Electric Vehicle : The Future Cars

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Abstract – A lot is said and heard about global warming and its causes. But still the global situation is the same and nothing much changes. This paper intends to bring, what is considered as the potential savior of the world today, ELECTRIC VEHICLES in the lime light. Provided the EV are known for their non-emission of air pollutants and zero noise workings, EVs may be the first step towards the clean and sophisticated world. This paper aims to discuss the past, the present and the future of the vehicles which seems to be the solution of the desperate situation. This paper also provides brief simulation of electric vehicle in MATLAB environment.

Keywords – Electric Vehicle (EV), Fuel Cell, IC Engine, Hybrid Vehicle, Photovoltaic Cell, Controller.

I. INTRODUCTION

Vehicles which predominantly use electric batteries for energy storage, electric motors and controllers for their operations are known as ELECTRIC VEHICLES. The decade of 1830's is held responsible for the genesis of EV's. In 1899, La Jamai's Contente was the battery driven car which not only exceeded the speed barrier of 60kmph; it also set a new land speed record of 106kmph. Electric vehicles seemed promising but the reign of electric vehicle declined steeply in between 1910-1920 due to its significant demerits and at the same time finding solution to those demerits in IC engines. Nevertheless, EV's are speedily gaining importance once again in today's world. Owing to mainly three reasons; they do not produce exhausts and toxic gases; they are noiseless vehicles; and limitations of non-renewable energy resources, they are promising vehicles for future [1].

II. ELECTRIC VEHICLES AND ITS TYPES

Electric vehicles use batteries and motors as their normal operating components. They are many times supplemented with other energy sources such as IC engines, solar cells, regenerative braking etc. depending upon their type. The EV's can be classified into five kinds, based on their sources of power and their utilizations;

1. Battery Electric Vehicles
2. IC Engine - Electric Hybrid Vehicles
3. Fuelled Electric Vehicles
4. Electric Vehicles Using Supply Lines
5. Solar Powered Vehicles

The hybrid vehicle is the best in class and promising.

III. BATTERY ELECTRIC VEHICLE

These vehicles are the most simple of the EV's. These vehicles consist of a battery, an electric motor and a controller. The battery is recharged from the main power supply, the controller controls the power supply to the motor and motor directly controls the translation speed of the vehicle. The figure 1 shows the schematic diagram of the rechargeable battery electric vehicle. This kind is widely popular, and there are many utility vehicles currently based on this kind. Electric bicycles, tricycles, electric golf buggies are some of the popular inversions of this kind.

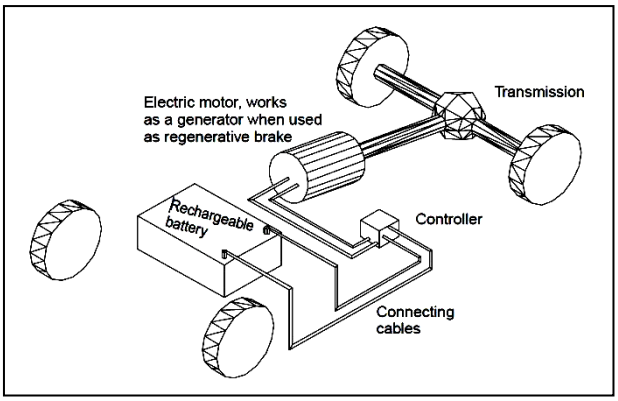

Fig. 1: Battery Electric Vehicles

IV. IC ENGINE – ELECTRIC HYBRID VEHICLE

These type of vehicles combines two or more power sources, generally IC engines with battery-electric motor. Combinations come in two types; series hybrid and parallel hybrid. In series hybrid the driving force comes entirely from electric motor; the electric motor draws power either from battery or from IC engine generating unit [2]. So, electric current is the only source of power. Parallel hybrid vehicle use either the IC engines with normal transmission system or battery powered electric motor (electric current) or both at the same time. The parallel hybrid machines with the help of controller tries to optimize the use of mechanical and electrical systems to increase performance to maximum and lower down exhaust gases to minimum.

The hybrid vehicles need not be plugged to main power supply for recharging battery. The generators in the vehicles can be used to recharge them while on move. Hence the size of the battery is also reduced considerably. Regenerative braking system comes handy as a supplement to the generator for recharging. Figure 2a and figure 2b shows the schematic diagram of the series and parallel hybrid vehicles respectively [3].

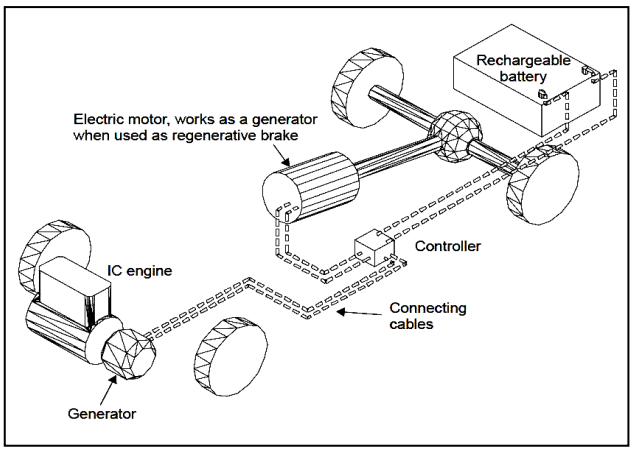

Fig. 2a : Series Hybrid Vehicle

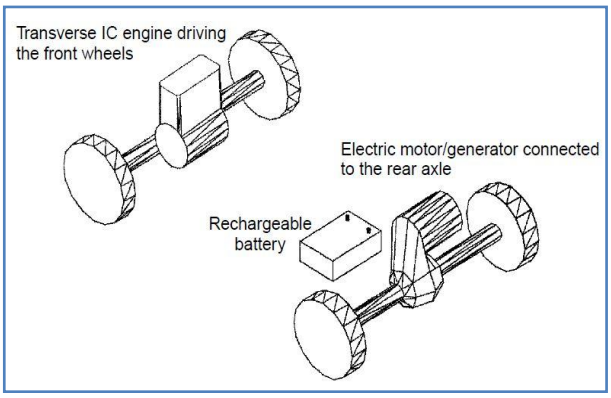

Fig. 2b : Parallel Hybrid Vehicle

Series hybrid systems are used in trains and ships; majorly to cut mechanical loses in transmission down. The parallel hybrids have a growing market and already, many vehicles based on this kind are on road. Toyota Prius and Honda Insight have been epitomes of this kind.

V. FUELLED ELECTRIC VEHICLE

In these vehicles the rechargeable battery is replaced with fuel cell or metal air battery. The main principle of fuel cell is to use hydrogen for production of electricity in the battery-like devices. It is essentially the combustion of hydrogen and by-products of the chemical reaction are water and energy. Fuel cells indeed give a hope to future and in fact, many international companies are already at closing ends of developing fuel cell; but still there are many challenges those must be overcome before the concept of fuel cell become commercial reality. The figure 3 shows the fuel cell with an acid electrolyte. Public buses based on fuel cells are on road in Germany presently.

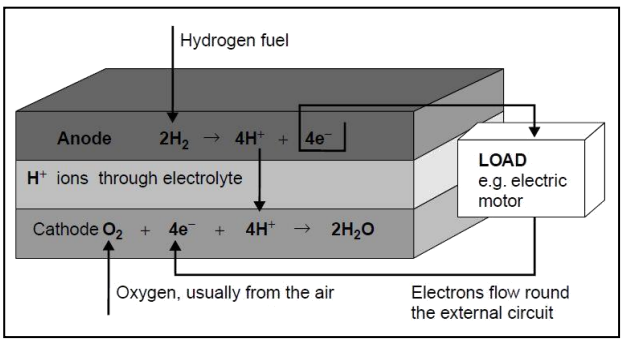

Fig.3 : Fuel Cell

VI. ELECTRIC VEHICLES USING SUPPLY LINES

These vehicles use electricity supplied by the overhead supply lines. Examples of this type of vehicles are tram and trolley buses. They had been in vogue in early 20th century but these days they are facing decline to the extinction. Their cost of installation is very high and they also impede the free motion of private vehicles [4]. The transmission lines running throughout the city spoils the aesthetics of the city. They are almost out of seen today, but still it can be used very effectively in railways and metro rails.

VII. SOLAR POWERED VEHICLES

The solar vehicles use the solar energy as a primary source of energy. This solar energy is used to recharge the battery placed in the vehicles. This seems to be a workable idea but it comes out to be almost non-effective. The power produced at the shaft (wheels) is

considerably low [5]. On it, owing to its dependence on the angle the sun rays make with the plane surface, the solar energy vehicles are good to be used only in tropical countries like India and Australia. Its global use is under doubt.

VIII. HOLISTIC ANALYSIS

EV's have two main demerits. Firstly, their range is considered to be very less as compared to their alternative IC vehicles. The batteries get exhausted soon and vehicles cannot be run for long. Secondly, the maximum speed and acceleration supported by EV's are quite lesser. The max speed for two wheelers is said to be near about 50kmph whereas the maximum speed of IC based two wheelers can range from 100 to 150khph. The third major reason for their unpopularity is the time it takes to get recharged. Typically it ranges from 5-6 hr whereas the time needed to refuel the petrol tank in IC vehicles is less than 1 min. IC vehicles definitely mark very ahead when it comes to these three criteria [6].

Nevertheless, the urgency in the world regarding pollution caused by mobile bodies and the overdependence of vehicles on non-renewables has given a great impetus to the research and development of EV's. EV's have been in good books of consumers mainly because of two reasons; non-emissions and noiselessness. The IC engine based vehicles, when working at low speeds, have very low efficiencies and their polluting capabilities are at the peaks .

Hybrid vehicles are thought to be the future clean cars. Efforts are on to develop hybrid vehicles those employ the merits of both types and eliminate the demerits at the same time. Vehicles employing battery-motor when at low speeds, making them zero emission vehicles, and employing IC engines when at high speeds or higher gears, thereby increasing the range, speed limits as well as acceleration, are awaited to hit the markets and solve the grave problem of balancing machines and pollution [7]. The popular support extended to Toyota Prius and Honda Insight proves the world is ready for the change.

IX. MODELING

Electric vehicle has been modeled in MATLAB simulation software and obtained performance of the motor. The total motive effect is a combination of several forces [8]. Given as

$$f_t = f_r + f_a + f_c + f_l + f_w;$$

Where

f_r= rolling resistance force

f_a= aerodynamic drag force

f_c= hill climbing force

f_l= linear acceleration

f_w= angular acceleration

The rolling resistance force is offered by the road to vehicle tyre. This force nearly remains constant irrespective of the vehicle speed, but it mainly depends upon the vehicle mass. Rolling force is given by following equation:

$$f_r = \mu_r \times mg;$$

The aerodynamic drag is produced due to the air pressure acting opposite to the direction of the motion of vehicle. It is the force actin on front pane and mirrors of vehicle [9]. The aerodynamic drag is given by following governing equation [12]:

$$f_a = 0.5\rho A C_d v^2;$$

Where

ρ= density of air

A= frontal area

V=velocity of vehicle

C_d= drag coefficient

The climbing force is the force required while vehicle climbs a slope[13]. It is just a component of weight acting along the slope and given as:

$$f_c = mg \times \sin\theta;$$

The linear acceleration force is the required force to drive the vehicle in the forward direction by overcoming all the other relevant forces. It is given by the newton's second law:

$$f_l = ma;$$

Similarly, angular acceleration is given as

$$f_w = G(a/r);$$

Placing all the above equations in the total motive force formula,

$$f_t = \mu_r(mg) + 0.5\rho A C_d v^2 + mg \times \sin\theta + ma + G(a/r);$$

A model car is taken for the experimental verification for electric vehicle with following parameters:

1. The car has mass of 1664.68kg
2. Gear ratio of 6.54:1
3. Wheel radii is 254mm
4. Area of front pane is 2.52m^2
5. The rolling friction of 0.01

6. Drag coefficient of 0.3
7. Battery(dc) of 20V

On substituting the values

$2362.204 = 163.138 + 3.4125(v^2) + 1050(dv/dt);$

$2199.06 - 3.4125(v^2) = 1050(dv/dt);$

$(dv/dt) = 2.09 – 0.00325(v^2);$

There are many practical and simple ways of solving this differential equation and obtain the voltage of the motor of the electric vehicle [10]. Here we consider a complete MATLAB installed simulated motor drive for the electric vehicle. The following figure 4 shows the MATLAB simulink based electric motor vehicle and results have been displayed in the next session.

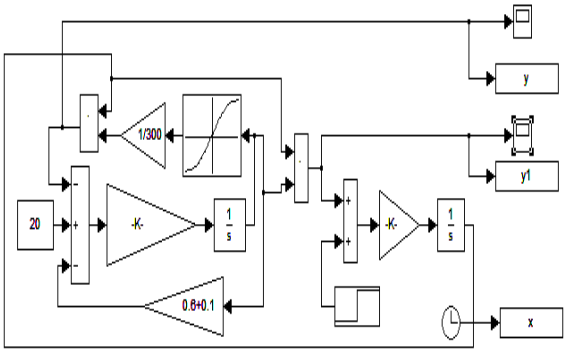

Fig.4 : MATLAB Simulink Diagram

A 20V dc battery is taken for the power supply of the dc motor which is simulated in a Simulink model and desired torque of 300Nm is obtained at the shaft. The results are shown with 20V battery as input and 300Nm as the maximum torque output [11]. However, we can increase the torque produced by increasing the number of additional batteries connected in series with the present one.

X. RESULTS

The figure 5 shows the voltage of the battery with respect to time. The figure 6 shows the torque generated by the motor at the shaft.

The voltage vs time plot is obtained by following MATLAB command;

Plot(x,y);

Similarly, torque vs time plot is obtained by following command;

Plot(x,y1);

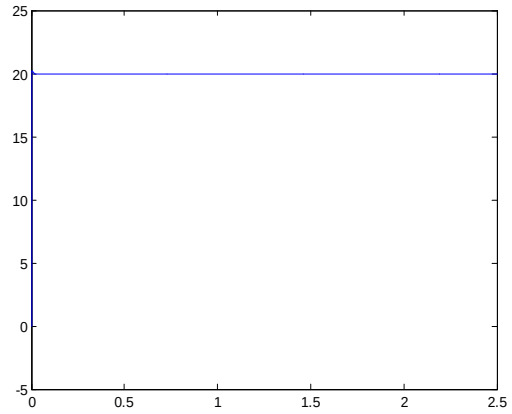

Fig.5

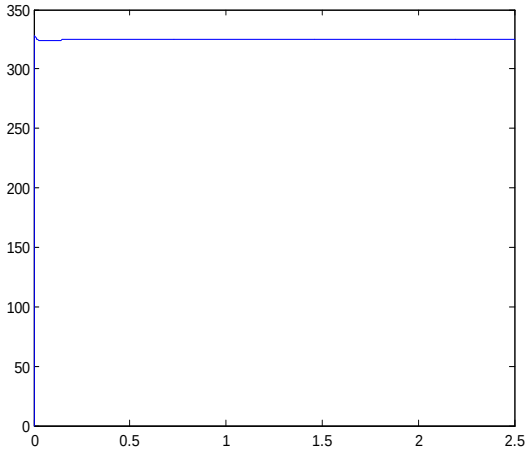

Fig. 6

XI. CONCLUSION

As shown above the torque at the output shaft ranges from 300 to 350Nm, the simple battery vehicle suits best to the common man for day to day chores and safe drives. On it, EV provides us with a potential solution to stand against the pollution and rising problem of global warming. EV's are quiet; hence, we can tackle the problem of noise pollution also. Hybrid vehicles are very promising.

In this paper an effect is made to provide comprehensive details regarding the entire growth of electric vehicle and also provides a simple simulated model for desirable torque achievements. Further, the designer may take any number of design attributes for production of efficient and reliable electric vehicle. In this paper an attempt is made to provide small contribution towards the growth of the future electric vehicles.

XII. REFERENCES

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