speed range. Numerous variations on electric motor architectures and technology have been used in EVs since their inception. The induction motor, permanent magnet motor, and switching reluctance motor are the three most common types (SRMs). In most cases, PM varieties are the best option for automobiles.

Induction Motor

Effective use of IMs was shown in the General Motors EV1. They're also standard on Tesla's Model S and Roadster electric cars. For all commutator-less motors, an IM is a realistic choice for EV applications because to its durability, toughness, reduced maintenance demands, established technology, and cheap cost. The performance of IMs under low to moderate loads is a major issue.

Permanent Magnet Brushless DC Motor (PMBLDC)

PMBLDCs are widely used in EVs because of their efficiency and power density. Samarium cobalt (Sm-Co) and neodymium-iron-boron (Nd-Fe-B) are examples of the high-quality rare earth permanent magnet materials used in its rotor's construction. With no windings on the rotor, copper loss is eliminated. Electronic switches are used in the PMBLDC in place of a commutator and brush gear to provide synchronous current to the motor windings, which is phase-locked to the rotation of the rotor. Hall sensors, resolvers, or optical encoders may be used to detect the rotor position, which is crucial to the PMBLDC's operation. The addition of position sensors increases the motor's size, cost, and control complexity. Control options that do not necessitate the use of sensors can frequently reduce the overall cost of propulsion systems.

3.Results and discussions

Emerging Technologies for the Future Development of EVs

Rapid progress has been made in EV technology in recent years. In addition to their minimal carbon footprint, EVs are sought after for their other advantages. Increased traffic safety and efficiency may be attained by the integration of cutting-edge technologies including vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), vehicle-to-pedestrian (V2P), and vehicle-to-grid (V2G) communication. Vehicle-to-everything (V2X) refers to two-way communication between motor vehicles and any roadside smart device. V2I communication, which is part of V2X, can enhance driving performance by allowing drivers to make speed decisions based on information about the distance and timing between traffic lights and by reducing the number of times vehicles start and stop, both of which contribute to safer and more comfortable driving. In V2G, electric vehicle batteries may be seen as either loads or a decentralised energy and power supply (Energies 2020, 13, 90, 19 of 29). Among the many benefits of a V2G-enabled vehicle is its ability to manage active power, provide reactive power, smooth the load, and get rid of current harmonics. Battery deterioration, a communication charge between the EV and the grid, effects on grid distribution equipment, and infrastructural improvements all contribute to the price tag of V2G. Grid operators and EV owners are paying more attention to V2G technologies because of the potential financial benefits, which are shown to be strongly correlated with charging and vehicle aggregation tactics. A rising number of people are interested in V2P communication systems for the sake of security and convenience. Recent studies have shown that V2P systems have used a variety of communication technologies and procedures to accommodate a wide range of users. V2X's primary goals are to increase passenger protection, improve traffic flow, and reduce energy consumption.Nonetheless, this technology is in its early stages and confronts a number of difficulties, such as cybersecurity and traffic safety brought about by V2X applications. Additionally, several academics have shown an interest in combining AI with V2X.

Charging Infrastructure

The availability of charging stations is a crucial factor in the widespread use of electric vehicles. Establishing a reliable charging infrastructure network is an important consideration for introducing electromobility. Coordinating the present state of charging infrastructure, learning how charging affects the power grid, and realising a fair charging payment system are all crucial steps in the process of constructing a strong charging infrastructure network.

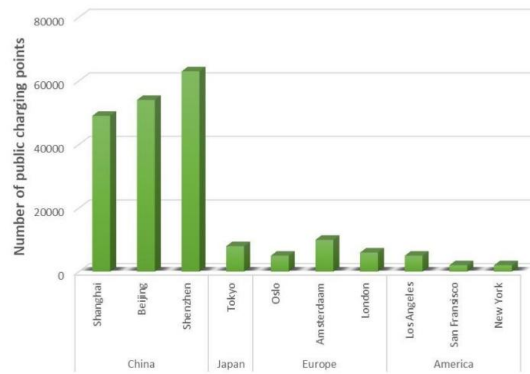

Fig 4: Number of public charging points in metropolitan areas.

An abundance of academics have conducted comprehensive investigations on this subject. However, whether or not lithium-ion batteries are really green is still up for debate, despite the fact that they are now the most often used batteries in EVs. Current lithium-ion battery cathode materials, such as cobalt or nickel, are both costly and poisonous. Because of the high amount of lithium-ion batteries being produced for EVs, many more landfills and other environmentally sensitive areas will get polluted. Large-scale manufacturing is technically and economically feasible, and this should be taken into account in future battery research. EV batteries also face the issue of safety.

4.Conclusion

This page provides an overview of the evolution of important EV technologies such the battery, charging, the electronic motor, charging infrastructure, and new technologies. Increased adoption of EVs relies heavily on advances in battery technology. A variety of battery types, not only the more common lead-acid ones, are finding their way into EVs. Electrochemical batteries like as nickel-metal hydride cells, Zebra cells, and lithium ion cells are used to power EVs because they are more efficient, safer, and more powerful than conventional batteries. There is now a widespread use of lithium-ion batteries. Still in the research phase, metal-air batteries and supercapacitors might one day power all EVs. The act of recharging batteries might help ease concerns about running out of juice. There have been several attempts to address the issue of EV charging. Lightweight, compact, high-performance, and easy-to-use are just some of the features included into today's on-board chargers. Charging electric vehicles quickly, safely, and with little heat generated and voltage spikes is the goal of conductive chargers that use constant, constant and constant and constant, constant, and pulse currents. With inductive charging, you can power up without being tied down to a certain location. Dynamic charging technology allows for more charging flexibility and may lower EV costs. An additional option for fast and easy charging is battery replacement. In addition to their battery swapping service, BSS may provide the distribution grid with energy and associated services. The charging industry needs universally accepted standards. Countries with the highest concentrations of electric vehicles (US, EU, Japan, and China) are also responsible for publishing the most widely used charging standards. Studies also focus on electric motors because of their central role in the propulsion system. Telesa's EVs utilise IMs. Vector control has been used to increase IM efficiency under mild loads. Even though PMBLDCs are often controlled without the use of sensors, rotor position is still a significant consideration. The PMBLDC's high power density and efficiency make it a promising option for in-wheel technology in electric vehicles. Many EV uses may be discovered for PMSMs, particularly the SM kind. These use FOC as a torque control approach, and their high power density, high efficiency, and simple design make them ideal for use in a wide range of applications. Recent research has focused on SRMs because they can provide the necessary power for EVs at a lower cost than traditional solutions that depend on rare earth minerals. It seems clear that widespread adoption of SRM for EVs would occur if the issue of acoustic noise associated with SRM could be resolved in the future. The charging infrastructure is an important part of EV use cases. There are several moving parts in a charging infrastructure network, including network organisation, infrastructure technological issues, and the potential for equitable billing payments. Present-day electric cars (EVs) serve not only as a tool for transporting people and commodities, like conventional vehicles, but also as a link that enables two-way communication between EVs and all smart devices. Thanks to advancements in V2X technology, these exchanges are now possible to some extent. We think that EVs will play a vital part in people's lives in the future, despite the fact that EV development must confront numerous technological hurdles, such as battery technology, charging technology, electric motor technology, and integration with other new technologies.

REFERENCES

1. Qinyu Qiao, Fuquan Zhao, Zongwei Liu, Xin He, Han Hao, Life Cycle Greenhouse Gas Emissions of Electric Vehicles in China: Combining the Vehicle Cycle and Fuel, Cycle, Energy (2019).

2. Li, C.; Negnevitsky, M.; Wang, X.; Yue, W.L.; Zou, X. Multi-criteria analysis of policies for implementing clean energy vehicles in China. Energy Policy 2019.
3. Coffman, M.; Bernstein, P.; Wee, S. Electric vehicles revisited: A review of factors that affect adoption Transp. Rev. 2017.
4. Choi, S.Y.; Gu, B.W.; Jeong, S.Y.; Rim, C.T. Advances in Wireless Power Transfer Systems for Roadway Powered Electric Vehicles. IEEE J. Emerg. Sel. Top. Power Electron. 2015.
5. She, Z.Y.; Sun, Q.; Ma, J.J.; Xie, B.C. What are the barriers to widespread adoption of Battery electric vehicles? A survey of public perception in Tianjin, China. Transp. Policy 2017, 56, 29–40, doi:10.1016/j.tranpol.2017.03.001.
6. Guarnieri, M. Looking back to electric cars. In Proceedings of the 2012 Third IEEE History of ElectroTechnology Conference (HISTELCON), Pavia, Italy, 5–7 September 2012; pp. 1–6.
7. Chan, C.C. The rise & fall of electric vehicles in 1828–1930: Lessons learned [scanning our past]. Proc. IEEE 2012, 101, 206–212, doi:10.1109/JPROC.2012.2228370.
8. Rajashekara, K. History of electric vehicles in General Motors. IEEE Trans. Ind. Appl. 1994, 30, 897–904, doi:10.1109/28.297905.
9. Onar, O.C.; Miller, J.M.; Campbell, S.L.; Coomer, C.; White, C.P.; Seiber, L.E. Oak; Ridge National Laboratory Wireless Power Transfer Development for Sustainable Campus Initiative. In Proceedings of the IEEE Transportation Electrification Conference and Expo(ITEC), Detroit, MI, USA, 16–19 June 2013.
10. Lu, L.; Han, X.; Li, J.; Hua, J.; Ouyang, M. A review on the key issues for lithium-ion battery management in electric vehicles. J. Power Sources 2013.
11. Manoj, V., Sravani, V., Swathi, A. 2020. A multi criteria decision making approach for the selection of optimum location for wind power project in India. EAI Endorsed Transactions on Energy Web, 8(32), e4
12. Dinesh, L., Sesham, H., & Manoj, V. (2012, December). Simulation of D-Statcom with hysteresis current controller for harmonic reduction. In 2012 International Conference on Emerging Trends in Electrical Engineering and Energy Management (ICETEEEM) (pp. 104-108). IEEE
13. Manoj, V. (2016). Sensorless Control of Induction Motor Based on Model Reference Adaptive System (MRAS). International Journal For Research In Electronics & Electrical Engineering, 2(5), 01-06.
14. V. B. Venkateswaran and V. Manoj, "State estimation of power system containing FACTS Controller and PMU," 2015 IEEE 9th International Conference on Intelligent Systems and Control (ISCO), 2015, pp. 1-6, doi: 10.1109/ISCO.2015.7282281
15. Manohar, K., Durga, B., Manoj, V., & Chaitanya, D. K. (2011). Design Of Fuzzy Logic Controller In DC Link To Reduce Switching Losses In VSC Using MATLAB-SIMULINK. Journal Of Research in Recent Trends.
16. Manoj, V., Manohar, K., & Prasad, B. D. (2012). Reduction of switching losses in VSC using DC link fuzzy logic controller Innovative Systems Design and Engineering ISSN, 2222-1727
17. Dinesh, L., Harish, S., & Manoj, V. (2015). Simulation of UPQC-IG with adaptive neuro fuzzy controller (ANFIS) for power quality improvement. Int J Electr Eng, 10, 249-268.