SWITCHING OF ICEV TO EV

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Abstract - *Global population with current trending may increase from 6 billion to 10 billion by 2050. It means the vehicles in use may increase from 700 million in 2000 to 2.5 billion in 2050. If all these vehicles are ICEV's then all cities may be covered with permanent smog with extreme air Pollution. 2011 ARB report states that around 9000 people per year die due to fine particle matters in California. The promising solution is Sustainable transport (ie) low or zero emission vehicles; promotion of public transport; renewable energy sources (less dependence on fossil fuels).*

Key Words: Electric Battery, motor drive, grid technologies, charging and swapping, Li-ion batteries.

1.INTRODUCTION

India stands 14th in the 20 most polluted cities in the world. The one such reason of pollution is the usage of petrol and diesel. The cost of petrol and diesel also rapidly increases as how our air pollutes. Therefore if this is altered by E-vehicles the cost and the rate of pollution can be reduced. It is observed that the Electric Vehicle is four times as energy efficient as Internal Combustion Engine. The motor efficiency of ICE is 22 or 23 percent whereas the motor efficiency of EV is 90%. Consuming and wasting energy impact more the world than impacting a small area. The another advantage of E-Vehicle ,it consists of 50 times lesser moving parts. Using of Lithium-ion battery may results in high energy density with less cost and usage of raw material. The problem arises in case of the battery. The size and weight of the battery is much higher than the normal petrol tank.Hence if the battery usage is taken into account E-vehicle would help us much better to move towards pollution free world.

2. LITERATURE SURVEY:

In order to finalize the work ,the reviews of literature have been taken. In this paper 1, Hybrid E-vehicles integrate both internal combustion engine and E-vehicle. From this ,it is observed that it has less emission than gasoline car. This hybrid E-vehicle runs at maximum efficiency.[1]

In paper 2, Intelligent battery management system and charging -charging and discharging of the battery is important, avoid thermal run away ,the working of microcontrollers is observed. Innovative power stage components to optimize the performance of E-vehicle is used.[2]

In paper 3, design and management of battery ,Li-ions battery and their modeling ageing, cell balancing ,battery monitoring ,their life-time, state of charge, health and function. Through this review in battery management system ,the life-time and energy availability ,cell modeling ,state of charge estimation is observed.

3.HISTORY OF E-VEHICLES

In 1834 ,the first non rechargeable battery operated EV was built by Thomas Davenport. After invention of lead acid battery a rechargeable battery based EV was built by David Salomons in 1874.Twelve years later first electric trolley system was built by Frank Spraguein in 1886.In 1900 among 4200 automobiles sold in USA,38% were EV,22% were cell modeling and 40% were steam powered vehicle. Several companies in US, England and France made EV's by 1900.Electric carriage and Wagon company came up with Electrobat in 1894.Pope Manufacturing company in US came up with Columbia in 1898 . Rike Electric Motor Company US came up with Victoria in 1897.BGS in France developed many types of EV's with a world record of

290km/charge. One among the famous one of them was Jamais Content with 110km/charge. By 1912 nearly 34000 EV's were registered in US . But unfortunately EV was disappeared by 1930.Henry Ford mass produced Ford Model T in 1925 and reduced its price by one third to price in 1999.This made EV costlier compared to ICEV. The second development was invention of automobile starter motor by Charles Keetering. This made ICEV user friendly compared to EV's .Later air pollution led to worst smog in London and Arab oil embargo increased demands for alternate energy needs. Many automobiles in US, Japan and Europe started development of EV's. General motors built number of EV's such as Electrovair in 1966, Electrovan in 1968 and Electrovette in 1979. Recently Ford, Nissan,Toyato,Fiat and BMW have developed EV's. The current popular EV's are Tesla Roadstar ,Model-3,Nissan leaf,Chevy bolt and BMW i3.

4.TYPES OF ELECTRIC VEHICLES

Electric vehicles can be classified in not various ways such as propulsion devices; energy sources and energy carriers etc. Based on propulsion devices Electric Vehicles can be classified as Pure Electric Vehicles and Hybrid Electric Vehicles. The Pure Electric Vehicles use electric motor as the soul device for propulsion whereas in Hybrid Electric Vehicles both the Electric motor and engine are used for propulsion. On the basis of energy sources they are classified as Hybrid Electric Vehicles(HEV), Battery Electric Vehicles(BEV) and Fuel cell Electric Vehicles(FCEV).The HEV uses liquid fuels and battery as energy sources. The BEV uses battery as the soul energy source. FCEV uses fuel cell and battery as the energy sources. The Pure Electric Vehicles are Battery Electric Vehicles; Fuel cell Electric Vehicles; Ultra Capacity Electric Vehicles; Ultra Flywheel Electric Vehicles. The Hybrid Electric Vehicles can be classified as Conventional Hybrid Electric Vehicles and Grid Able Hybrid Electric Vehicles. The Conventional Hybrid Electric Vehicles are classified as Micro Hybrid; Mild Hybrid and Full Hybrid. Full hybrid is classified as series hybrid; parallel hybrid; series parallel hybrid and complex hybrid. The Grid Able Hybrid Electric Vehicles are classified as Plug in Hybrid and Range Extended Electric Vehicles.

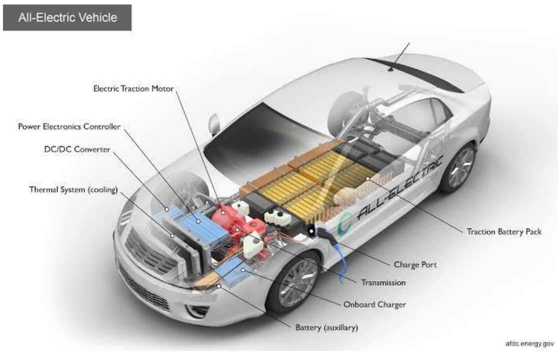

Fig - 1: All Electric Vehicles

4.1.Battery Electric Vehicle:

The battery bank in the BEV is normally charged directly from the grid using a battery charger and the Electrical energy stored in the battery is transferred to the wheels using an electric drive consisting of a power converter in the Electrical machine via transmission gears and differentials. This power converter has to be designed to carry bidirectional power flow since it can also be used to regenerate the power coming from the wheels during braking. The clutch is not required in BEV

4.2 Fuel cell Eletric Vehicles:

Fuel cell is used as the source of energy that is been connected to the hydrogen tank. The boost converter is used to step up the voltage of the fuel cell to charge the battery and store the energy. The electric drive and the mechanical propulsion system is similar to the BEV. The Battery bank allows fuel cell to operate in optimum efficiency and it can support the transient mechanical energy requirements in the wheels; store regenerative energy during braking since fuel cell is incapable of store the regenerative energy.

5.ELETRIC MOTOR DRIVE TECHNOLOGIES

IC engine requires the support of clutch and multiple transmission gears to achieve multiple speed and multiple top profiles required in a vehicle application. When the clutch is engaged, the IC engine is coupled to the gearbox and the energy is transferred from the IC engine to the wheels using gear box. So when different speed and torque is be delivered from IC engine, the clutch is disengaged and different gear is used to meet the requirements such that the required torque and speed is used. So a typical IC engine vehicles require multiple gear system. The force speed characteristics offered by the Electric motor with the fixed gearing it can be seen that the electric motor readily provides high torque at the beginning and high speed with reduced torque. This can be achieved in Electric Vehicles without variable gears and clutch. Thus BEV does not require complex gearing. It also provides smooth driving and high transmission efficiency when compared to the ICEV. The typical industrial motor gives maximum torque equal to twice the rated torque of the machine. But the maximum torque requirement of the EV motor is 4-5 times the rated torque of the motor. The maximum speed of the industrial motor is two times the rated speed of the motor whereas in EV the maximum speed is 4-5 times the rated speed. EV motors demand high power density and good efficiency map (high efficiency over speed and torque ranges)for the reduction of the total vehicle weight and the extension of driving range. EV motors desire high controllability, high steady state accuracy and good dynamic performance. It also needs to operate in harsh operating conditions such as high temperature, bad weather and frequent operation. The major requirements of an EV motor are high torque density and power density; very wide speed range including constant torque and constant power regions; high efficiency over torque and speed ranges; reliability and robustness with low acoustic noise; low cost.

6.ELETRIC VEHICLE ENERGY SOURCE TECHNOLOGIES

The four energy sources used in EV's and HEV's are batteries; ultra capacitors; ultra flywheels and fuel cells Ultra capacitors store energy as Electrostatic force. Ultra flywheels are essentially electrical machines spinning at very high speed and thus storing the energy in the form of kinetic energy. Fuel cell uses hydrogen as the fuel and stores the energy electrically. Ragon plot is used to analyse the performance comparison of energy sources. In which specific charge determines the driving range/charge and specific power determines the acceleration rate. Batteries are compared based on the specific energy; specific power; cycle life; cost. Similarly the onboard renewable energy sources are braking energy, solar energy, waste heat energy and vibration energy.

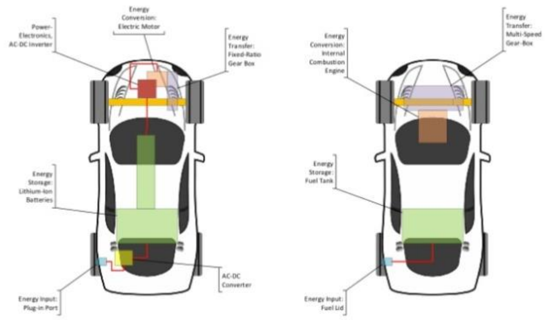

Fig - 2: EV vs ICE powered cars

7. ELECTRIC VEHICLE TO GRID

Vehicle to Grid is an emerging technology comprising grinding electric vehicles, utility grid or power systems and information technology. In hybrid vehicles PHEV and REV can be charged either by filling stations or by grid whereas BEV can be charged only by grid. EV can communicate with the grid to deliver power to the grid and to control the charging rate. EVs are unused 95% of time and each EV can store/generate 4KW to 80KWhr.It minimises the power demand and losses. It also optimises voltage deviation and total harmonic distortion. It is observed there will be a bidirectional energy flow between vehicle to vehicle; vehicle to homes and the aggregator will see the dynamics and energy flow within this pools of arms and vehicles. Vehicle to Grid technology has lot of application in power systems like coordinated charging; peak shaving; active regulation; spinning reserve; motor starting; reactive regulation and renewable transients etc.

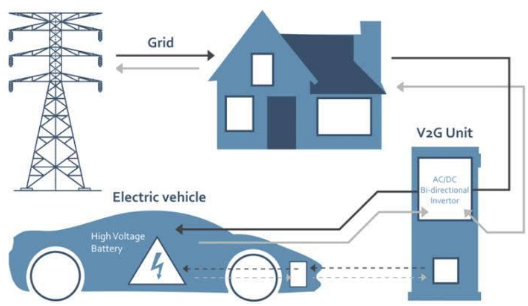

Fig - 3: Electric Vehicle to Grid

8. ELECTRIC BATTERY

The battery been used in electric vehicles when compared to the petrol tank the energy is 10 times heavier and the volume is 7 times higher. As the energy density increases the cost get decreased. The energy efficiency of the vehicle can be improved by improving the motors and controllers; by improving the tyres and aerodynamics the energy density can be improved. Larger batteries required large range and the cost too is found to be high whereas the small batteries require small range and the cost too will be reduced but whereas the charging takes place for a long time instead filling petrol in the tank happens in a few minutes. Hence swapping battery is the next idea where the battery can be swapped in necessary cases us been considered. The number of charge and discharge of a battery cycles usage depends on the rate of charging and discharging; temperature usage(below and above 25°C are not possible);depth of discharge (charging and discharging for a particular limit) and calendar life. State of health is a measure of battery capacity remaining as compared to the initial capacity as the battery is used. A EV battery at the end of its life, it's capacity get reduced to 75-80% of initial capacity will surely limit the vehicle range to 75-80% of its initial value. Battery life depends on rate of charging, when charged slowly it has best life and in case of fast charging impacts the battery life. Typical battery life consists of 500-2000 charge-discharge cycles. The size of the battery and the number of the cycles must be used based on the usage. Batteries with high range and 600 km can be charged quicker and expensive.

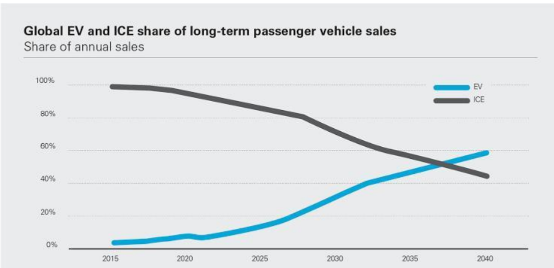

Fig - 4: Global EV and ICE share of annual sales

9. CHARGING AND SWAPPING INFRASTRUCTURE

It is necessary to think about the standardisation of charging and discharging the battery. So the things that to be standardised are the connector (socket or plugs); maximum voltage, power and current; communication to vehicle and energy supplier; charging operator or utility manager; billing customer and protection. In case of swapping batteries the size and weight of the battery is taken into account. Energy Operator sets up swapping batteries infrastructure in specific locations where the battery is been charged and discharged in a particular location and they also enrol the customer who takes battery from them. Hence in these places rather than single chargers, bulk chargers play a major role where the customer pays for the energy been used and the charges will take into account depreciation and interest cost for purchased batteries, infra costs, electricity costs and operation cost besides EO's operator. Swappable batteries are charged in such a way that they can't be charged in anywhere except by EO at its bulk chargers(Locked Smart Batteries).The charging strategy for best battery life is charging slowly at night because at night times temperature is found to be less and the time taken to charge also be quiet large or it can be charged partially in case of parking slots of the company.15 amp Single phase charger is best upto to a range of 3kw whereas in case of 6kw to 20kw three phase of larger battery is been used. Petrol pumps cannot be changed into EV charging places whereas the in case of filling petrol it takes 3-4 mins whereas in case of EV charging requires time and the place would be crowded. In alter to that it can be charged in parking lots, offices and shopping malls and in case of slow public chargers multi storied buildings are been used.

10. EV SUBSYSTEM

Body and frame of the existing ICE car; existing door and power windows; improves the wheels by rolling resistors including all the wheel components like rim,hub,knuckle and tyres; suspension system existing system including the lower arm and struts; power steering system (from hydraulic to electric); power braking system (hydraulic to electric)-vacuum pump to actuate the braking system; safety system-all airbags and parking sensors; wipers and fluid pump-existing viper liquid pump and vipers; Mirrors(electronic or manual);interiors-all interiors including seats,seat belts,A/C vents,cabin lights and other interior components. These are found to be same in the existing system.

The parts and components that should be modified are:
1.Air conditioning system: Integration of variable speed DC motor for existing hydraulic actuated AC compressor.
2.Cooling system: Can be reused for motor and batteries with electric water pump integration.
3. Some variations in the dashboard

Parts and components to be removed are:
1. Fuel tank: Remove fuel tank and associated connections.
2. Engine: Remove engine and associated connections like sensors.
3. Clutch and transmission: Since single speed transmission system is used, it should be removed.
4. ECU and connections other sensors
5. Fuel pump and other engine subsystems.

Parts and components to be added are:
1. Electric motor: High performance electric motor used for propulsion.
2.Motor Controller: Motor controller for motor drive with closed loop feedback system.

11. USAGE OF LITHIUM ION BATTERY

To select a battery, battery capacity, state of charge of a battery plays a vital role. The capacity of battery is affected by the aging or time; charging or discharging. Most Li battery functions best as it has maximum number of life cycles. Its temperature of usage is 25°C;it's C rate is less than 0.1C;it's battery charge-discharge is in between SoC of 10% and 80%.If charging and discharging at higher rate,it affects the life of the battery.

12. BENEFITS OF USING EV'S

The promising solution of pollution is Sustainable transport (ie) low or zero emission vehicles; promotion of public transport; renewable energy sources (less dependence on fossil fuels).

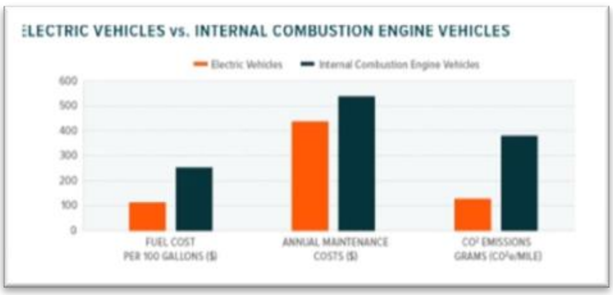

Fig - 5: Fuel cost, Maintainence costs, CO2 emissions

The benefits of using EV'S are

- Energy sources
- Pollution
- Energy diversification
- Efficiencies
- Capital /operating cost
- Performance

There are various types of pollutants and greenhouse gases which are released as emissions from vehicles and they are particulate matter,CO,CO2,CH4,NOx, Volatile organic compound, Total hydrocarbon and SOx. These are some of the reasons of switching into EV. The battery electric vehicles have an efficiency of 72% whereas the fuel cell electric vehicles have an efficiency of 40% and IC engine vehicles have an efficiency of 16%.If the source of the energy (ie) cent percent crude oil ,the efficiency in the wheels of the Battery EV's are 18% whereas the efficiency of the IC engine vehicles are 13%.

13. CONCLUSION

The battery electric vehicles has advantage of higher fuel economy than the ICEV. They are more expensive than ICEV due to the high initial battery cost and replacement of battery after years. It requires less maintenance and is more reliable. It can recover energy during braking and it is also less noisy. It allows high performance and smooth control .It requires charging and has limited range per charge. It can be charged by renewable sources such as solar. For the same energy requirement, BEV requires more space and it's heavy.

REFERENCES:

[1] M.Viswanth, K.M.Arunraja, K.Lakhan Raj , "A Literature review on Electric Vehicles," in IJERT , ISSN:2278-0181, 2018
[2] Sang Chon, Jon Beall," Intelligent battery management and charging for electric vehicles " in Texas Instruments.2017.
[3] M.Brandl, M.Wenger, F.Baronti, A.Thaler, "Batteries and Battery Management Systems for Electric Vehicles " in Research gate , 2012.