

# An overview and operation of hybrid vehicles

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## Abstract

The principle of Internal combustion engine (ICE) works on conventional vehicles that operates on fossil fuel such as gasoline, diesel etc from oil deposit which is millions of years old. These vehicles emit hydrocarbon, sulphur oxide, carbon dioxide, and carbon monoxide through their outer pipes. These resultant gases which emits from the conventional vehicles increases the concentration of Carbon dioxide in the atmosphere and it results global warming and pollution which is very dangerous for the climate and lives. Fuel and electricity is two storage units of hybrid electrical vehicles. Electricity stands for battery which is used as a storage of energy and this energy is used to operate an electric motor (also called motor) and it will used as a traction motor. As we all know that motor plays important role in the Hybrid Electric vehicles drives systems. This motor operates the wheels of the vehicle. However a traditional vehicle, where the engine must be “ramp up” before full torque can be reached, at low speed an electric motor gives full torque. The motor can provide low noise and high efficiency. Excellent off the line acceleration, good fault tolerance, flexibility and good drive control are the other characteristics in alliance to voltage fluctuation. This works describe the overview and operation of hybrid vehicles

*Keywords:* CO<sub>2</sub> emission, Battery Option, Hybrid Configurations.

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## 1. Introduction

The principle of Internal combustion engine (ICE) works on conventional vehicles that operates on fossil fuel such as gasoline, diesel etc from oil deposit which is millions of years old. These vehicles emit hydrocarbon, sulphur oxide, carbon dioxide, and carbon monoxide through their outer pipes. These resultant gases which emits from the conventional vehicles increases the concentration of Carbon dioxide in the atmosphere and it results global warming and pollution which is very dangerous for the climate and lives. Due to the global warming, increases the temperature which melts the glacier and permafrost and change in the climate. Also, the price of fuel and population are increasing rapidly day by day. The fuel consumption which is another global problem and it is totally dependent on the number of population and number of vehicles in operation. To resolve the above issues the vehicles manufacturers come up with new fuel efficient vehicles. The mechanical Engineers and electrical engineers came up with many ideas for changing the primary fuel from oil to other fuel and efficient engine management

that enhances the fuel consumption a lot respectively. We call these types of vehicles as Hybrid vehicles.

## 2. Types of drivetrain structure

### 2.1. Series Hybrid vehicle

In this type of system, the combustion engine spins an electric generator (commonly as 3 phase alternator with rectifier) in place of directly driven the wheels. The only means of providing the power to the wheels is electric motor. The generator works both to charge the battery and give power to an electric motor that helps to move the vehicle. This series configuration already exists a long time such as hydraulic earth moving machine, diesel-electric locomotive and power groups, loaders. The structure of the series hybrid configuration is given below:

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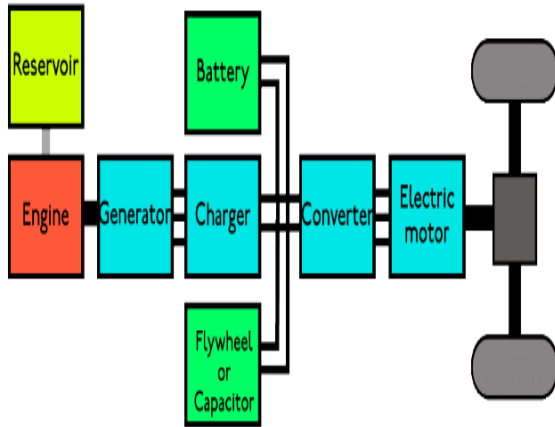


Fig.1. Structure with flywheel [1]

## 2.2 Parallel Hybrid

In this configuration, both an electric motor and an internal combustion engine are connected parallel for mechanical operation.

The following diagram is the structure of parallel hybrid configuration of vehicle and it is given below:

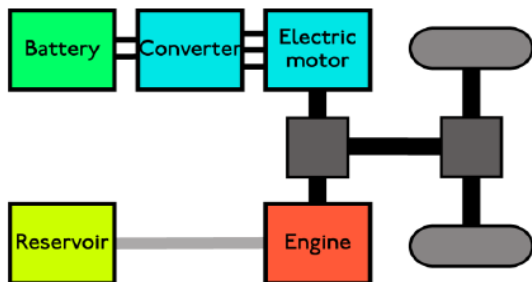


Fig.2. Parallel Hybrid Structure [1]

### 2.2.1 Operation Mode

The diverse operating mode works in parallel configuration of hybrid vehicle. The following are four sub mode in the diverse operating mode:

1. Electric mode only: The electric motor works only with the power of the batteries during the speed of the vehicle up to 40 Km/hr. During that time the battery is not recharged by the ICE. This mode usually operating around the city and as well as in reverse gear.

2. ICE power only or both ICE and electric power: During ICE Power only, the engine operates at the speed more than 40Km/hr. If the vehicle needs more power(during acceleration or at very high speed) than the current power, the electric

motor starts working with the engine which is connected parallel to each other and hence generates more power.

3. Both ICE and Battery charging mode: If the vehicle needed less power, the excess energy is used to charge the battery. In this case it drives at higher efficiency and the engine is operating at higher torque than compulsory torque.

4. Regenerating Braking Mode: During decelerating or braking, the moving vehicle act as a generator and the electric motor gets gain of the kinetic energy of the vehicle.

The following block diagram shows four sub mode of diverse operating mode

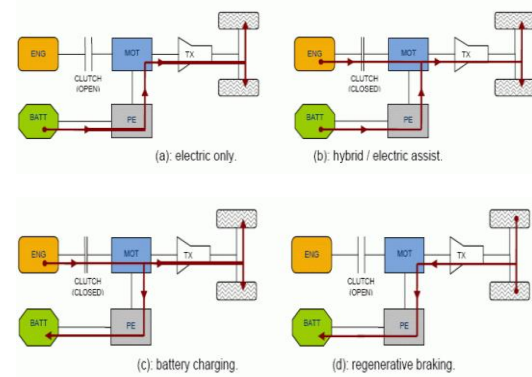


Fig.3 Diverse operating mode [1]

## 2.3. Combined Hybrid

In this configuration it shows features of both series and hybrid system. The connection between the engine and the drive axle is doubling i.e. mechanical and electrical. The mechanism of split power is grants interconnecting electrical and mechanical power. The powertrain is incorporated by the power-split devices. The power delivered to the wheels can be either mechanical or electrical or combination of both power. The same mechanism happens in parallel hybrid system. However the main phenomena behind this combined configuration is the power demanded by the driver which is decoupling of power supplied by the engine.

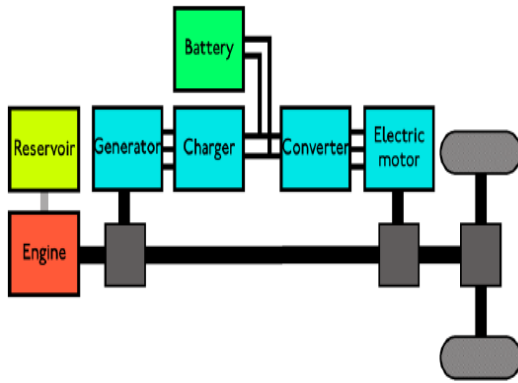


Fig.4. Combined Hybrid Structure [1]

A larger engine is used to implement acceleration from standstill position than one which needs the steady speed cursing in a conventional vehicle because the torque of the combustion engine is minimal at low RPM. IF we talk about electric motor, it's torque exhibits maximum at standstill and is suitable for enhancing the torque of the engine deficiency at low RPM. However in case of combined hybrid system the engine can be smaller, less flexible and highly efficient. This leads to a higher total efficiency of the vehicle with less use of regenerative braking mode.

This combined hybrid system drives as a series HEV at lower speed, however in case of higher speed where the efficiency of the series system is lower. It is more expensive system as compared to the pure parallel system because it needs a split power system, an extra generator and more calculating power to control the dual system.

### 3. Battery Options

There are several factors like energy density, lifetime, cost, performance characteristics including depth of discharge and temperature effects and consideration are major considerable factor for choice of battery for hybrid vehicle. Lithium-ion (Li-ion) or nickel-metal-hydrate (NiMH) battery is used in recent Hybrid models and EV models. Due to low energy density and present toxicity concern on recycling, PbA battery was used as primarily. NiMH battery has high energy density compare to PbA and Li-ion battery due to this advantages most HEV use it as primarily. Li-ion battery having higher energy density and

higher cost are most favourable technology for EVs in the near future. Other battery technologies like zinc NaNiCl which have been partially used in recent year. Ultracapacitor is the other option for energy storage with batteries which are able to charge and discharge very quickly, also used to store energy from regenerative braking. Major concern about that has very low energy density which is going to increase in research project.[2]

### 4. Environment impact of hybrid vehicle.

Hybrid vehicle consume less fuel and has lower emission compare to IC engine vehicles. There are basically three main types of elements in design which describe advantageous saving:

1. Smaller engine size for average usage ,can have low weight and low internal losses.
2. High capacity of battery storage during the instant stop and go operation in traffic by store and reuse of energy.
3. Regenerative Braking, Utilization of significant amount of recapturing energy that are usually wasted as heat during braking.

First thing to be consider that amount of energy requires for manufacturing of hybrid vehicle and battery. In Recycling of used battery packs, Lead, Nickel, Lithium batteries has some harmful metal which cause the bad impact on environment. Amount of lead and nickel contents at ground level which pollute the ground water causing acid rain and it will be harmful for plant life and even for human daily life. By using of lithium based battery in hybrid car having negative impact on environment, for promoting recycle of the batteries, some company gives the incentives like Toyota automobile.[3]

Hybrid vehicle technology has major advantage to reduce carbon dioxide emission in environment which is responsible for Greenhouse gas. It could be change the percent of fresh air quality in environment. There are several policies of reducing the level of carbon emission which some countries have adopted.

if global warming will be still standstill then we would be developed to find the new ecofriendly way of transportation, minimize the significant amount of energy consumption, find out the method of recycling of waste.[3]

Environmental and Social Issues Concerned with Hybrid Cars, 2009/2010.

## 5. Conclusion

Reduction of GHG emission and less energy consumption by use of hybrid vehicles instead of conventional vehicles could be positive effect on the environment and human life. Today HEV become popular technology mobility for heavy and light duty application due to less emission of CO<sub>2</sub> in environment and fuel consumption. Thus overall benefit for human life and environment by hybridization of vehicle. All sectors-governments, manufacturers, importers and consumers support eco friendly technology by implementing hybrid technology. Due to high price of battery, there is good option of hybridization of vehicle by more source of power utilization.

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## Symbols

|                 |                            |
|-----------------|----------------------------|
| ICE             | internal combustion engine |
| Li-ion          | Lithium Ion                |
| NiMH            | Nickel Metal Hydride       |
| RPM             | Revolutions per minute     |
| IC              | Internal combustion        |
| HEV             | Hybrid electric vehicle    |
| GHG             | Green House Gas            |
| CO <sub>2</sub> | Carbon dioxide             |

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