Conversion of an IC Engine Vehicle into Electric Vehicle

K. S. Sathish Kumar[1], Franklin Xavier. A[2], Avinash. R[3], Muthupitchiya. P[4], Jerrin K Abraham[5]
[1.] Associate Professor,
[2,3,4,5] Final Year B.E, Department of Mechanical Engineering,
Park College of Engineering and Technology, Coimbatore

Abstract— **After more than a century of ruling the roads, oil is starting to lose its dominance over the automobile industry due to increasing oil prices and depleting oil resources. In June 2018, India announced that it would end sales of gas and diesel cars by 2030. So there is no doubt that the electric vehicles are going to be next revolution in automobile industry. It is also estimated that the discovered oil resources have reserves only for the next 50 years. So we developed a guideline for converting IC engine vehicle to electric vehicle which would save the IC engine vehicles from going to scrap when all the oil resources get depleted and also save the cities from pollution.**

Keywords— IC Engine, Battery, Electric vehicle, Motor, Charger, Conversion.

I. INTRODUCTION

Global oil reserves are getting drained. It is estimated that the discovered oil resources have reserves only for the next 50 years. Whereas, it is expected an increase of the overall vehicles number from 700 million to 2.5 billion during the same period [1],[2] .The price of the oil is skyrocketing day by day. The prices of the fuels are very high for the common people to afford. More and more automakers are introducing electric models, and according to one report, sales of electric cars will surpass those of regular cars within twenty-five years. China, India, France and the United Kingdom have all shown support for moving away from gas-powered vehicles. In June 2018, India announced that it would end sales of gas and diesel cars by 2030. The fossil fuel powered vehicles are the major source of environmental pollution. Seventy-five percent of carbon monoxide emission comes from automobiles. In urban areas, harmful automotive emissions are responsible for anywhere between 50 and 90 percent of air pollution. So electric vehicle is the only solution to overcome these problems

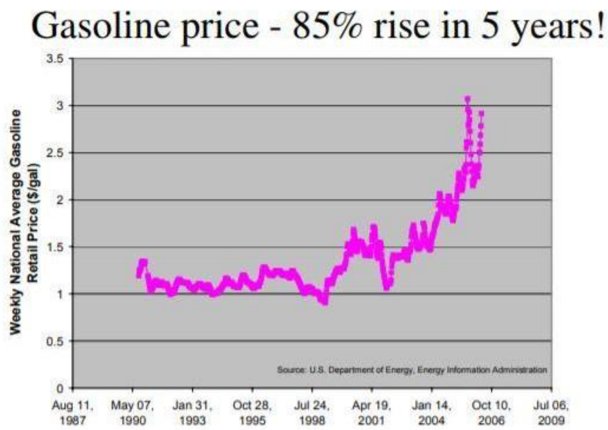


Fig. 1 Comparison of gasoline prices over the decades

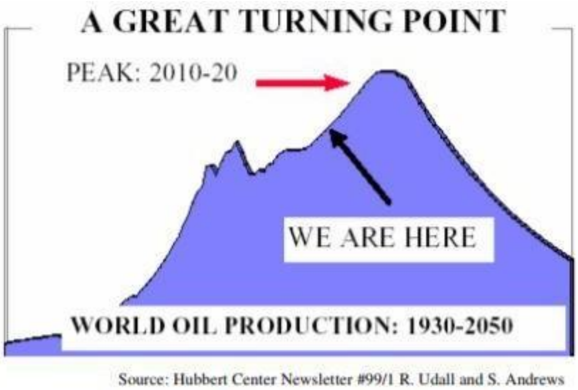


Fig. 2 World Oil Production

II. ELECTRIC VEHICLE

Hybrid Electric vehicles (HEV) are very popular in the last decade which uses both electric motor and an IC engine [3]. It generates the required power to drive the motor from the IC engine. But it also has emission problems due to the use of the IC engine. Battery Electric vehicles (BEV) are based on electric propulsion system which only uses the power from the motor to drive the vehicle. No internal combustion engine is used here, so there will be no emissions

III. ELECTRIC VEHICLE COMPONENTS

Control of Electric Vehicle (EV) is not an easy task since it changes with respect to time [4]. Therefore, the controller should be robust and adaptive, improving the system on both dynamic and steady state performances. Currently, the major limiting factor for wide-spread use of EV's is the mileage per battery charge. Hence, besides controlling the performance of vehicle significant efforts have to be paid to the energy management of the batteries on the vehicle. The remarkable merit of EV's is the electric motor's excellent performance in motion control, torque generation is very quick and accurate hence electric motors can be controlled much more quickly and precisely; output torque is easily comprehensible, motor can be small enough to be attached to each wheel; and the controller can be easily designed and implemented with comparatively low cost.

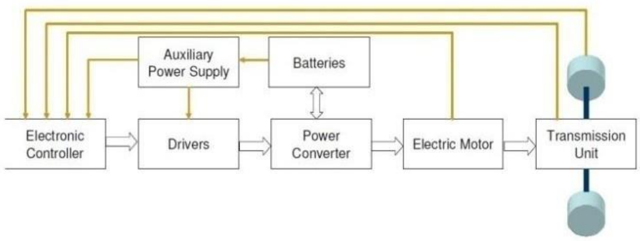


Fig. 3 Components of EV

IV. THE MOTOR

There are a number of motors available for electric vehicle: DC motors, Induction motor, DC brushless motor, Permanent magnetic synchronous motor and Switched reluctance motor.

1. DC motors:
It is a classical motor and has been used in motor control for a long time. All the power involved in electromechanical conversion is transferred to the rotor through stationary brushes which are in rubbing contact with the copper segments of the commutator. It requires certain maintenance and has a shorter life time. However, it is suitable for low power application. It has found applications in electric wheel- chair, transporter and micro-car. Today, most of the golf-carts are using DC motors. The power level is less than 4kW.

2. Induction motor
It is a very popular AC motor [5]. 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, uses induction motor. Usually a vector drive is used to provide torque and speed control.

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 [6], [7]. 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. Presently, its applications find in low power EV.

3. Permanent magnetic synchronous motor
The stator is similar to that of an induction motor. The rotor is mounted with permanent magnets. It is equivalent to an induction motor but the air-gap filed is produced by a permanent magnet. The driving voltage is sine wave generated by Pulse Width Modulation (PWM).

4. Switched reluctance motor
It is a variable reluctance machine and it became famous recently because of the fault tolerance because each phase is decoupled from other[8]. Each phase winding is connected in a flyback circuit style.

V. ENERGY STORAGE SYSTEM

1. Battery
Electric-vehicle batteries differ from starting, lighting, and ignition (SLI) batteries because they are designed to give power over sustained periods of time [9]. Deep-cycle batteries are used instead of SLI batteries for these applications.. Compared to liquid fuels, most current battery technologies have much lower specific energy, and this often impacts the maximal all-electric range of the vehicles. However, metal-air batteries have high specific energy because the cathode is provided by the surrounding oxygen in the air. Rechargeable batteries used in electric vehicles include lead–acid , NiCd, nickel–metal hydride, lithium- ion, Li-ion polymer,and,less commonly, zinc–air and molten- salt batteries. The most common battery type in modern electric cars are lithium-ion and Lithium polymer battery, because of their high energy density compared to their weight. The amount of electricity (i.e. electric charge) stored in batteries is measured in ampere hours or in coulombs, with the total energy often measured in watt hours.

2. Ultracapacitor

An ultracapacitor, also known as a supercapacitor, or electrochemical capacitor, is a device for storing electrical energy which is growing rapidly in popularity. The design and mechanism of operation is somewhere between an ordinary capacitor and a battery, which opens up some interesting and valuable applications.

VI. CHARGING SYSTEMS

1. General charger
The charger needed for the battery system for slow charging or fast charger are both required to handle high power. The H-bridge power converter is needed [10]. The converter is famous for its efficiency and has found application in charger and DC-DC converter.

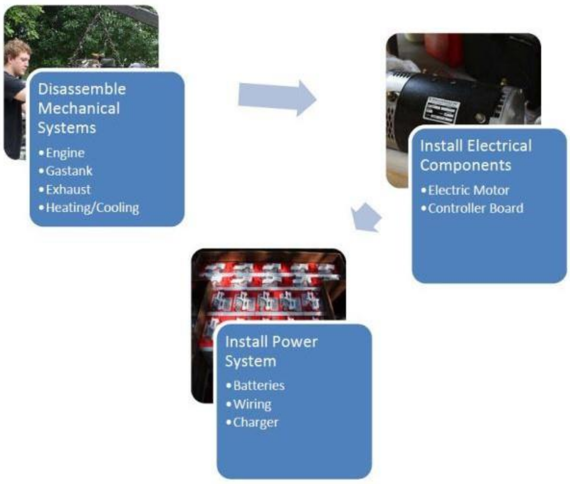
2. Ultra-capacitor charger
The voltage on the ultra-capacitor various from the full-voltage to zero when nits energy storage varies from full to zero. This is different from the battery as its voltage will only varies within 25%. The capacitor voltage is internal point and is not in contact with users. The transformer isolated converter is not necessary. A tapped converter should be used as it will have higher efficiency for power conversion [11]. The efficiency of the power converter is higher than the transformer-isolated version. The structure is simple.

3. Battery management systems
It is also referred as BMS. The battery system is formed by a number of battery ells. They are connected in parallel or series that is according to the design. Each of the cell should be monitoring and regulated. The conditioning monitoring includes the voltage, current and temperature. The measured parameters are used to provide the decision parameter for the system control and protection. Two parameters are usually provided. They are the state of charge (SoC) and the State of Health (SoH). SoC is like the oil tank meter that provides the battery charging condition. It is measured by the information of voltage and current. The SoH is to record the health or aging condition. Cell balancing is to ensure each cell is operating under the same conditioning or a regulation is used to charge or discharge each cell by the balancing control. This avoids the overload of a particular cell

4. Energy management systems
Even for ultra-capacitor system, the energy storage is made by a number of capacitors or in a combination with other energy storage devices such as battery. The same conditioning monitoring and management system will be used.

VII. EV CONVERSION PROCESS

The conversion process is shown. The gasoline engine, muffler, catalytic converter, tailpipe, and gas tank were removed. The clutch assembly was removed but the existing manual transmission was left in place, although the clutch is no longer needed. A new electric motor was bolted to the transmission with an adapter plate. An electric controller was added to control the motor. The controller takes power from the batteries and delivers it to the motor. The accelerator pedal is hooked to a potentiometer that provides the controller with the signal that indicates the amount of power to be delivered. The controller can deliver zero power when the car is stopped, full power when the accelerator pedal is pushed all the way down, or any amount between. A battery box is installed in the car containing a pack of several lithium phosphate batteries. An electric heater was added and a vacuum pump is used for the power brakes. A charger was added so that the batteries could be recharged from any 110-volt or 220-volt wall outlet. The gas gauge in the instrument panel was replaced with a voltmeter and an ammeter.



VIII. CONCLUSION

This paper presented the conversion of a traditional Internal Combustion Engine vehicle into an Electric Vehicle. The main constitutive elements that were integrated were presented. This conversion will save the IC engine vehicles from going to scrap when the world oil resources gets completely depleted and also it saves the environment from toxic emissions by automobiles and prevent global warming.

IX. REFERENCES

[1] J. Dixon, “Energy storage for electric vehicles,” International Conference on Industrial Technology, pp. 20-26, 2010.
[2] A. Khaligh, and Z. Li, “Battery, Ultracapacitor , Fuel Cell , and Hybrid Energy Storage Systems for Electric , Hybrid Electric , Fuel Cell , and Plug-In Hybrid Electric Vehicles : State of the Art,” IEEE Transactions on Vehicular Technology, vol. 59, pp. 2806-2814, 2010.
[3] Jones, W.D., “Hybrids to the rescue [hybrid electric vehicles]”, IEEE Spectrum, Vol. 40(1), 2003, pp. 70 – 71.
[4] Qi Huang, Jian Li and Yong Chen, Control of Electric Vehicle, University of Electronic Science and Technology of China P.R.China. www.intechopen.com, 2012
[5] Haddoun, A.; Benbouzid, M. E. H.; Diallo, D.; Abdessemed, R.; Ghouili, J.; Srairi, K., “A Loss- Minimization DTC Scheme for EV Induction Motors”, IEEE Trans on Vehicular Technology, Vol. 56(1), Jan. 2007, pp. 81 – 88.
[6] Jinyun Gan; Chau, K.T.; Chan, C.C.; Jiang, J.Z., “A new surface-inset, permanent-magnet, brushless DC motor drive for electric vehicles”, IEEE Transactions on Magnetics, Vol. 36, Issue 5, Part 2, Sept 2000, pp. 3810 – 3818.
[7] Chau, K.T.; Chan, C.C.; Chunhua Liu, “Overview of Permanent-Magnet Brushless Drives for Electric and Hybrid Electric Vehicles”, IEEE Trans. on Industrial Electronics, Vol. 55, Issue 6, June 2008, pp. 2246 – 2257.
[8] Rahman, K.M.; Fahimi, B.; Suresh, G.; Rajarathnam, A.V.;

Ehsani, M., “Advantages of switched reluctance motor applications to EV and HEV: design and control issues”, IEEE Transactions on Industry Applications, Vol. 36, Issue 1, Jan.-Feb. 2000, pp. 111 – 121.

[9] Massimo Ceraolo,Tarun Huria, Giovanni Pede, Francesco Vellucci **“**Lithium-ion starting-lighting- ignition batteries: Examining the feasibility” Vehicle Power and Propulsion Conference (VPPC), 2011 IEEE

[10] Y.Lu, Cheng K.W.E., S.L.Ho, J F Pan, “Passivity- Based Control of Phase Shifted Resonant Converter”, IEEE Proc. Elect. Power Appl., Vol. 152(6), Nov. 2005, pp.1509 – 1515

[11] K.W.E.Cheng, “Tapped inductor for switched-mode power converters”, 2 Int. Conference on Power Electronics Systems and Applications, 2006, pp. 14- 20.