Hybrid Vehicle

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***Abstract*- With the advancement in 21st Century, there has been increase in usage of Oil and Gas leading to problems like Global Warming, climate change, shortage of crude oil, etc. Due to these reasons Automobile Companies have started doing research for making Hybrid Technology usable into the daily life. The Paper starts from brief history about Hybrid Technology and also some brief introduction on it. Paper will also discuss the technologies used in the making of Hybrid Cars such as "Hybrid Solar Vehicle", "Hybrid Electric Vehicle" and "Plug In hybrid electric vehicles". Our Paper is based on the explanation of such technologies, their function, drawback of this technology, efficiency of Hybrid Cars, Case studies on the present commercial hybrid cars such as Toyota Prius series, Astrolabe etc and the fuels and raw materials used in the Hybrid Cars. Paper concludes on the advantages and dis-advantages of Hybrid Cars and how this technology will take over the world in future and would become the alternative for Petrol and Diesel Cars. Keywords - hybrid electric vehicle; hybrid solar vehicle; plug in hybrid electric vehicle; Toyota Prius series**

INTRODUCTION

With the invention of Internal Combustion Engine by Nicolas Otto, there was revolution in Automobile field. Later on, Petrol and Diesel became the main source of fuel for these vehicles. This technology made Human Efforts very easy through commercializing in the market. As, the world went through 20th Century, there happened many advancements for making this technology efficient and cost-effective. Due, to which it became the commercial success and its use in the day to day period increased. People could reach thousands of kilometres /miles in hours with the help of this technology. As we know everything has its own positive and negative side. The rate of Carbon Monoxide (CO) and Carbon Dioxide (CO2) suddenly increased at the dangerous level in the beginning of 21st Century which made a negative impact on Ecosystem, reason for Global Warming, Health related issues, etc. This forced Scientist, Researchers and Policymakers to focus or made them start thinking for Green Technology or the technology which can stop the adverse effect happening on Nature. Hence, the 21st Century will become the Century for Evolution in various technologies with the main focus in Automobile Sector. The technologies which will change the face of Automobile Sector would be "Hybrid Electric Vehicle", "Hybrid Solar Vehicle", "Hydrogen Fuel Cell", etc. From all this Hybrid Electric Vehicle is considered as the most industrially matured technology and has efficiency more than cars running on Petrol/Diesel/CNG while Hybrid Solar Vehicle has lower efficiency than vehicle running on Petrol/Diesel/CNG. So, this technology is for drivers who want to cover less distance. To overcome this constraint, "Plug-In Hybrid Electric Vehicle" came into existence. "Toyota Prius Series" is an example of Hybrid Electric Vehicle technology, "Astrolab" is an example of Hybrid Solar Vehicle and "Chevrolet Volt" is an example of Plug-In Hybrid Electric Vehicle.

TYPES OF HYBRID VEHCILE

A. Hybrid Electric Vehicle (HEV)

A hybrid electric vehicle is a type of hybrid vehicle which combines a conventional internal combustion engine propulsion system with an electric propulsion system. Or in a technical way, a Hybrid Electric Vehicle is a type of technology which indulges both mechanical drive train and electric vehicle. A mechanical drive consists of the Fuel tank (containing conventional fuels like petrol/diesel/CNG), the Combustion Engine, the gear

box and transmission to the wheels in. An electric drive consists of the Battery, an electric motor and Power Electronics for control. The use of Ultra capacitors [1] has a high potential in the Hybrid Electric Vehicles. They have the advantage of being a more robust power device when compared to batteries (Lithium Ion and Nickel Metal Hydride), as an example during regenerative braking which is considered as a high powered event.

CLASSIFICATION OF HYBRID ELECTRIC VEHICLE

Series Hybrid: [3] the traction power is delivered by the electric motor, while the internal combustion engine, via a generator, produces electric power to drive the electric motor [2]. The excess power is then stored in the battery pack. The Internal Combustion Engine is decoupled from the driven wheels and can be operated mostly in the maximum efficiency region. The major shortcomings of the series hybrid drive train configurations are the high power installed in each component and the request of a generator. In fact the energy from the Internal Combustion Engine is converted twice before to drive the wheels. Thus the system is more expensive than the parallel one.

Parallel Hybrid:[3]
There is direct mechanical connection between the hybrid power unit and the wheels. In addition, this layout has an electric traction motor that drives the wheels and can recuperate a share of the braking energy, in order to charge the batteries (regenerative braking) or help Internal Combustion Engine during acceleration conditions. In fact, Internal Combustion Engine and electric motor are coupled by a mechanical device. Then the electrical machine can be designed with a reduced capability, i.e. cost and volume. There are several configurations depending on the structure of the mechanical combination between the Internal Combustion Engine and the electrical motor. There can be a torque-coupling with a single shaft or two shaft configuration, a speed-coupling with planetary gear unit, a merge of both previous coupling.

Series-Parallel Hybrid:
[3] the series layout and the parallel layout are merged together in order to have both advantages. In particular the ICE is able to supply the electrical motor or charge the battery thanks to a generator.

Complex Hybrid:
[3] There are two separate mechanical links obtaining a light transmission system and a flexible mounting. As an example, the front wheels are powered by hybrid propulsion, while the rear wheels have a pure electric system. There is a wide flexibility on the power flux managing. Moreover, general Hybrid Electric Vehicle can be classified depending on the relevance of the power Table 1 [4, 5]. Table 1: Hybrid Electric Vehicle Classification based on power Micro Mild Full Power (kW) 2.5 10-20 30-50 Voltage Level (V) 12 100- 200 200- 300 Energy Saving (%) 5-10 20-30 30-50 Price increase (%) 3 20-30 30-40 Fig. 2: Flow of energy within a mechanical drive train [10] Fig. 3: Flow of energy within a electric drive train [10]: Series Hybrid Structure Fig. 5: Parallel Hybrid Structure Fig. 6: Series-Parallel Hybrid Structure B. Hybrid Solar Vehicle (HSV) This technology is an integration of Vehicle and Photovoltaic Panels. Normally, photovoltaic panels are mounted on the roof-tops of the vehicles. It is also classified into four types: - Series Hybrid, Parallel Hybrid, Series-Parallel Hybrid and Complex Hybrid. Out of which, Series Hybrid technology is very efficient and more research is going on this type lug-In Hybrid Electric Vehicle (PHEV) A plug-in hybrid electric vehicle is similar to the hybrid electric vehicles (HEVs) on the market today, but it has a larger battery that is charged both by the vehicle's gasoline engine and from plugging into a standard 110 V/230V electrical outlet for a few hours each day [7]. Classifications of Plug-In Hybrid Electric Vehicle:- Series Plug-In Hybrids: [8] Also called as Extended Range Electric Vehicles (EREVs). Only the electric motor turns the wheels; the gasoline engine is only used to generate electricity. Series plug-ins can run solely on electricity until the battery needs to be recharged. The gasoline engine then generates electricity to power the electric motor. For shorter trips, these vehicles might use no gasoline at all. Parallel or Blended Plug-In Hybrids: [8] Both the engine and electric motor are mechanically connected to the wheels, and both propel the vehicle under most driving conditions. Electric-only operation usually occurs only at low speeds. III. Toyota Prius Series A.1. First Generation: THS (Toyota Hybrid System)

The first generation consisted of two hatchback models the "NHW10" and the "NHW11". Challenges:- • Longevity of the battery (7-10 years) • Need for a hybrid system • High performance of engine for charging the battery. Solutions:- • The battery pack is always charged between 40%-60% for maximum efficiency. • The introduction to the "Toyota Hybrid System". • Introduction of the Double Overhead Cam-Shaft (DOHC) engine. Benefits: - The introduction of the DOHC engine allowed the engine to have four valves per cylinder. By having four valves in the cylinder instead of two, a larger portion of the area could be used to let air in and exhaust out. The engine made more power if more air entered the cylinder, and it wasted less power and it was easier to pump the exhaust out of the cylinder. At higher engine speeds, the engine pumped a lot of air though the cylinders. Having four valves per cylinder allowed the engine to pump enough air to run and make useful power at these higher speeds. Hence the general problem of low speed was overcome. A.1.1. Working of Toyota Hybrid System The Toyota Hybrid system consists a petrol engine along with two motor generators (MG1 and MG2) a power control unit and a battery. When the car is started it runs solely on the electric motor (MG2) .Later when the car achieves a higher speed the petrol engine kicks in and the car runs both on the motor and the petrol engine. Moreover the engine also operates a generator with the help of a power split device which in turn drives the electric motor (MG2 (288 V)). This power splitting is controlled by the power control unit which manages the power for the maximum efficiency. During braking the motor acts as a generator and the energy recovered is stored in the battery. The battery doesn‟t need any external charging. If the battery is drained, the car is run on the petrol engine in "stand mode" which charges the battery. Drawbacks:-

• The backing of the car at steeps was difficult.

• The ride was jerky at times Overall, the mileage for the First Generation Prius was 5.6 L/100 km in city driving, 5.7 L/100 km for highway driving and 5.7 L/100 km for combined driving. Fig. 8: Diagram of Toyota Hybrid System A.2 Second Generation: Hybrid Synergy Drive The Hybrid Synergy Drive adds a DC to DC converter boosting the potential of the battery to 500 V or more. This allows smaller battery packs to be used, and more powerful motors.3]

CONCLUSION

Hybrid Cars use no energy during idling state; they turn off and use less energy than petrol engines at low speeds. At lower speeds, no smog is emitted maintaining its sustainable advantage. Till lower speed, the car runs on the electric motor and on cruising speed, it runs on IC engine. They offer greater mileage than conventional cars. Noise pollution and emission of CO2 is considerably reduced. But, they are more expensive than conventional cars, are more complex in construction and

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REFERENCES

[1] M. I. Marei, S. J. Samborsky, S. B. Lambert, M. M. A Salama. On the Characterization of Ultracapacitor Banks Used for HEVs, Proceedings of the IEEE Vehicle Power and Propulsion Conference, VPPC ‟06, Windsor, UK, 2006, pp. 1-6.

[2] M. Ehsani, Y. Gao, S. Gay, A. Emadi. Modern Electric, Hybrid Electric, and Fuel Cell Vehilces, CRC Press: USA, 2005.

[3] M. Barcaro, N. Bianchi, F. Magnussen. PM Motors for Hybrid Electric Vehicles. The Open Fuels & Energy Science Journal, Vol. 2, pp. 135-141, June 2009.

[4] C.C. Chan. In Global Sustainable Mobility and EV/HEV/FCEV Development in China & Japan, Keynote Presentation of the IEEE Vehicle Power and Propulsion Conference, VPPC‟06, Windsor, UK, 2006.

[5] T. Yaegashi. In Challenge of Achieving Sustainable Mobility through Hybridization, Research and Development of Hybrid Vehicles in Japan and Sweden Seminarim, Göteborg, Sweden, 2006.

[6] Zs. Preitl, P. Bauer, J. Bokor. Fuel Consumption optimization for Hybrid Solar Vehicle, Page: 11-18. International Workshop on Hybrid and Solar Vehicles. University of Salerno, Italy. November 5-6, 2006. , 4th February 2013.
[7] "What is Plug-In Hybrid?". 22nd December 2014.
[8] "Different Kinds of Plug-in Hybrids" 22nd December 2014.
[9] Astrolab - Venturi Automobiles, 22nd December 2014.
[10] Hybrid Electric Vehicles: An Overview of current technology and its application in developing and transitional countries. Printed, United Nations Environment Programme, Nairobi, Kenya, September 2009.
[11] "Hybrid Cars -- Pros and Cons", 22nd December 2014.
[12] "Regenerative braking systems", 22nd December 2014
[13] "Toyota Prius (XW10)", 22nd December 2014.
[14] "Toyota Prius (XW20)", 22nd December 2014.
[15] "Toyota Prius (XW30)", 22nd December 2014.
[16] "Review: Toyota XW30 Prius, Specifications", 22nd December 2014
[17] "Toyota Prius c, Specifications", 22nd December 2014.
[18] "Toyota Prius Plug-In Hybrid", 22nd December 2014.