# Hybrid Motor Vehicle

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***Abstract***

*The modern day automobiles are manufactured with the idea of presence of fossil fuels which are depleting at a higher rate and fuel prices have increased drastically. In order to maintain a sustainable development, Hybrid Vehicles are made which have the advantages of both I.C. Engines and Electric Motor. Till date Hybrid technology implemented in a two wheeler has not hit the market yet due to cost issues, unavailability of resources, etc. We have made an attempt to implement hybrid technology in a two wheeler. We have modified a conventional motorcycle, installed all the components, tested and found to be successful in our objectives by showing enhanced performance results, in terms of drivability, power train shift, efficiency, etc. The following pages show the detailed report of our project*

**Keywords:** *Hybrid technology, two-wheeler, efficiency*

## INTRODUCTION

A hybrid vehicle is a vehicle that uses two or more distinct power sources to move the vehicle. The term most commonly refers to hybrid electric vehicles (HEVs), which combine an internal combustion engine and one or more electric motors.

Early hybrid systems are being investigated for trucks and other heavy highway vehicles with some operational trucks and buses starting to come into use. The main obstacles seem to be smaller fleet sizes and the extra costs of a hybrid system are yet compensated for by fuel savings, but with the price of oil set to continue on its upward trend, the tipping point may be reached by the end of 1995. Advances in technology and lowered battery cost and higher capacity etc. developed in the hybrid car industry are already filtering into truck use as Toyota, Ford, GM and others introduce hybrid pickups and SUVs. Kenworth Truck Company recently introduced a hybrid-electric truck, called the Kenworth T270 Class 6 that for city usage seems to be competitive. FedEx and others are starting to invest in hybrid delivery type vehicles—particularly for city use where hybrid technology may pay off first.

Hybrid Electric Vehicles (HEV) offer many improvements over conventional vehicles in terms of a variety of societal and environmental benefits as implemented in a variety of demonstration, concept and production vehicles. Relative to conventional vehicles, these benefits include reduced vehicle and societal greenhouse gas emissions, reduced vehicle and societal petroleum consumption, reduced regional criteria emissions, improved national energy security, reduced vehicle fuelling costs, and improved transportation system robustness to fuel price and supply volatility. In many cases, the benefits of HEVs have been shown to justify the additional functional, monetary, environmental, and infrastructural costs of their production and use. Relative to conventional vehicles, these costs may include: reduced vehicle utility and performance, increased vehicle lifecycle costs, increased regional criteria emissions, an increased rate consumption of resources for HEV production and fuelling, and costs associated with new infrastructure. The effectiveness with which HEVs can achieve a balance between the benefits and costs of their implementation is highly dependent on the detailed design, function, and conditions of use of the individual vehicle. At present, there exists no universally agreed upon or optimum design for HEVs.

The increasing demand for the implementation of more fuel and energy efficient vehicles has caused automotive designers to branch out into other areas beyond the Conventional Vehicle (CV), Battery Electric Vehicle (BEV), and HEV platforms. As an extension and subset of HEVs, Plug-in Hybrid Electric Vehicles (PHEV) offer highly improved efficiencies with minimal increases in system incremental costs. Simplified vehicle architectures of the CV, BEV, HEV, and PHEV types are shown in the Figure with a key of included components. Due to the complex nature of the systems used in creating PHEVs including the architecture, system integration, component selection and controls, highly technical methods must be used to accurately identify all critical areas and ensure that they are accounted for appropriately. In the coming years it is likely that a majority of consumers who use motorized transportation will begin to see the benefits of hybrid and PHEVs.

When the term *hybrid vehicle* is used, it most often refers to a Hybrid electric vehicle. These encompass such vehicles as the Saturn Vue, Toyota

Prius,Toyota Camry Hybrid, Ford Escape Hybrid, Toyota Highlander Hybrid, Honda Insight, Honda Civic Hybrid Lexus RX 400h and 450h and others. A petroleum-electric hybrid most commonly uses internal combustion engines (generally gasoline or Diesel engines, powered by a variety of fuels) and electric batteries to power the vehicle. There are many types of petroleum-electric hybrid drive trains, from **Full hybrid** to Mild hybrid, which offer varying advantages and disadvantages.

Henri Pieper in 1899 developed the first gasoline-electric hybrid automobile in the world. In 1900, Ferdinand Porsche developed a series-hybrid using two motor-in-wheel-hub arrangements with a combustion generator set providing the electric power, setting two speed records[*citation needed*].

While liquid fuel/electric hybrids date back to the late 19th century, the braking regenerative hybrid was invented by David Arthurs, an electrical engineer from Springdale, Arkansas in 1978–79.

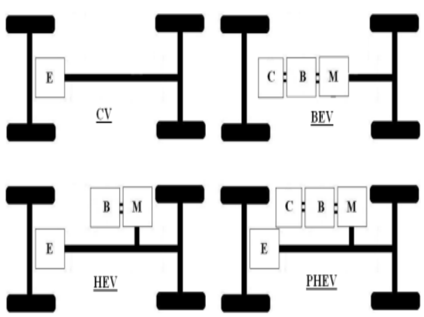
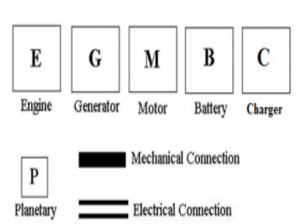



Figure 1 Sample CV, BEV, HEV, and PHEV architecture configurations.




**PARALLEL HYBRID**

In a parallel hybrid the single electric motor and the internal combustion engine are installed so that they can both individually or together power the vehicle. In contrast to the power split configuration typically only one electric motor is installed. Most commonly the internal combustion engine, the electric motor and gear box are coupled by automatically controlled clutches. For electric driving the clutch between the internal combustion engine is open while the clutch to the gear box is engaged. While in combustion mode the engine and motor run at the same speed.

**MILD PARALLEL HYBRID**

These types use a generally compact electric motor (usually <20 kW) to provide auto-stop/start features and to provide extra power assist during the acceleration, and to generate on the deceleration phase (aka regenerative braking).

On-road examples include Honda Civic Hybrid, Honda Insight, Honda CR-Z,Honda Accord Hybrid, Mercedes Benz S400 BlueHYBRID, BMW 7-Series hybrids, General Motors BAS Hybrids and Smart for two with micro hybrid drive.

**POWER-SPLIT OR SERIES-PARALLEL HYBRID**

Typical passenger car installations include the Toyota Prius, the Ford Escape, Ford Fusion, the Lexus RX400h, RX450h, GS450h, LS600h and CT200h.

In a power-split hybrid electric drive train there are two motors: an electric motor and an internal combustion engine. The power from these two motors can be shared to drive the wheels via a power splitter, which is a simple planetary gearset. The ratio can be from 0-100% for the combustion engine, or 0-100% for the electric motor, or an anything in between, such as 40% for the electric motor and 60% for the combustion engine. The electric motor can act as a generator charging the batteries.

On the open road, the primary power source is the internal combustion engine, when maximum power is required, for example to overtake, the electric motor is used to assist maximizing the available power for a short period, giving the effect of having a larger engine than actually installed. In most applications, the engine is switched off when the car is stationary reducing curbside emissions.

**SERIES HYBRID**

A series- or serial-hybrid vehicle has also been referred to as an Extended Range Electric Vehicle or Range-Extended Electric Vehicle (EREV/REEV); however, range extension can be accomplished with either series or parallel hybrid layouts.

Series-hybrid vehicles are driven by the electric motor with no mechanical connection to the engine. Instead there is an engine tuned for running a generator when the battery pack energy supply isn't sufficient for demands.

This arrangement is not new, being common in diesel-electric locomotives and ships. Ferdinand Porsche used this setup in the early 20th century in racing cars, effectively inventing the series-hybrid arrangement. Porsche named the arrangement "System Mixt". A wheel hub motor arrangement, with a motor in each of the two front wheels was used, setting speed records. This arrangement was sometimes referred to as an *electric transmission*, as the electric generator and driving motor replaced a mechanical transmission. The vehicle could not move unless the internal combustion engine was running.

The setup has never proved to be suitable for production cars, however it is currently being revisited by several manufacturers.

In 1997 Toyota released the first series-hybrid bus sold in Japan. Meanwhile, GM will introduce the Chevy Volt EREV in 2010, aiming for an all-electric range of 40 miles, and a price tag of around $40,000.Supercapacitors combined with a lithium ion battery bank have been used byAFS Trinity in a converted Saturn Vue SUV vehicle. Using supercapacitors they claim up to 150 mpg in a series-hybrid arrangement.

**PLUG-IN HYBRID ELECTRIC VEHICLE (PHEV)**

Another subtype added to the hybrid market is the Plug-in Hybrid Electric Vehicle (PHEV). The PHEV is usually a general fuel-electric (parallel or serial) hybrid with increased energy storage capacity (usually Li-ion batteries). It may be connected to mains electricity supply at the end of the journey to avoid charging using the on-board internal combustion engine.

This concept is attractive to those seeking to minimize on-road emissions by avoiding – or at least minimizing – the use of ICE during daily driving. As with pure electric vehicles, the total emissions saving, for example in $CO_2$ terms, is dependent upon the energy source of the electricity generating company.

For some users, this type of vehicle may also be financially attractive so long as the electrical energy being used is cheaper than the petrol/diesel that they would have otherwise used. Current tax systems in many European countries use mineral oil taxation as a major income source. This is generally not the case for electricity, which is taxed uniformly for the domestic customer, however that person uses it. Some electricity suppliers also offer price benefits for off-peak night users, which may further increase the attractiveness of the plug-in option for commuters and urban motorists.

**FUEL CELL, ELECTRIC HYBRID**

The fuel cell hybrid is generally an electric vehicle equipped with a fuel cell. The fuel cell as well as the electric battery is both power sources, making the vehicle a hybrid. Fuel cells use hydrogen as a fuel and power the electric battery when it is depleted. The Chevrolet Equinox FCEV, Ford Edge Hyseries Drive and Honda FCX are examples of a fuel cell/electric hybrid.

**ROAD SAFETY FOR CYCLISTS, PEDESTRIANS**

A 2009 National Highway Traffic Safety Administration report examined HEV accidents that involved pedestrians and cyclists and compared them to accidents involving combustion-engine vehicles. The findings showed that, in certain road situations, HEVs are more dangerous for those on foot or bicycle. For accidents where a vehicle was slowing or stopping, backing up, entering or leaving a parking space (when the sound difference between HEVs and CEVs is most pronounced), HEVs were twice as likely to be involved in a pedestrian crash than CEVs. For crashes involving cyclists or pedestrians, there was a higher incident rate for HEVs than CEVs when a vehicle was turning a corner. But there was no statistically significant difference between the types of vehicles when they were driving straight.

**ENVIRONMENTAL ISSUES**

Fuel consumption and emissions reductions the hybrid vehicle typically achieves greater fuel economy and lower emissions than conventional internal combustion engine vehicles (ICEVs), resulting in fewer emissions being generated. These savings are primarily achieved by three elements of a typical hybrid design:

1. Relying on both the engine and the electric motors for peak power needs, resulting in a smaller engine sized more for average usage rather than peak power usage. A smaller engine can have less internal losses and lower weight.
2. Having significant battery storage capacity to store and reuse recaptured energy, especially in stop-and-go traffic, which is represented by the city driving cycle.
3. Recapturing significant amounts of energy during braking that are normally wasted as heat. This braking reduces vehicle speed by converting some of its kinetic energy into electricity, depending upon the power rating of the motor/generator;

Other techniques that are not necessarily 'hybrid' features, but that are frequently found on hybrid vehicles include:

1. shutting down the engine during traffic stops or while coasting or during other idle periods;
2. Improving aerodynamics; (part of the reason that SUVs get such bad fuel economy is the drag on the car. A box shaped car or truck has to exert more force to move through the air causing more stress on the engine making it work harder). Improving the shape and aerodynamics of a car is a good way to help better the fuel economy and also improve handling at the same time.
3. Using low rolling resistance tires (tires were often made to give a quiet, smooth ride, high grip, etc., but efficiency was a lower priority). Tires cause mechanical drag, once again making the engine work harder, consuming more fuel. Hybrid cars may use special tires that are more inflated than regular tires and stiffer or by choice of carcass structure and rubber compound have lower rolling resistance while retaining acceptable grip, and so improving fuel economy whatever the power source.
4. Powering the a/c, power steering, and other auxiliary pumps electrically as and when needed ; this reduces mechanical losses when compared with driving them continuously with traditional engine belts.

These features make a hybrid vehicle particularly efficient for city traffic where there are frequent stops, coasting and idling periods. In addition noise emissions are reduced, particularly at idling and low operating speeds, in comparison to conventional engine vehicles. For continuous high speed highway use these features are much less useful in reducing emissions.

**HYBRID VEHICLE EMISSIONS**

Hybrid vehicle emissions today are getting close to or even lower than the recommended level set by the EPA (Environmental Protection Agency). The recommended levels they suggest for a typical passenger vehicle should be equated to 5.5 metric tons of carbon dioxide. The three most popular hybrid vehicles, Honda Civic, Honda Insight andToyota Prius, set the standards even higher by producing 4.1, 3.5, and 3.5 tons showing a major improvement in carbon dioxide emissions. Hybrid vehicles can reduce air emissions of smog-forming pollutants by up to 90% and cut carbon dioxide emissions in half.

**ENVIRONMENTAL IMPACT OF HYBRID CAR BATTERY**

Though hybrid cars consume less petroleum than conventional cars, there is still an issue regarding the environmental damage of the hybrid car battery. Today most hybrid car batteries are one of two types: (1) nickel metal hydride, or (2)lithium ion; both are regarded as more environmentally friendly than lead-based batteries which constitute the bulk of gasoline car starter batteries today. There are many types of batteries. Some are far more toxic than others. Lithium ion is the least toxic of the three mentioned above.

The toxicity levels and environmental impact of nickel metal hydride batteries—the type currently used in hybrids—are much lower than batteries like lead acid or nickel cadmium. However, nickel-based batteries are known carcinogens, and have been shown to cause a variety of teratogenic effects.

The Lithium-ion battery has attracted attention due to its potential for use in hybrid electric vehicles. Hitachi is a leader in its development. In addition to its smaller size and lighter weight, lithium-ion batteries deliver performance that helps to protect the environment with features such as improved charge efficiency without memory effect. The lithium-ion batteries are appealing because they have the highest energy density of any rechargeable batteries and can produce a voltage more than three times that of nickel–metal hydride battery cell while simultaneously storing large quantities of electricity as well. The batteries also produce higher output (boosting vehicle power), higher efficiency (avoiding wasteful use of electricity), and provides excellent durability, compared with the life of the battery being roughly equivalent to the life of the vehicle. Additionally, use of lithium-ion batteries reduces the overall weight of the vehicle and also achieves improved fuel economy of 30% better than gasoline-powered vehicles with a consequent reduction in CO2 emissions helping to prevent global warming.

**OUR INNOVATION**

In the above topics we have discussed about hybrid technologies embedded in four wheelers and above. We have coincide our views to the existing Parallel hybrid with the combination of both I.C. Engines and Electric motor appropriate for a two wheeler. A lot of research has been undertaken and a successful model has not hit the market yet. The following topics are purely based on the attempts that have been undertaken by us.

**INITIAL STAGE:**

A lot of paperwork was made before actually getting our hands on the project. The search of a two-wheeler with better engine performance was done and purchased. Initialled the bike had the following specs.

| | |
|---|---|
| Engine Type: | 4Stroke Single Cylinder Air-cooled OHC |
| Displacement: | 97.2 cc |
| Compression Ratio: | 8.8:1 |

Maximum Power: 7.5BHP@8000 RPM BHP@RPM
Maximum Torque: 7.55@6000 Nm@rpm
Cylinder Bore: 50 mm
Stoke: 49.5 mm
Ignition: CDI
Starting: Kick-start.

Later few modifications were made and certain unwanted parts were removed from the vehicle in order to reduce the weight. They were,

- Air filter casing
- Air filter
- Tool box
- Head lamp assembly
- Tail lamp assembly

Side covers (both left & right)

**MOTOR SPECIFICATIONS:**
Power : 1000 W (1.3 Hp)
Voltage : 24 V

Ampere rating: 40 A

Type: Permanent magnet

Maximum speed : 1500 rpm

**FLLY WHEEL**

In a conventional bike the purpose of the flywheel is satisfied by the presence of a magneto coil. The magneto encloses five parts of the electrical system:

- An armature.
- A primary coil
- A secondary coil
- A simple electronic control unit that commonly goes by the name "Pulser Coil" (or a set of breaker points and a capacitor)
- A pair of strong permanent magnets embedded in the magneto.

A new flywheel was designed and fabricated with a pulley embedded on to it. A rot which is a small metal strip made of mild steel is welded along with a kick back over the flywheel in accordance to the ignition timing. The pulley was provided in order to transmit the power from the flywheel to the alternator by a belt drive

**conventional flywheel**

**modifided flywheel**

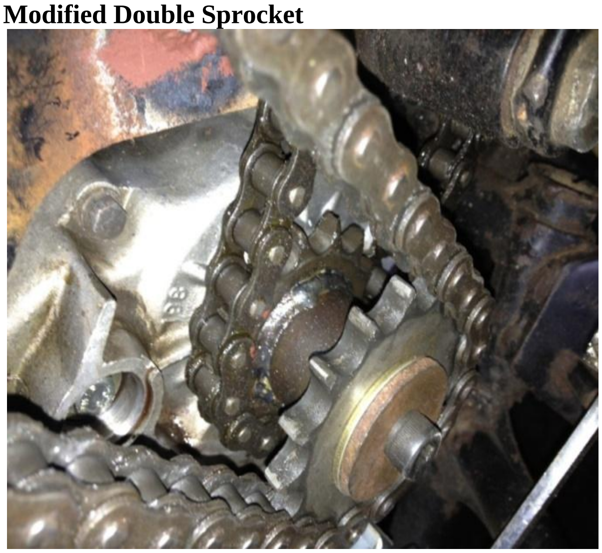
**DOUBLE SPROCKET**

The double sprocket was fabricated by welding two sprockets one with 14 teeth internally and the other with 16 teeth externally. The Specifications of the double sprocket is listed below.

- Material used: tempered steel
- No of teeth in sprocket 1: 14 teeth
- No of teeth in sprocket 2: 16 teeth
- Distance between 2 sprockets: 3 cms

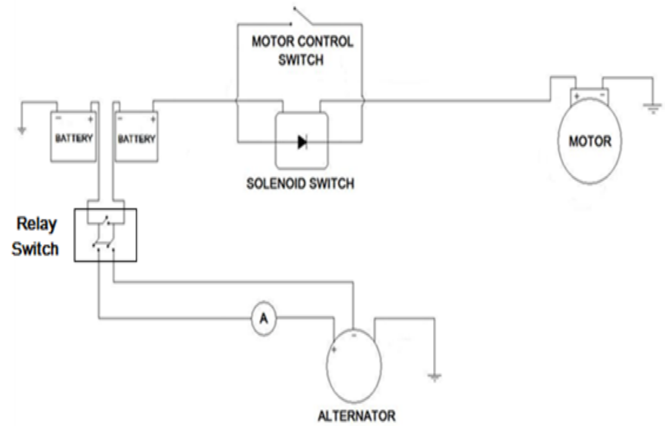
**Conventional Inner Sprocket**

**Modified Double Sprocket**



**CHARGING CIRCUIT USED IN BATTERY**

As the engine gets started, flywheel which is connected to alternator through V-Belts, electricity is generated. Pulley is welded and connected inside the flywheel. During idealing condition the charging rate is 7Amps. Where in running condition its about 12-15 Amps. With the increase in rotation speed the amount of charging rate will be getting increased.

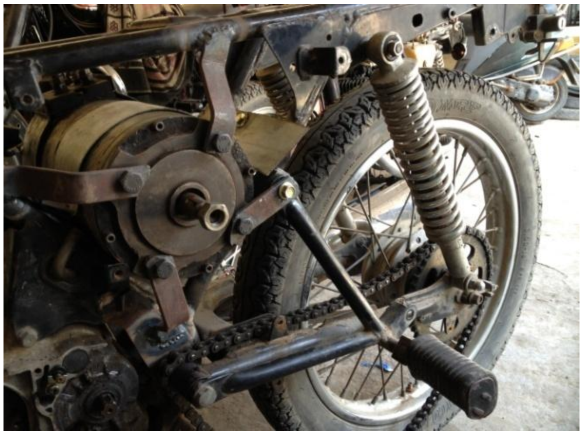



Circuit diagram for motor and recharging circuit

**DC MOTOR**

The Parallel power-train, the electric motor was mounted in the chassis and supported it with clamps for rigidity.

In normal vehicle the place where the motor mounted is occupied by air filter, it has been fitted in four sides for getting structural rigidity. we are mounting a Rajdoot filter from carburetor.



## CALCULATION

Motor speed=1500rpm

Sprocket Z1=14

Sprocket Z2=16

Z1/Z2=N2/N1

14/16=N2/1500

.875*1500=N2

N2=1313rpm

Gear box sprocket Z1=14 for1313rpm

Rear wheel sprocket Z2=42

Z1/Z2=N2/N1

14/42=N2/1313

.33333333*1313=N2

N2=438rpm

Time for Battery charging

Charging rate =13 Amps

Battery capacity=4 nos with 20 Amps each

Loss during charging=10%

Charging with loses=0.1×13=1.3

Battery charging =Actual charging rate-losses

Battery charging=13-1.3=11.7

Charging time= capacity/Battery charging

Charging time=80×/11.7

Charging time=6.8 hrs.

Battery discharge timings

Battery capacity=80Amps

Motor rating=40Amps

Battery discharge time= battery capacity/motor rating

Battery discharge timing=80/40

Battery discharge timing ≈2 hrs

Only 70% of energy will be used remaining 30% remains unused for increasing the battery life.

## COMPARISON AND CONCLUSION

| PARAMETERS | BEFORE CONVERSION | AFTER CONVERSION |
|---|---|---|
| weight | 116kg | 150kg |
| Engine speed | 1279rpm | 899rpm |
| Recharging circuit | 1.05Ah | 12.7Ah |
| Total distance travelled by engine | 54.6km | 42km |
| Total distance travelled by motor | nill | 60km |
| Battery capacity(4nos) | 12V,2.5Ah | 24V,80Ah |

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