Study and Investigation on Recent Trends in Electric Vehicles

Sumedh Sunil Vidhate[1] Mohan Kulkarni[2]
[1]Student [2]Assistant Professor
[1,2]Department of Mechanical Engineering
[1,2]MIT School of Engineering, Loni Kalbhor, Pune, India

Abstract— As in the era of 21st century, more numbers of industries rising and with these industries there are many innovations been made to help the mankind. With the rising industrialization the production cost and time both are decreased to a great extent. As industrialization occurs the use of resources like petrol and gas or fossil fuels increases drastically. With industrialization there is also increase in number of internal combustion engine cars which has led to more load on the nature resources like petrol diesel and natural gas. The other problem with the internal combustion engine is the pollutants that are released by them. For resolving these problems, the electrical cars come into picture. An electrical vehicle comprises a traction motor, starter motor, and a battery bank controlled by a microprocessor in support with the vehicle's instantaneous torque required so that the engine is run only under conditions of high efficiency. All electric vehicles run on the energy stored in the battery. These batteries are connected to a motor and direct power supply is given to motor by the batteries. Each wheel may have different motors or all the power is transferred to the wheels by a single motor and mechanical linkages. The advantage of all electric vehicles is that they are zero emission vehicles. But all electric vehicles are not solution as they only reduce the pollutants. The major issue of all electric vehicles is that the current battery technology is not capable of producing Electric Vehicles (EVs) which can compete with current generation automobiles.

Keywords: Electric Vehicles (EVs), Direct Wheel Motor

I. INTRODUCTION

As we all have entered 21st century the environmental problems are increasing day by day. There is large load of the fossil fuels. Fossil fuels are used at many places like power generation and mostly in Internal Combustion Engines. Today the number of vehicles on road is increasing day by day on rate scale. In the case of developed and developing countries 22% of rise of vehicles occur every year and the road sizes are the same as the before which has led to traffic jams. The main source of pollution is these Internal Combustion Engines. There should be a stop to these engines as they pollute the environment as well as they run on fossil fuels which are going to finish in few years. Replacement to this is the ELECTIC VEHICLES. The electric vehicle runs on the battery and electric motor. There is no emission of harmful gases as there is no combustion of fuel. The battery stores the electric energy, this energy is passed to motors and from motors it is passed to wheels. These electric vehicles are also known as the green vehicles. In develop countries and in developing countries efforts are made to increase the number of electric vehicles so the internal combustion engines get less and we can tackle the increasing environmental problems.

II. LITERATURE REVIEW

A. *Direct Drive and in Wheel Motor*

K.W.E Chengl et al. [1] direct drive reduces the loss in the mechanical units of the drive train. The motor is connected directly to the shaft to reduce needs of transmission, clutch, and gear box.Recently the in-wheel motor is promoted by researcher. The in-wheel motor is to tum the rotor inside out and attached to the wheel's rim and the tire. There is no gear box and drive shaft. The motor is also called wheel-hub motor. Its main advantage is the independent control of each wheel. Each of the wheels works any speed and direction.

Fig. 1: Direct wheel motor

B. *Future Trends on Batteries of Electric Vehicle*

Farhan Faisal et al. [2]. Says Lithium ion batteries can significantly improve range of EV. They are capable of high energy density. Researchers say that it could hold 5-10 times the energy of lithium ion battery. They have an energy density of 2000-3500wh/kg. Here anode is lithium and air cathode made of porous material draws O_2 from surrounding lithium combines with O_2 and form lithium oxide and release energy. Toyota and BMW have announced a joint program in research in lithium air batteries and it will have a range of 500 miles per charge

K.W.E Chengl et al. [1] Capacitor is basically a static component. There is no chemical reaction in the components. Its charging and discharging speeds are very fast. However, the energy storage is limited. Its energy storage density is less than 20% of the lead-acid battery. Although the expected ultra-capacitor density will go up in next few years, its total solution for main energy storage is a challenge. The number of cycles and the temperature range is excellent.

Kwo Young, Caisheng Wang [6] concerns over the driving range have been addressed by improving battery technology. Energy densities in batteries have been improved by almost 400% and automobile manufacturers like Tesla Motors have aimed to break the USD 100/kWh mark by 2020.As a result of this improvement, costs have also been lowered as seen in fig, where Li-ion batteries are the dominant chemistry. Moreover, range anxiety issues have been addressed because the average American commutes 40 miles every-day, which is half the range of a Nissan Leaf, thereby providing for more than sufficient energy availability for driving. It can be noted that the battery costs have reduced by 73 percent since 2009 for seven years, and has been projected to decrease by another 58 percent for the next seven years till 2023, thereby boosting the range of an EV overcoming range anxiety issues.

C. Advanced Charging Control Strategies

Fan Zhang et al. [4] charging process of the battery system may be affected by a large number of nonlinear factors, especially when it is a part of a dynamical system. These nonlinear factors are produced by electronic devices, high-frequency transformers, and pulse modulators etc. However, the control theory of the charging process is based on a small-signal model, which is linear and cannot satisfy the requirements of system reliability. As mentioned in the previous section, system reliability in terms of charging voltage and current is crucial for charging an electric vehicle. Therefore, nonlinear control strategy is most suited to be used in this scenario. With the development of microprocessors in recent years, it is possible to apply complex control strategies in high frequency switching converters, e.g. chaos control, neural network control, and fuzzy control strategies. It may be possible to extend these advanced control theories, combined with conventional PID control, to the designs of battery systems and charging piles in order to meet the charging requirements of reliability, precision, and battery aging.

D. Wireless Charging Techniques

Fan Zhang et al. [4] In order to provide a more convenient charging service for electric vehicles, a wireless charging technique is proposed. This technique employs the coupled magnetic field to transmit power without physical connecting. Nowadays, three wireless charging methods are frequently used to charge an electric vehicle. First, electromagnetic induction can be used to convert electrical power to magnetic power and then back to electric power. The fundamental theory of wireless charging using electromagnetic induction is quite similar to that of the transformer. The advantage of this charging method is its simplicity and maturity. Its disadvantage is the small maximum charging distance between the charging pile and the electric vehicle. Moreover, the reliability of this method is still questionable. The second wireless charging method utilizes the theory of electromagnetic resonance and the charging distance of this method is generally larger than the first method. However, the practicability of the second method is still negligible.

E. The Impacts of EV Charging and Discharging on the Operation of the Power Grid

1) The Impact of Load

EV technology gradually mature and large scale utilize, the application may cause the local load increase of the power distribution network [5]

2) Impact on the Environment and Health

EV in the large current centralized charging process, the high voltage electromagnetic radiation near platform line substation may have an impact on the surrounding environment and human health [5].

3) Impact on the Capacity of the Power Grid

With the increase of load, will increase the burden of power, transmission and distribution system, installed capacity and power transmission equipment, it also makes adjust correspondingly [5].

4) Impact on Power Quality

EV access use increases the corresponding charging equipment, including a large number of highly nonlinear power electronic device, when the charger for EV charging, DC between the three-phase AC constant commutation will generate harmonic, harmonic current may pollution power grid and electrical equipment and can influence the power quality of distribution system [5].

5) Electric Vehicle Trend in India.

K.V.Muralidhar Sharma et al [3]. In India the sales of electric vehicles are around 1%. Indian road is dominated by the conventional vehicles. The Indian EV industry is in the back seat because of the different challenge faced which are similar to the other developing countries. Price of the battery and cars are the major obstacle for the sales of the EV in India. The price of EV is 2.5 times the normal car in India. The life of the battery of the car is only 5 to 6 years which adds to the cost of the maintain of the vehicle. Besides the cost the major barrier is the range of the electric vehicle. The other major proper is the lack of the infrastructure for charging of the EV. The government has to plan a proper layout for the charging of the EV. Plus the charging station must be rugged and inexpensive

III. METHODOLOGY

A. Basic Structure of Power Train of Electric Vehicles

The battery is the main energy storage. The battery charger is to convert the electricity from mains to charge the battery. The battery voltage is DC and I is inverted into switched-mode signal through power electronic inverter to drive the motor. The other electronic components in a vehicle can be supplied to the battery through DC-DC converter that step down the voltage from the battery pack to lower voltage such as 5V-20V [1].

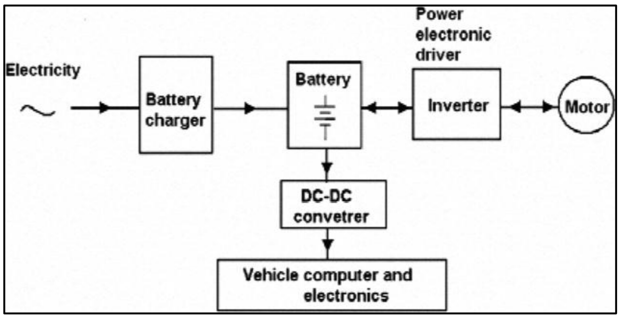

Fig. 2: The key components of an Electric Vehicle.

B. Motors Used for Electric Vehicles

1) Induction Motor

It is a very popular AC motor. It also has a large market share in variable speed drive application such as air-conditioning, elevator or escalator. Many of the higher power electric vehicles, for more than 5kW, use induction motor. Usually a vector drive is used to provide torque and speed control[1].

2) DC Brushless Motor

The conventional DC motor is poor mechanically because the low power winding, the field, is stationary while the main high-power winding rotates. The DC brushless motor is "turned inside out. The high-power winding is put on the stationary side of the motor and the field excitation is on the rotor using a permanent magnet. The motor has longer life time than the DC motor but is a few times more expensive. Most of the DC motor can be replaced by the brushless motor with suitable driver[1].

C. Basic Terms of Battery Performance and Characterization

Various terms have been defined for batteries to characterize their performance. Commonly used terms are summarized in the following as a quick reference. Cell, Module, and Pack. A single cell is a complete battery with two current leads and separate compartment holding electrodes, separator, and electrolyte. A module is composed of a few cells either by physical attachment or by welding in between cells. A pack of batteries is composed of modules and placed in a single containing for thermal management. An EV may have more than one pack of battery situated in a different location in the car[3].

Ampere-hour Capacity. Ampere-hour (Ah) capacity is the total charge that can be discharged from a fully charged battery under specified conditions. The Rated Ah capacity is the nominal capacity of a fully charged new battery under the conditions predefined by the manufacturer. A nominal condition, for example, can be defined as 20^0C and discharging at 1/20 C-rate. People also use Wh (or kWh) capacity to represent a battery capacity. The rated Wh capacity is defined as Rated Wh Capacity= Rated Ah Capacity x Rated Battery Voltage

Specific power, also called gravimetric power density of a battery, is the peak power per unit mass. It is expressed in W/kg as

Specific Power = Rated Peak Power x Battery Mass in kg

Specific Energy. Specific energy, also called gravimetric energy density, is used to define how much energy a battery can store per unit mass. It is expressed in Watthours per kilogram (Wh/kg) as

Specific Energy = Rated Wh Capacity x Battery Mass in kg.

Power Density

Power density is the peak power per unit volume of a battery (W/l)[3].

Energy Density

Energy density, also referred as the volumetric energy density, is the nominal battery energy per unit volume (Wh/l).

D. Batteries Used in Electric Vehicles

1) Lead Acid Battery:

It is the most commonly using battery in conventional automobiles. It is also mentioned as Pb-acid battery. Its operating temperature range is-10 to 500C.Heat capacity and mass density is 0.35Wh/kg-K and 2.1kg/litre. Specific energy and specific power is 30- 40Wh/kg and ≈200W/kg. Energy density and Power density is 70-75Wh/litre and ≈400W/litre. Cycle life is 500 to 1000 and Annual life is 5-8 years. Cost of the battery is 30,000 Rs/kWh[2].

2) Lithium Ion:

It is also mentioned as Li-ion battery. Its operating temperature range is10 to 45^0C. Heat capacity and mass density is 0.38Wh/kg-K and 1.35kg/litre. Specific energy and specific power is 90-120Wh/kg and 200- 220W/kg. Energy density and Power density is 200-250Wh/litre and 400-500W/litre. Cycle life is 500 to 1000 and Annual life is 3-5 years. Cost of the battery is 180,000 Rs/kWh[2].

3) Lithium Polymer:

It is also mentioned as Li-polybattery. Its operating temperature range is 50 to 70^0C. Heat capacity and mass density is 0.40Wh/kg-K and 1.35kg/litre. Specific energy and specific power are 100- 200Wh/kg and >200W/kg. Energy density and Power density is 150-300Wh/litre and >350W/litre. Cycle life is 500 to 1000 and Annual life is 2-4 years. Cost of the battery is >180,000 Rs/kWh[2].

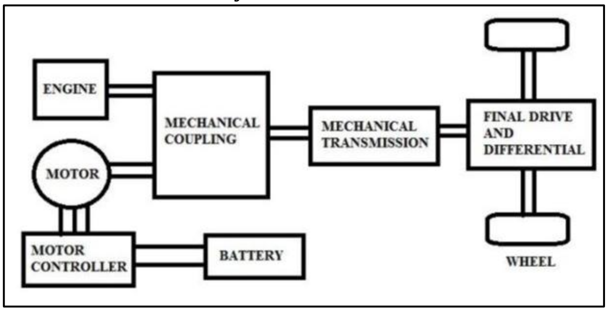

Fig. 3: Block Diagram of EV.

E. Charging of the batteries of electrical vehicles

1) Charging by Constant Current and Constrained Voltage:

This charging model is used for the battery system consisting of batteries in series. However, the charging process is nonlinear so that the lifetime of the battery charged in this way would be shortened. Another disadvantage is the low overall charging rate in comparison with other models[4]

2) Charging by Constant Voltage and Constrained Current:

The most evident advantage of this model is that the charging time would be much shorter than the first model. However, by employing this model, the initial current would be much larger; and potentially damaging to the electric apparatus inside the battery system [4].

3) Fast Charging:

This charging model uses periodic current pulse and a large negative current pulse to depolarize the battery. This model may increase the charging rate, but has a detrimental effect on the battery lifetime [4].

4) Three-Stage Charging:

In this model the charging process is divided into stages. At the first stage, constant current is employed to charge the battery system until the terminal voltage reaches its rated value. Secondly constant voltage is applied and the current keeps decreasing [30]. This model can be regarded as a compromise between the first and second models[4].

IV. CONCLUSION

There is a large boost in the development of the EVs as the load on the fossil fuel is increasing day by day. Carbon level has hit alarming level in 2016 only. EV is the only solution to this. There are efforts made in the battery technology so that the range of the EVs will increase. The main challenges are faced in the battery section of the car hence companies are collaborating with each other to develop battery technology. Another problem faced is the charging of the EVs. Researches are made to reduce the charging time of the batteries of the EVs. Making availability of charging station of EVs is another challenged faced. The rise of EVs since the late 20th century in some developed nations has sparked a movement for mass adoption in some developed nations. As the developing are also adopting the EV culture and making changes according to the need infrastructure for EVs. People are not ready to accept the EVs as the batteries part which makes the car costlier than the combustion engine. As there is development in the batteries the cost of the batteries is reducing which ultimately reduces the cost of the EVs. EV is necessity of world as to reduce the pollution and for a greener future.

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