ALTERNATE FUELS IN AUTOMOBILE

5.1. INTRODUCTION

At present every country is facing two major challenges namely energy crisis and environmental degradation. Crying need of the day is to mean fuel, more fuel and cheaper fuel. Moreover the growing use of petroleum fuels in the ever increasing number of automobiles is causing rapid degradation of environment in every country due to vehicle exhaust pollution. To meet this twin problems of fuel oil scarcity and air pollution caused by the growing use of petroleum fuel, alternate renewable clean burning fuel should be explored for using motor vehicles. Most prominent eco-friendly fuels are the bio-solar fuels namely alcohol, natural gas and hydrogen.

5.2 NATURAL GAS

CNG – an abbreviated version of compressed natural gas as an alternate fuel for automotive usage would be of great use in reducing the fuel consumption as well as patterns of pollutants. This alternate fuel reduces considerably the dependence on conventional automotive fuels, thus achieving a saving in terms of foreign exchange as well as reduction in emission of toxic pollutants responsible for urban ecological degradation.

Natural gas (CNG) comes under the promising alternate fuels.

5.2.1 Compressed natùral gas

Natural gas is available in large quantities in India and does not need elaborate processing or refining, as is the case with other petroleum fuels. Natural gas is a natural hydrocarbon energy resource formed in the earth's crust by millions of years of biological action on organic matter. It occurs along with oil, deep in the earth's crust and is recovered from wells under very high pressure. It has very low levels of pollution, does not materially restrict vehicle performance and is far more economical to use than petrol.

Natural gas occurring as gas under pressure in rocks beneath the earth's surface are more often in solution with crude oil as volatile fraction of petroleum. This is composed mainly of methane (CH_4) with varying amounts of the paraffinic hydrocarbon family, ethane (C_2H_6), PROPANE (C_3H_8), BUTANE (C_4H_{10}) etc.

It is a clean burning fuel, no lead and sulphur compounds in the exhaust, simple and small molecular structure, very low carbon to hydrogen ratio, forms no deposits on spark plug, thus reducing engine maintenance cost.

The natural gas is compressed to a pressure of around 200 kg/cm^2 and stored in transportable cylinders of capacity ranging from 20 litres to 100 litres, which can be kept safely and conveniently on the automobile. These cylinders, usually called CNG cylinders, provide a good range for the vehicle for a travel from 250 to 350 Kms.

In general Natural gas are obtained from oil field as Associated Gas and Wastelands or landfills as a result of bio degradation.

The composition of Natural Gas can be given as following :

It is a mixture of hydrocarbons

General composition for Natural Gas

Methane (CH_4)	:	85 – 90 %
Ethane (C_2H_6)	:	5 – 7 %
Propane (C_3H_8)	:	2 %
Carbon di oxide	:	3 – 5 %
Others	:	1 %

Natural gas is received from pipeline and is compressed to 250 kg/cm^2 with the help of reciprocating compressors installed at Mother and On-line CNG stations. CNG is dispensed to vehicles at maximum 200 kg/ cm^2 pressure.

Some of the physical properties of Natural gas (CNG) are :

- Colourless
- Odourless
- Non-toxic
- Lighter than air

5.2.2 Need for CNG

Following are some of the reasons why CNG is to be used.

1. Rising urban pollution
2. Rising global concern for environment
3. Rising vehicle pollution
4. Rising public awareness and expectations
5. Economics
6. Indigenous availability.

5.2.3 Characteristics of CNG

CNG is a safe fuel. Being lighter than air, it disperses easily into the atmosphere and does not form a sufficient rich mixture for combustion to take place. In this respect, CNG is superior to LPG or propane or even petrol. The excellent knock – resistance property of CNG allows use of a higher compression ratio for increased power output and fuel economy, compared to petrol. Due to its anti-knock property, CNG can be safely used in engines with a compression ratio as high as 12:1 compared to normal gasoline (ranges from 7.51 to 10:1) At these high compression ratios, natural gas fuelled engines have higher thermal efficiencies than those fuelled by gasoline.

CNG has a higher octane number than petrol, making it possible for CNG engines to operate at a higher compression ratio than petrol engines without knocking. The fuel efficiency of CNG engines is better than that of petrol engines . However, compared to diesel engines, the compression ratio is lower for CNG engines. CNG engines are efficient, easy to maintain and user-friendly solution to overcome environmental problems .CNG also allows the use of catalytic converter more efficiently diesel.

5.2.4 Constraints in CNG

Gas availability

Capacity planning becomes difficult due to non-availability of demand projections

Availability of CNG equipment

Pipeline network infrastructure

Competition from other fuels

5.2.5 Description of CNG system

The CNG system essentially incorporates two kinds of refueling principles based on

a. Mother-Daughter concept

b. On-line station concept.

In Mother-Daughter concept, MOTHER STATION is a compressor station, which caters compressed gas. The compressed natural gas (CNG) thus produced is transported to various refueling stations with the help of LCV/ trailer mounted cascade of cylinders. The refueling stations, where a essentially retail dispensing of CNG takes place, is called DAUGHTER STATIONS, which are the Retail Outlets (Ros) of CNG.

The working pressure as adopted in India has a range of 240-250 kg/ cm^2. To avoid transportation of high pressure gas in urban areas, the concept of 'On-line Stations' has also been used in India and many other countries where gas is tapped from city utility/ gas trunk line compressed, stored and dispensed at the same station, thereby eliminating additional expenses of transportation of cascades with CNG. This concept is not widely used due to the fact that urban areas are yet not linked with natural gas grids. Indian cities of Mumbai, Delhi and Surat have such on-line stations.

Comparative properties of available fuels

PROPERTIES	UNIT	PETROL	DIESEL	CNG
Calorific Value	KCAL/KG	11200	10850	10600
Relative density	AIR = 1	2.4	3.9	0.65
Autoignition Temperature	°C	232-282	225	540
Flammability Limit	% IN AIR	1-8	0.6-5.5	5-15
Flame temperature	°C	1977	2054	1790
Octane number	-	87	-	127
Cetane number	-	10	45	10

5.2.6 Advantages of using compressed natural gas (CNG) over diesel

1. Natural gas (CNG) is lighter than air and therefore dispersed quickly in the event of leakage instead of puddling like Petrol and Diesel.
2. Natural gas ignites at higher temperature (550 to 704 deg.c) than petrol and diesel.
3. The explosive limit of natural gas mixture is higher than air- diesel mixture.
4. Because of the flammability limits and high self-ignition temperature, fire or explosion is less likely in case of natural gas in the event of fuel leak. This supports the high degree of safety claimed in the use of Compressed Natural gas (CNG).
5. Natural gas provides clean burning characteristics.
6. Natural gas does not saturate flammable materials.
7. Due to higher oxygen required its combustion reduced, NOx pollutant, thus reducing the formation of Nitric acid in the Lungs Toxicity.
8. Due to proper combustion with homogeneous mixture of fuel and air reduced unburnt hydrocarbon (HC)) will reduce the environment pollution of Photochemical smoke-visibility.

9. Natural gas having good chemical composition and with low carbon molecules reduces low emission of CO.

10. Due to proper burning of fuel in the cylinder and nature of chemical and physical properties reduces Particulate Matter (PM).

11. Compared with other fuels natural gas is very economical and environmental friendly one.

12. Use of CNG will reduce the human effect such as lung cancer and natural cough and other diseases.

5.3 GAS POWERED VEHICLE

LPG fuel requires a special fuel system. There are actually two types of LPG that have been used for automotive-engine fuel, propane and butane. Of these, propane is more widely used. Thus, it can be used in any climate where temperature is below 0°C, since it is liquid below that temperature. If it remains liquid, it will not vaporize in the fuel system and will never reach the engine.

When the pressure is induced, the fuel vaporizes. Thus, the system must have a pressure- tight fuel tank to store the fuel at high-pressures. A typical LPG fuel system is shown in figure. Pressure forces the fuel through the filter, high-pressure regulator, and vaporizer. The high-pressure regulator reduces the pressure so that the fuel starts to turn in to vapor. This vaporizing process is completed in the vaporizer. The vaporizer has an inner tank surrounded by a water jacket through which cooling-system water passes. The water adds heat to the fuel so that it is fully vaporized. It then passes through the low- pressure regulator, where the pressure is further reduced. It then enters the carburetor. The low-pressure regulator reduces pressure to slightly below the atmospheric pressure. This prevents it from flowing into the carburetor when the engine is off. Fuel will flow only when the engine is running and there is a vacuum in the carburetor venture. LPG fuel systems have been used on some cars, trucks, buses and forklift platform trucks.

Liquefied petroleum gas (LPG) is a mixture of light hydrocarbons, mainly propane / propene and butane / butanes. It is easier to distribute and store than compressed natural gas, liquefied at a pressure of 4 -15 bar. LPG gas is used in view of conventional fuels because of their hydrocarbon rating and higher octane rating. The engine of LPG has been differed from conventional shapes. The LPG is disc shaped engine and differ in the numbers of valves and their arrangements.

system. India, Pakistan, and Sri Lanka import about 30-40 percent of LPG consumption. There is also a need to invest in refueling equipment required to transfer pressurized LPG from storage tanks to vehicles and to ensure that no LPG escapes during refueling. The lack of adequate investment in LPG refueling stations constraints widespread use of LPG in South Asia.

5.4 HYDROGEN AS FUEL IN AUTOMOBILE ENGINES

As the demand for the present day fuel of I.C. Engines - petrol and diesel increases, it ultimately stresses the scientists to find an alternate fuel to run the I.C. Engines, which lead to the use of Hydrogen as a fuel for I.C. Engines.

Hydrogen

Hydrogen is an excellent fuel, which could be the acceptable as permanent energy source that meets most of the obvious requirements for universal application in energy consumption in automobiles. It is available everywhere, since it is produced mainly from water.

The aspect of hydrogen as a fuel can be described by the following sections :

Production of Hydrogen

At present the hydrogen that is required by world industry is mainly produced by catalytic steam reforming of natural gas.

$$CH_4 + H_2O \rightarrow CO_2 + 3H_2$$

However, for large-scale use as a fuel, hydrogen will have to be produced only from the renewable sources, in order to prevent the extinction of Non-renewable sources as Petrol and Diesel.

Electrolysis of Water

Water is made electrically conducting, by adding a small amount of Sulphuric acid (H_2SO_4) or Potassium Hydroxide (KOH). Electric current is passed between the electrodes leading to the separation and collection of H_2 and O_2 separately. The energy efficiency of this process is about 75 percent.

Thermal Decomposition of Water

Water can also be split by the application of heat as

$$2\ H_2O \rightarrow 2\ H_2 + O_2$$

This however requires a temperature of 3000 to 4000°C.

2. Properties of Hydrogen

Hydrogen has a very low density both as gas and as liquid. Hence in spite of its high calorific value on mass basis, its energy density as a liquid is only one fourth of that of gasoline.

Hydrogen has to be stored as compressed gas, as liquid (in cryogenic containers) or in absorbed form (as metal hydrides) none of which is convenient as gasoline storage.

An important point to be noted is the wide ignition limits of Hydrogen. Only 4% by volume of hydrogen in hydrogen-air mixture and 75% by volume of hydrogen in hydrogen-air mixture are both ignitable.

Hydrogen has a high self-ignition temperature, but requires very little energy to ignite it.

Hence it is very prone to pre-ignition and back flash in S.I. engines. The adiabatic flame temperature for hydrogen is a little lower than for gasoline but the rapid combustion allows very little heat loss to the surroundings and hence high, instantaneous, local temperatures are produced. This leads to high nitric oxide formation.

It can be seen from the above discussion that hydrogen has both advantages and disadvantages as an engine fuel. The engine system has to be adapted to take into account of these properties.

Hydrogen supplementation

Hydrogen can also be used as a supplement to gasoline in S.I. engines. In this system hydrogen is introduced along with gasoline, compressed and ignited by a spark.

The mass fraction of hydrogen lie over the test range. The heat contribution of hydrogen is however, much greater since the calorific value of hydrogen on mass basis is 2.8 times as high as that of iso-octane.

5.4.1 Hydrogen in S.I. Engines

Hydrogen can be used in S.I. engines by three methods:

1. by manifold introduction
2. by direct injection of hydrogen into the cylinder,
3. by supplementation to gasoline.

5.4.2 Use of hydrogen in C.L engines

There are two ways by which hydrogen can be used in diesel engines.

(i) By introducing hydrogen with the air and using a spray of diesel oil to ignite the mixture - that is, by the Dual fuel mode.

(ii) By injecting hydrogen directly into the cylinder at the end of compression. Since the self- ignition temperature of hydrogen is very high the gas spray is made to impinge on a hot glow plug in the combustion chamber - that is, by surface ignition.

The first method has the advantage of minimum modification of existing engines and is flexible with regard to the relative proportions of diesel oil and hydrogen. The second is suitable where an assured supply of hydrogen is available.

Advantages of hydrogen as a fuel

1. It is extremely clean burning. The main product of combustion is only water.
2. It can be produced from an abundant raw material, water and hence is renewable.
3. Many of its properties are highly suited to I.C. engines.

Disadvantages

1. Its energy density, either as a gas or as a liquid is quite low.
2. Since it is a highly reactive fuel, special safety precautions are necessary in handling it.
3. It can produce pre-ignition and back flash in engines, again due to its high reactivity.

5.5 ELECTRIC CAR

It is a natural fact that every automobile used for commercial purposes run by non-renewable source of energy. Moreover emission norms for automobiles are getting strict day by day and there seems to be no distinction between gasoline and diesel engines. Thus the search for alternative fuels for automobiles leads to the invention of electric cars which get the clean source of power from electric motor and can really lead to zero contamination during use.

The battery operated vehicles are popularly called as Electric vehicles (EV). All electric vehicles are non polluting, zero emission vehicles.

Electric cars use batteries to store energy needed to run the car. The lead-acid storage battery used in automobiles to start the engine is used in most electric cars. The

trouble with these batteries is that they are very heavy. And they will not provide enough electricity to run the car more than a few kilometers. That is after 80 k.m or so; the batteries need to be recharged. Driving an electric car is so easy and relaxed that it is in fact a pleasure even in the citys stop and go traffic. With no cluth or gear, it drives like an automatic.

The vehicle is equipped with a scale of charge battery indictor, which is a fuel meter. It measures the remaining charge in batteries at any point of time. By reading the lighted bars on the fuel indicator the driver can ascertain the vehicle running time before it can be brought back to the charging bay for recharging. The vehicle is provided with a spacious 8 seater compartment for commuters, headlights, turning indicator lamps, dash board indicator, cabin light, tail lights, reverse light and name plate light.

Can be a Commercial Transit Van, School Van, Private Hotel Van, Jungle Safari Van etc.

Fuel – Batteries

Lead acid batteries are the most common type of batteries used in EV, because of their low initial cost and universal availability. There are many different types of sizes and designs, but the EV industry uses the deep cycle type, because they can tolerate repeated discharges. Deep cycle batteries are designed for repeated discharge of 80 % of capacity without serious damage. Shallower cycles will increase the life of any battery. The life expectancy is greatly shortened if the batteries are not fully recharged after every discharge cycles. Letting a battery remain discharged for any length of time will cause sulfation of the positive plates and a permanent loss of capacity.

But nowadays electric cars are not used practically for commercial purposes due to the necessity of expensive storage batteries.

Battery Charging

There is no need in queuing at petrol bunks. Just plug in, charge up and taking off is the simple way at it. The charging system is extremely simple, very reliable and safe. It has an on board charger along with a charge cable and can be charged anytime, anywhere - in the convenience of home or at workplace, by simply plugging in to a 220 volt, 15 Ampere household electrical socket. The battery attains 80% charge in less than two and half hours and full charge in less than six hours.

Salient features

Two computers and the state - of - the - art electronics in the electric vehicle provide an efficient energy management system with advanced computerised vehicle diagnostics.

The running chassis consists of a very strong, self supporting, light weight space frame and includes the motor, integrated power system, drive train, steering, suspension, brakes, wheels, tyres and high voltage systems. ABS (Acrylonitrile Butadiene Styrene) body panels are directly attached to the space frame of the running chassis.

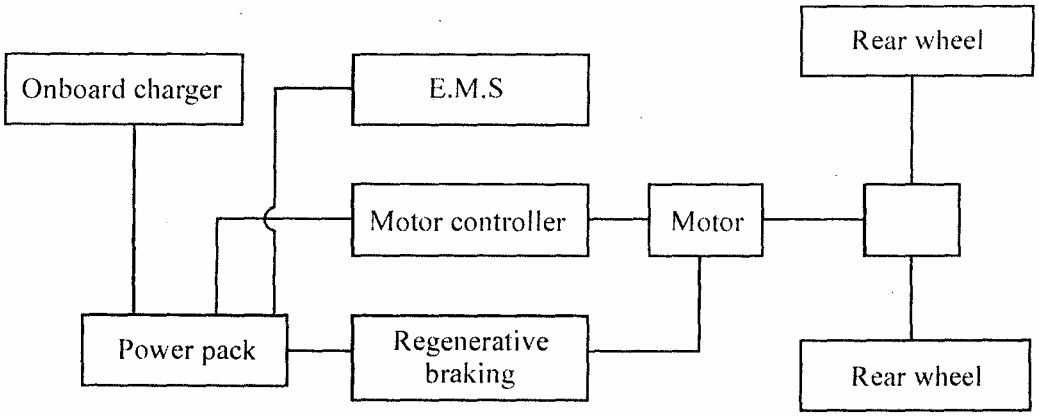


Figure 5.3 Power path of electric car

Working of electric vehicle

Electric vehicle mainly consists of the following components

1. Motor
2. Power pack
3. Onboard charger
4. Motor controller
5. Energy management system
6. Regenerative braking

Motor

The prime mover in electric vehicle is the motor. It is similar to the engine in a conventional car. It has a 13kW separately excited DC motor with a high torque of 70 Nm at zero speed. When in use, the motor converts the energy stored in the power pack into mechanical motion. The high torque electric motor ensures a quick acceleration. The power from the motor is delivered to wheels through the Trans-axle that propels the vehicle. While braking, the motor acts like a generator and recharges the power pack.

Power pack

Power pack consists of eight 6-volt EV tubular type lead acid batteries that attain 80% state of charge in under 2.5 hours. A complete charge is achieved in less than six hours. The power pack is housed beneath the front seats, which lowers the centre of gravity, thus increasing the safety of passengers. The battery power pack has a life of 3-5 years depending on usage.

Onboard charger

This converts AC into DC power to charge the power pack. The charger is computer controlled with an in - built stabilizer and auto shut - off mechanism. The smart charger's output is connected to the power pack and ensures that optimum current and voltage is maintained at all times.

Motor controller

This regulates the flow of energy from the power pack to the motor in direct relation to pressure applied on the accelerator. It ensures perfect speed control and optimum use of energy in both forward and reverse directions.

Energy management system

This monitors and controls all vital functions. The EMS is a computer based system that optimizes charging and energy output of batteries to maximize operating range and improve performance. The system also predicts available range for a given state of battery charge.

The EMS also maintain an electronic log of the vehicle performance, enables service personnel to run diagnostic checks on the car to give service information about the car.

Regenerative braking

Regenerative braking recovers useful electricity by putting it back into the batteries. Regenerative braking lets the motor act as a generator, converting the vehicle's momentum into electricity. So, when you take your foot off the accelerator or press the brake, the motor becomes a generator, slowing the car and returning energy to the battery.

Since it takes energy to make energy, the vehicle's momentum is consumed and the vehicle slows down. The immediate benefit of this process is that it simulates the compression braking (slow down effect) feature of gas engines, reducing the brake wear normal to most cars.

13. Being an electric vehicle, it is zero polluting and noiseless.
14. It does not require frequent oil changes.
15. This has high recyclable content.

5.5.2 Disadvantages of electric car

1. Batteries life is short, hence high replacement costs.
2. As the batteries are to be recharged the range is limited to about 60-70 km.
3. Need for the distribution of charging points.
4. More energy will be needed in the night to charge the batteries.
5. Unfavorable relationship between the weight of the energy storage system and tl weight of the rest of the vehicle.
6. Inferior performance parameters like acceleration, drivability
7. Lesser autonomy than I C Engine driven cars

5.6 HYBRID VEHICLES - Introduction

Many alternative power sources and fuels are being investigated all over the wor to meet the following requirements.

- Increased fuel efficiency
- Reduced emissions
- Increased acceleration capability
- Reduced noise emissions

The electric car in its present form does not represent a very easy option to use e though it is more environment friendly as compared to the I.C. Engine driven automob The immediate option seems to be to run an I.C. Engine in a better way so that it en lower levels of pollutants and also uses lesser fuel. Another option seems to be to use fuel cell as a source of power. Low emissions are possible by using a combinatior power sources i.e. a hybrid power pack. The hybrid can function as a pure electric veh for relatively short commutes while retaining the capability of a conventional automobil make long trips.

5.6.1 Components and classification of hybrid vehicle

A hybrid vehicle uses both an internal combustion engine and a battery/ generator operated motor to run an automobile. The power of a hybrid's internal-combustion engine generally ranges from one tenth to one quarter that of a conventional automobiles. This engine can run continuously and efficiently and hence the Hybrid is much cleaner than a conventional car. With good design, moreover, HEVs can achieve several times the fuel efficiency of a gasoline-powered vehicle. In the hybrid vehicle the high thermal efficiency at which the engine can be operated to charge the batteries as compared to conventional automotive type operation leads to overall improved performance.

The main components of a hybrid drive train are the following:

1. An engine, considerably lesser in power capacity than an engine in a similar conventional automotive.

2. A motor/generator that may be on a common shaft on the engine output shaft or may be connected to the engine by a gear, belt, chain or other drive system.

3. A controller for the motor generator system. This must be efficient and capable of two way power control.

4. A storage device that can give short bursts of high output needed for acceleration etc and also be capable of long time energy supply for constant speed driving and operation of auxiliaries. Batteries, flywheels, fuel cells, cryogenic expander systems etc.

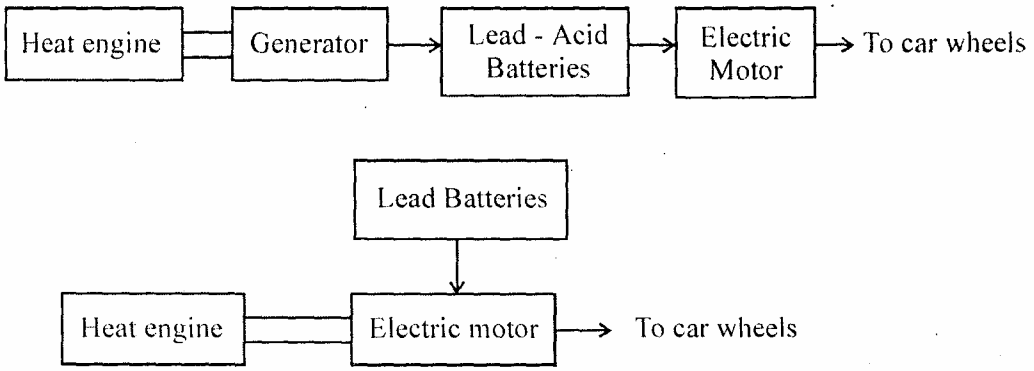
5. Differential and drive shaft.

6. Control circuits for the motor power controller, modified carburetor and engine throttle, sensors for vehicle speed, battery voltage, charge level.

Hybrid vehicles can be classified as follows:

1. **Series Hybrid :** Here the engine runs a motor directly and also charges a battery. Thus the motor thus drives the vehicle always. The motor can also be used for regenerative braking.

2. **Parallel Hybrid :** Here the I. C. Engine and the electric motor are coupled to the wheels in parallel. The engine runs at its optimal point and the motor supplements the torque of the engine. The motor can also be used for regenerative braking.



In order to achieve maximum efficiency and minimum emissions, a Hybrid vehicle can go through the following schedule and details :

a) Prime mover is a turbocharged diesel engine.

b) Under cruising conditions engine should be geared so as to operate to the best fuel conditions. The kinetic energy is absorbed by the vehicle during the acceleration.

c) The potential energy absorbed by the vehicle while climbing up the hill has to be recovered while going down the hill by regenerative braking.

d) Ideally the regenerative processes described in the modes c and d have to be reversible i.e. we should not use the brakes or the engine friction to decelerate the vehicle.

e) The vehicle operation must be as reversible as possible to reduce fuel consumption.

5.6.2 Hybrid concept

In hybrid cars there are three main components,

1. An electric motor
2. A generator
3. Direct injection gasoline engine

The electric motor is used to supply power to the wheels. The electric motor derives its energy from Nickel - Metal Hybrid battery or the Nickel - Cadmium to drive the wheel and also from electric generator. The generator is used to give power and to the wheels there by to the electric motor.

The gasoline engine is used only when the electric battery fails to get recharged. It also depends upon the acceleration.

The fuel efficiency of the hybrid system is to be increased as the engine automatically switches off when the engine stops.

Types of Hybrid System

The hybrid system consists of two systems.

1. Parallel hybrid operation
2. Series hybrid operation
3. Series hybrid system

The I.C engine liberating the heat energy converts it to mechanical energy by using a gas turbine and runs an electric motor which controls the speed of the vehicle by giving drive to the vehicles.

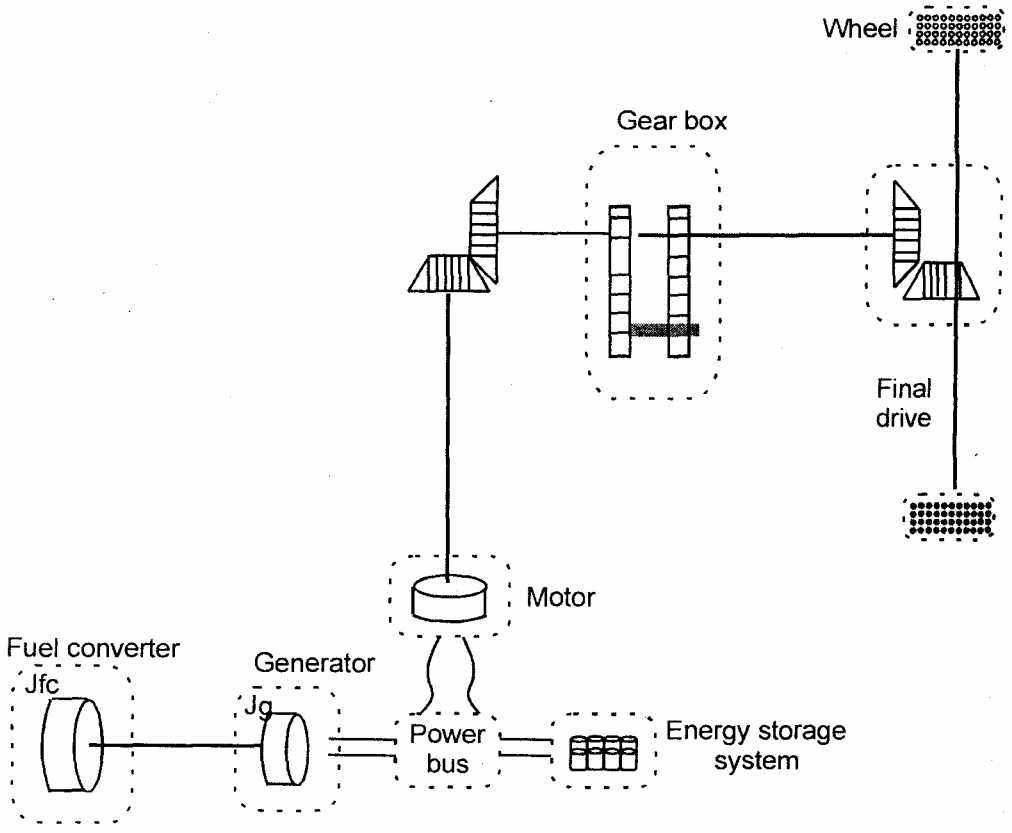


Figure 5.4 Series vehicle configuration hybrid system

Parallel drive train system

In the parallel hybrid version the engine and the motor are connected in parallel to obtain the required speed of vehicles. Under slow driving condition the motor can act in reverse as a generator for braking and to charge the batteries. The connectors are using sensors to detect the engine speed.

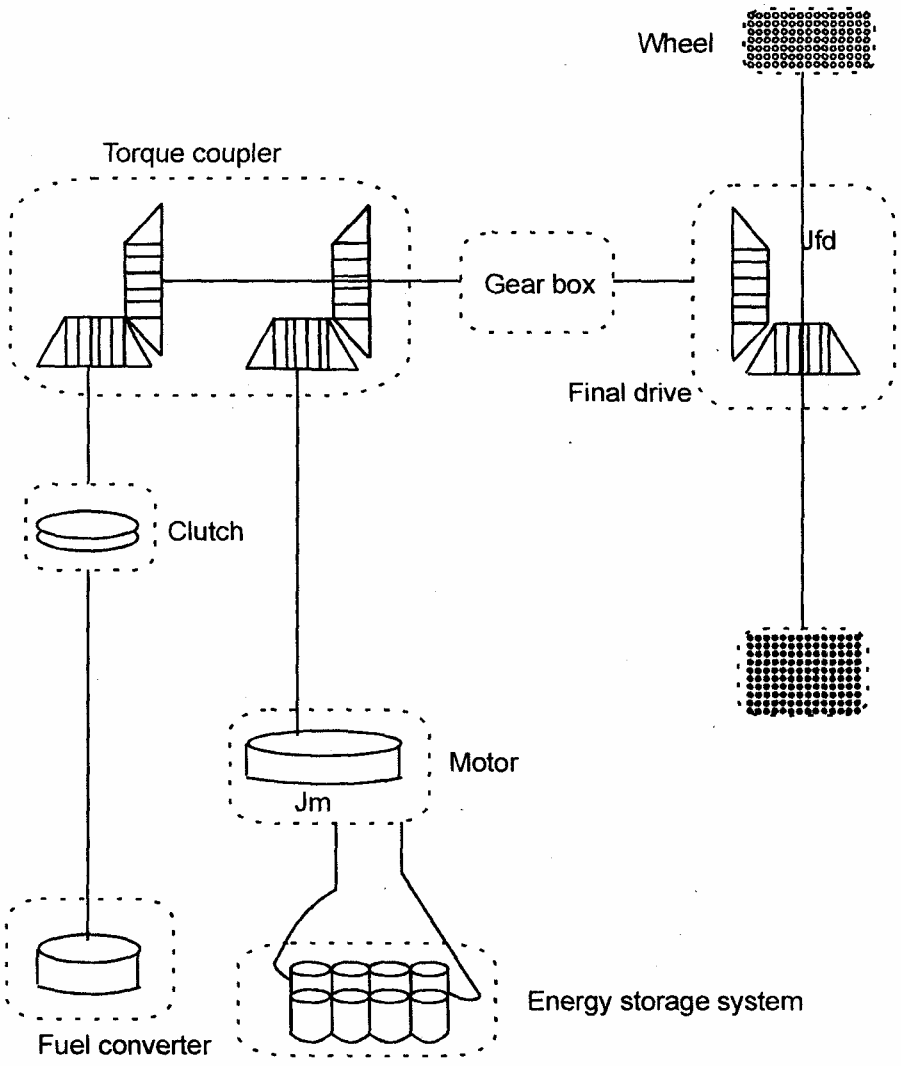


Figure 5.5 Parallel vehicle configuration

Advantages of hybrid system

1. Exceptionally low emission levels.
2. The cost of the engine is low as compared to that of installation of gas turbine and motor etc.,
3. Lesser fuel consumption

Disadvantages

1. It can be used for short distances only
2. The batteries cannot serve for or withstand to long distances.

5.7 FUEL CELL

A fuel cell is a device that harnesses the energy produced during the electro chemical reaction between hydrogen and oxygen. The products are water heat and electricity. There are no oxides of nitrogén, HC and Carbon monoxide.

Thus the use of the fuel cells can provide all the benefits of the battery and more along with extended range. They are also more efficient than the IC Engine.

Fuel cell automobile

Fuel cells are those cells which generate power to drive the vehicle using chemical reactions.

Need for fuel cells

The fuel cells have been developed due to the following reasons.

1. Depletion of conventional types of fuels leading to energy crisis.
2. Low emission required to make a car economic friendly.
3. To attain certain standards of emission control.

Fuel cell gases

The gases used for chemical fuel cells are Hydrogen and Oxygen. Though hydrogen gas is present in abundance in the atmosphere it causes serious difficulties for storing the fuel. Through a series of scientific development several storage devices are being developed. Hydrogen for example is stored in porous metals. The hydrogen when required is removed from these porous metal and then sent to for combustion. The oxygen is stored in cylinder in normal form of liquid.

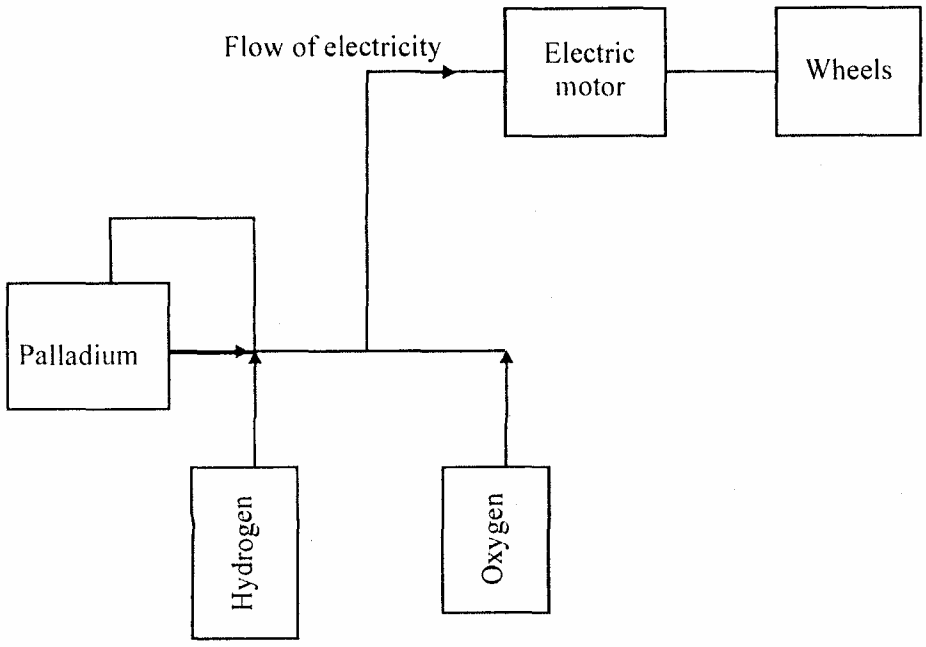


Figure 5.6 Fuel cell system

Fuel cell reaction

The hydrogen and oxygen combine in the presence of palladium to form water which generate electricity. The electricity generated is then used to run an electric motor. The end product of the reaction is water and it does not contain CO_2. The electric motor has sensors attached to the engine. When the engine decelerates, the sensors sensing the deceleration control the valve and opens the gas fuel cylinder valves.

Several hydrogen and oxygen filling stations have to be constructed which could be operated by man as well as robots. While filling at these stations, extra amount of oxygen is added. This is to prevent any suffocating inside the cars. When this occurs the oxygen air bags get dropped in.

Another interesting phenomena is that the carbon dioxide exhaled by the passengers inside a vehicle is collected by creating a vacuum. The collected carbon dioxide is then mixed with stemming water to form carbonated water. This carbonated water is collected in a tank and the water is disposed at a region where the hydrogen gas is filled. This is one of the most economic friendly gases.

Advantages of fuel cell

1. The fuel cell have very low emission of pollutants.
2. The oxygen air bags are very useful for the passengers.
3. The fuel cell prevents the depletion of the fossil fuel.
4. The carbon di oxide exhaled by the passengers is also removed.
5. Products are water, heat and electricity. There are no oxides of Nitrogen, HC and CO.
6. Provide all the benefits of the battery and more along with extended range.
7. More efficient than IC engine.
8. High efficiency and low emissions.

Disadvantages

1. Increased load capacity.
2. An elaborate storage methods for hydrogen have to be used.
3. Costly construction.