INNOVARE JOURNAL OF ENGINEERING & TECHNOLOGY

Vol 3, Issue 1 , 2015 ISSN: 2347-1573

Review Article

PERFORMANCE OF HYBRID SYSTEM FOR AUTOMOBILE

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Received: 30 November2014, Revised and Accepted:17 January 2015

ABSTRACT

Studies on new fuel-saving technologies have been popular in recent years because of decreasing global crude oil supplies and growing environmental concerns. The price of crude oil, according to the Department of Energy (2007), is over 400% higher than ten years ago (Figure 1.1) and is likely to continue to surge in the future because of shrinking oil supplies. To reduce oil consumption by Figure 1.1: World crude oil price have increased over 400% since 1998 (DOE, 2007) *Courtsey:www.howstuff.com* ground vehicles, the Corporate Average Fuel Economy (CAFE) was enacted by the US Congress in 1975. The CAFE legislation is overseen by the National Highway Traffic Safety Administration (NHTSA), which sets fuel economy standards for cars and light trucks (trucks, vans, and sport utility vehicles) sold in the US and other countries fallow it's rule as suitable change . While the CAFE standards have remained relatively constant for the last twenty years, the discussion of increasing it is significant in the past fifteen years regarding shrinking oil supplies and increasing oil demands

Keywords: *environmental,Oil,Hybrid vehicle,electric vehicle,power,conventional, efficient*

INTRODUCTION TO HYBRID VEHICLE

A hybrid electric vehicle (HEV) adds an electric power path to the conventional power train, which helps to improve fuel economy by engine right-sizing, load leveling, and re-generative braking. A right-sized engine has better fuel efficiency, lower heat loss, and reduced peak power. The reduced power is compensated by an electric machine (or machines) during surged power demand. Compared with internal combustion engines, electric machines provide torque more quickly, especially at low speed. Therefore, launching performance can be improved, even with reduced overall rated power. Load leveling can also be achieved by the electrical path. With the electric drive assistance, the engine can be controlled to operate in an optimal region regardless of the road load. Finally, when the vehicle is decelerating, the electric machine can capture part of the vehicle's kinetic energy and recharge the battery.

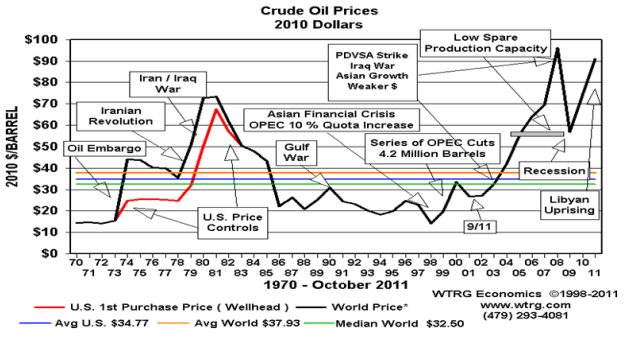

Figure 1.1: World crude oil price have increased over 400% since 1998 (DOE, 2007) *Courtsey:www.howstuff.com*

Fusion between an internal combustion engine and electric motor—achieving different functions through different power combinations. According to the Swedish National Encyclopedia the hybrid comes from the Latin word (h) I'brida, hy'brida which means "cross" or bastard and its origin in the Greek word "bastard"

Hybrid vehicle is define as by encyclopedia this is fitted with more than one type of energy transformer and energy storage system for its propulsion, and where the drive or the regulating system of the vehicle determines which type shall be used. Automobile hybrid systems combine two motive power sources, such as an internal combustion engine and an electric motor, to take advantage of the benefits provided by these power sources while compensating for each other's shortcomings, resulting in highly efficient driving performance. Although hybrid systems use an electric motor, they do not require external charging, as do electric vehicles.

BRIEF DESCRIPTION OF THE THEORY AND EXPERIMENTAL ANALYSIS

Air Standard Cycle

The air standard cycle is a cycle followed by a heat engine which uses air as the working medium. Since the air standard analysis is the simplest and most idealistic, such cycles are also called *ideal cycles* and the engine running on such cycles are called *ideal engines.*

In order that the analysis is made as simple as possible, certain assumptions have to be made. These assumptions result in an analysis that is far from correct for most actual combustion engine processes, but the analysis is of considerable value for indicating the upper limit of performance. The analysis is also a simple means for indicating the relative effects of principal variables of the cycle and the relative size of the apparatus.

Assumptions

The working medium is a perfect gas with constant specific heats and molecular weight corresponding to values at room temperature.

No chemical reactions occur during the cycle. The heat addition and heat rejection processes are merely heat transfer processes.

The processes are reversible.

Losses by heat transfer from the apparatus to the atmosphere are assumed to be zero in this analysis.

The working medium at the end of the process (cycle) is unchanged and is at the same condition as at the beginning of the process (cycle).

In selecting an idealized process one is always faced with the fact that the simpler the assumptions, the easier the analysis, but the farther the result from reality. The air cycle has the advantage of being based on a few simple assumptions and of lending itself to rapid and easy mathematical handling without recourse to thermodynamic charts or tables or complicated calculations. On the other hand, there is always the danger of losing sight of its limitations and of trying to employ it beyond its real usefulness.

Equivalent Air Cycle

A particular air cycle is usually taken to represent an approximation of some real set of processes which the user has in mind. Generally speaking, the air cycle representing a given real cycle is called an *equivalent air cycle*. The equivalent cycle has, in general, the following characteristics in common with the real cycle which it approximates:

A similar sequence of processes.

Same ratio of maximum to minimum volume for reciprocating engines or maximum to minimum pressure for gas turbine engines.

The same pressure and temperature at a given reference point.

An appropriate value of heat addition per unit mass of air.

Internal Combustion Engine

An IC engine is one in which the heat transfer to the working fluid occurs within the engine itself, usually by the combustion of fuel with the oxygen of air. In *external* combustion engines heat is transferred to the working fluid from the combustion gases via a heat exchanger. e.g. steam engines; Stirling engines IC engines include spark ignition (SI) engines using petrol as a fuel, and compression ignition (CI) engines (usually referred to as Diesel engines) using fuel oil, DERV, etc as a fuel .

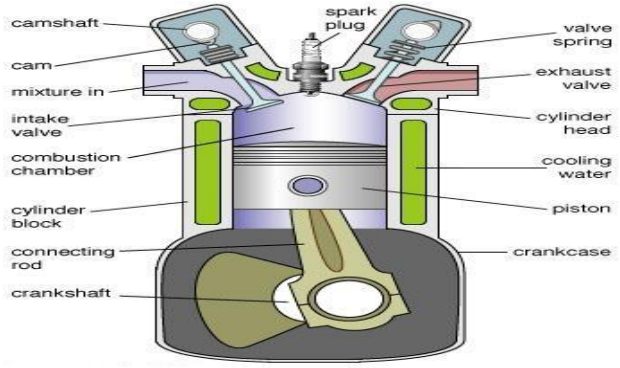

Fig.NO.2.1 ***Courtesy: thoughtworkinovetion.com***

In our project we are used an IC engine which have 49.77cc capacity and generate 4.2 n-m torque

We are using a small IC engine for giving our hybrid concept. As we are running our engine with dual power in which one is the IC engine which is running with the petrol. The specification of our IC engine is given al below.

Brushless D.C. motor

The motor has been based on the technologies that while working on electric vehicles. -type motor, which is a high-efficiency DC brushless motor with DC current. Neodymium magnets (permanent magnets) and a rotor made of stacked electromagnetic steel plates form a high-performance motor. Furthermore, by arranging the permanent magnets in an optimum V-shape, the drive torque is improved and the output is increased. This, combined with a larger power supply achieved by an increase in the power supply voltage, has increased power output by approximately 1.5 times from THS, i.e., to 50 kW from 33 kW, even with a motor of the same size, producing the highest output per unit of weight and volume in the world. For motor control, a newly developed over-modulation control system has been added to the medium-speed range, in addition to the existing low- and high-speed control methods. By improving the pulse width modification method, the output in the medium-speed range has been increased by a maximum of approximately 30%

Table NO 1

Bore	38.4 mm
Stroke	43 mm
No. of cylinder	One horizontal
Displacement (cc)	49.8 cc
Compression Ratio	8.0:1 (+0.5)
a. Max. Engine Output (kw)	1.25 + 0.06 kw@ 4500 + 500 rpm
b. Max. Engine Output (HP)	1.67
Max. Torque (Nm)	2.943 @ 3000 rpm
Weight of Engine (Kg.)	7.5
Air cleaner	Wire mesh
Oil sump capacity	N.A.

The next power supplying to our hybrid bike is the Electric motor. We are using the DC (direct current) motor for our hybrid bike. Specification of used DC motor are given as below.

Table NO.2

Wattage	*200W*
Gear Box	Helical
Max. Torque (Nm)	*2.1*
Weight(kg)	*2.2*
Binding	Copper
Speed(rpm)	1500

We are using a **Moped** as to hybrid our concept. As before I had given the detail study of our one power source i.e., IC engine which is driving our wheel. Now we are modifying these bike by our hybrid concept in which in we are combing the power from IC engine and DC motor.

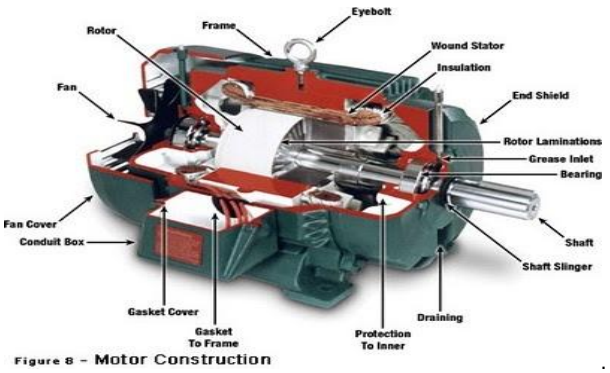

Fig. NO.2.2 ***Courtesy: thoughtworkinovetion.com***

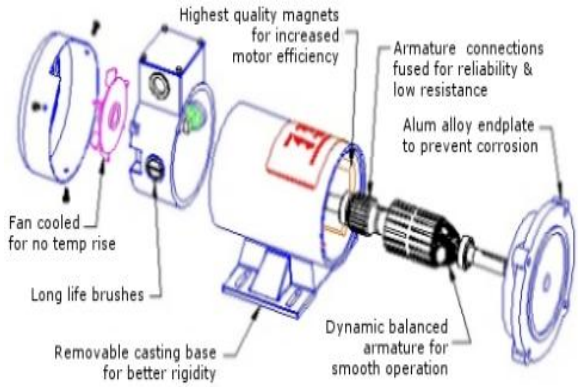

Fig. NO 2.3 ***Courtesy thoughtworkinovetion.com***

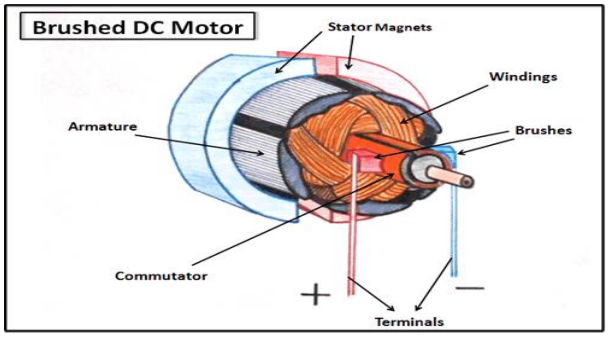

Fig.. NO 2. ***Courtesy: thoughtworkinovetion.com***

Battery

We used 12 volt battery for as electric power supply

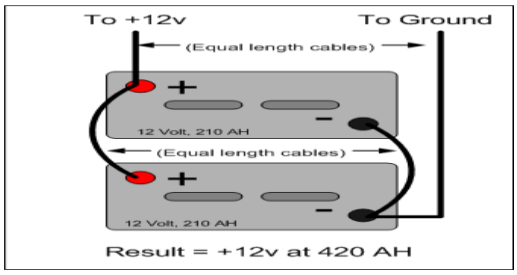

Fig. NO.2.5 ***Courtesy: thoughtworkinovetion.com***

Cassette Free hub

The concept of a 'cassette' or unit hub was devised and manufactured by British company Bayliss-Wiley in 1938 and won the Cyclists Touring Club (CTC) award for that year. On the Bayliss-Wiley design the freewheel unit was threaded to accept the sprockets. A different four speed design was manufactured by BSA Cycles Ltd in 1949 to accompany their BSA 4 Star derailleur gear. The BSA design had a splined freewheel unit (BSA part No.8-1913) which attached to the hub shell (BSA part No.8-701) and carried four sprockets. Shimano made their first free hub in 1978 in both the Dura-Ace, and 600 (later known as Ultegra) models. It was a significant improvement. It proved to be the first widely commercially successful free hub. Modern Hyper glide-type cassettes (everything made since the late 1980s) use a threaded locking to hold the sprockets onto the splines of the free hub body. A **free hub** is a type of bicycle hub that incorporates a ratcheting mechanism, and the name *free hub* is a registered trademark of Shimano. A set of sprockets (called a "cassette") are mounted onto a splined shaft of the free hub to engage the chain. The ratcheting mechanism is a part of the hub, in contrast to a freewheel, an older technology, which contains both the sprockets and a ratcheting mechanism in a single unit separate from the hub. In many high-end and midrange bicycles, free hubs have replaced freewheel systems. Freewheels are threaded onto an axle hub, using conventional right-hand threads. As the bicycle rider pedals, the freewheel is continuously kept tight, as chain torque is in the right-hand direction. This becomes a problem when the freewheel needs to be removed. Having undergone high torque from leg muscles, it is difficult to loosen and remove the freewheels. A free hub, on the other hand, has cogs that slide onto an axially-splined cylindrical outer shell. A locking or the last cog(s) are threaded onto the free hub. It is fastened to the wheel hub itself with a hollow retaining screw (for example, using a hex key on some models) through which the axle is inserted during operation.

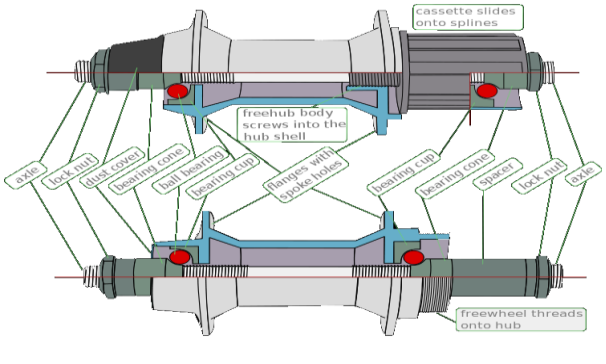

Fig. NO.2.6 ***Courtesy: thoughtworkinovetion.com***

Sprockets

A sprocket or sprocket-wheel is a profiled wheel with teeth, cogs, or even sprockets that mesh with a chain, track or other perforated or indented material. The name 'sprocket' applies generally to any wheel upon which are radial projections that engage a chain passing over it. It is distinguished from a gear in that sprockets are never meshed together directly, and differs from a pulley in that sprockets have teeth and pulleys are smooth

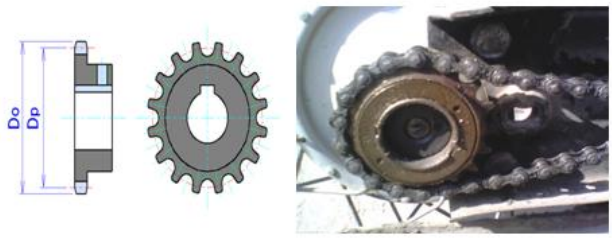

Fig. NO 2.7

Mechanical chain link

A **chain** is a series of connected **links** which are typically made of metal. A chain may consist of two or more links.

Obsolete chain designs previously used on bicycles included the block chain, the skip-link chain, and the Simpson lever chain. Most modern bicycle chains used with a single chaining and single rear sprocket are conventional industrial bushing chain. Until the 1980s, most derailleur chains were also bushing chains, but today, virtually all derailleur chains are of the "Sedis" bushing less design. Compared to a bushing chain, a bushing less chain is cheaper to make, is less likely to break under shifting load, promotes better lubricant flow inside the rollers, and creates more lateral flexibility for multi-geared bicycles. However, it also wears much faster and has slightly worse mechanical efficiency than a bushing chain

A **bicycle chain** is a roller chain that transfers power from the pedals to the drive-wheel of a bicycle, thus propelling it. Most bicycle chains are made from plain carbon or alloy steel, but some are nickel-plated to prevent rust, or simply for aesthetics. Nickel also confers a measure of self-lubrication to a chain's moving parts. Nickel is a relatively non-galling metal.

A bicycle chain can be very energy efficient: one study reported efficiencies as high as 98.6%.The study, performed in a clean laboratory environment, found that efficiency was not greatly affected by the state of lubrication. A larger sprocket will give a more efficient drive, reducing the movement angle of the links. Higher chain tension was found to be more efficient: "This is actually not in the direction you'd expect, based simply on friction".

METHODOLOGY

Introduction

This chapter comprises of two halves. First half contains the fabrication and second half is containing the methodology.

In the first half the fabrication i.e. the complete construction of our project model is being described from the commencement to the accomplishment. Here we have mentioned the specifications of every individual part and from where it is brought and how one by one all the parts are assembled.

In the second half methodology i.e. how the data analysis is done. Here we have explained that what procedure is adopted to collect data and how the calculations are done.

Mechanical Fabrication:-

IC Engine

We are using a **Moped** for our hybrid concept which is best suited for our concept. As our concept is that we using the sprocket for driving the wheel from both IC engine and Electric Motor. The working of sprocket is that it will drive in only one direction i.e., only in anticlockwise direction.The output shaft coming from the IC engine is attached with the centrifugal clutch to the pulley and then pulley is connected with the another pulley by means of belt drive. The pulley connected with the belt drive is welded on the engine frame on the shaft combined with the gear arrangement. The

gear arrangement is then connected with the sprocket by means of chain drive. Chain specification which we are

using is given as below:-

The chain is use on modern bicycles has a ½" pitch, which is ANSI standard #40, where the 4 indicates the pitch of the chain in eights of an inch, and metric #8, where the 8 indicates the pitch in sixteenths of an inch.

Chain can be very energy efficient: one study reported efficiencies as high as 98.6%. Efficiency was not greatly affected by the state of lubrication. Higher chain tension was found to be more efficient: "This is actually not in the direction you'd expect, based simply on friction. Chain is connected to the sprocket and the sprocket is connected to rear wheel which provide the rotational motion coming

Fig.. NO 3.1

from the Engine to the pulley and pulley to the sprocket and then to the rear wheel. There are some losses due to this arrangement of pulley and belt drive. As the moped which we are using is a belt driven. And we do note disassemble these due the material of the centrifugal clutch. Centrifugal clutch is made up of the Beat material in which welding is not suitable (not successful). These centrifugal clutch is fabricated with the pulley that's why it is not possible to remove the belt drive mechanism One unique thing is that the rear wheel can be disconnected from the engine drive so as to convert the wheel in to bicycle- transmission by pedaling. Press the lever shown in figure () downward to release locking with. Then push the knob inside the innermost position and release the lever to lock once again with knob .this mechanism convert vehicle into the bicycle drive. To convert back to the engine drive, release locking of knob by pressing lever downwards, if necessary rotate wheel to lock the engine drive mechanism .this operation are to be done when engine is not running.

Fig.. NO 3.2

Electric Motor

Fabrication of DC motor to the Moped body:-

DC motor is fixed to a wooden surface by means of Nut and Bolt. The adjustment is given so that there is clearance for adjusting the belt drive to the tighten the belt. The wooden surface is used as a bed To the DC motor. As the wooden bed is cheap and also absorb the mechanical shock easily. These arrangement is then fixed to the body of the Moped by means of Welding. DC motor having a pulley attached to it. We added an axle in which one pulley and one gear is welded to drive this mechanism. The DC motor is connected by means of belt drive which rotate the pulley in the same direction as the motor rotate. Pulley (DC motor attached) which is attached with

Fig.. NO 3.3

the next pulley having a gear attached with it. The gear which is attached to the pulley is then attached to the sprocket by means of chain drive. The gear rotate in the same direction in which the motor rotate and the sprocket also rotate in the same direction in which the motor rotate thus the sprocket 2 which is attached on the right side and sprocket 1 which is attached to the left side rotate in the same direction thus the wheel rotate in the same direction. We had given these arrangement because the motor which we have got having the pulley in it that's why we have to give the belt drive mechanism and then these belt drive motion is then converted into chain drive by adding one gear to it. Does do u sprocket having in these direction the wheel movement will be in the forward direction only not in the reverse direction thus in the reverse direction it will move freely i.e., there is movement of the sprocket but not the movement of the chain. As we are giving our hybrid concept which is running the bike in the three modes:-

With the IC engine.
With the Electric Motor.
Combined with IC engine and Electric Motor.

With IC Engine

The power coming from the IC engine is given to the second pulley by means of belt drive by the centrifugal clutch. These second pulley is then connected to the gear on the same shaft by means of welding. These gear is then connected to the sprocket by means of chain drive thus there is only forward moment. Thus the bike is running with the IC engine.

Fig. NO 3.4

With DC Motor

Power coming from the DC motor is given to the fourth pulley by means of belt drive and on the same shaft of the fourth pulley a gear is attached which is connect to the sprocket by means of chain. Thus the bike is running with the DC motor in forward direction only.

Combined with IC Engine and DC Motor

For running the bike combined with IC Engine and DC motor we are using an RPM sensor and Micro controller. The working of RPM sensor and Micro controller is that the power coming from the IC Engine is delivered to the rear wheel then this RPM sensor sense the rotation of rear wheel and gives the output to the Micro controller. Working of Micro controller is that it takes the output from RPM sensor as input and gives the current to the DC motor such that it will rotate with the same RPM as wheel is rotating. Thus at the same time both the power from the IC Engine and DC motor is same i.e., at same time rear wheel is getting same power from DC motor as given by IC engine. Hence the combined power from IC engine and DC motor run the bike.

Fig. NO3.5

Methodology
Introduction

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In the second half methodology i.e. how the data analysis is done. Here we have explained that what procedure is adopted to collect data and how the calculations are done

Since our concept was fully based on series hybrid system in which we are using 2 power modes i.e. from engine and from motor. For the analysis of fuel consumption firstly the calculation is done in single mode i.e. in engine mode and then we will calculate the fuel consumption in dual mode that is in engine and motor.

In case of single mode (engine mode):For checking up the fuel consumption the first and the foremost thing is to empty up the fuel tank and then take 100 ml of petrol with the help of particular measurement and pour it into the tank then count time using stop watch and start the engine and the watch simultaneously. With the help of tachometer measure the r.p.m. of the wheel (note - do not accelerate the engine). After total consumption of the fuel stop the experiment and it is repeated three times.

In case of double mode (engine and motor): For checking up the fuel consumption the first and the foremost thing is to empty up the fuel tank and then take 100 ml of petrol with the help of burette and pour it into the tank then take up the stop watch and start the engine and the watch and at the same time motor is connected to battery simultaneously. After doing so with the help of tachometer note down the r.p.m of the wheel (note that do not accelerate the engine). After finishing up the fuel of the engine the it stops automatically and at the same time stops the watch and also disconnect the motor to the battery.

Chapter 4

Observation and analysis

Calculations of distance travelled by moped with single mode using known quality of fuel:

Table 3

Radius Of Wheel	**25.4cm Or .254 m**
Fuel Used	100 ml
R.P.M	160
Time	10:58 Min Or 658 Sec

As we know that

Angular velocity $\omega = 2\pi N/60$

$= (2\times3.14\times160)/60$

$=16.75$ rad /sec

Now,

Linear velocity $v = \omega \times r$

$=16.75\times.254$

$=4.25$ m/s

Distance=velocity*time

$= 4.25\times65 = 2796$ meters

Calculations of distance travelled by moped with double mode using known quality of fuel with motor

Table 4

Radius Of Wheel	**25.4cm Or .254 m**
Fuel Used	100 ml
R.P.M	240
Time	12:20 Min Or 740 Sec

As we know that

Angular velocity $\omega = 2\pi N/60$

$= (2\times3.14\times240)/60$

$=25.13$ rad /sec

Now,

Linear velocity $v = \omega \times r$

$=25.13\times.254$

$=6.38$ m/s

Distance=velocity × time

$= 6.38\times658$

$=4721.2$ meters

For 1km fuel consumption is 35.16ml.for the same distance but in dual mode the fuel consumption reduced to 21.18ml.

The average of the engine is increased to 68%

CHAPTER 5

RESULTS AND CONCLUSION

RESULT

As we have seen that by driving the vehicle on the single mode with 100 ml of fuel it covered the distance of 2791 meters or 2.79 km
By driving the vehicle on the dual mode with 100 ml of fuel and motor it covered the distance of 4721.2 meters or 4.72 km

CONCLUSION

A hybrid electric vehicle (HEV) adds an electric power path to the conventional power train, which helps to improve fuel economy by engine right-sizing, load leveling, and re-generative braking. A right-sized engine has better fuel efficiency, lower heat loss, and reduced peak power. The reduced power is compensated by an electric machine (or machines) during surged power demand. Compared with internal combustion engines, electric machines provide torque more quickly, especially at low speed. Therefore, launching performance can be improved, even with reduced overall rated power.

As we had worked on 49 cc I.C. Engine and 12 v. D.C. Motor to transmit the power on the rear wheel simultaneously as well as separately. This is done by using the sprocket and gear arrangement at the rear wheel. Gear arrangement is provided on the rear wheel such that we can engage and disengage the power coming from the I.C. Engine and the sprocket gear arrangement for the D.C. Motor. Thus the sprocket is having the one side rotation so no effect is produced or no rotation of the D.C. motor when the I.C. engine is on and motor is off.

Thus our vehicle can run separately with power coming from the I.C. Engine and similarly with the D.C. Motor and also as it is hybrid vehicle it can run with simultaneously with I.C. Engine and D.C. Motor. Furthermore modification can be done in the vehicle to reduce the overdrive condition in the hybrid mode. As we are synchronizing with the sprocket arrangement in the hybrid mode there is condition occurring that I.C. Engine is overdriving the Motor thus to reduce this problem we can use the microcontroller which is connected with the rpm sensor. RPM sensor is attached on the rear wheel which give the input to the microcontroller so that microcontroller gives the output to the D.C. motor in such a way that it will take the power from the battery such that it can also rotate the vehicle in same speed that the engine is delivering power to the rear wheel.

As our Moto is also to reduce the emission from the engine which is also possible due to over hybrid system. Firstly the vehicle is running only 27 kmpl on petrol mode and by hybrid with electric motor it is running 48 kmpl using only 3 unit of electricity which cost 10 Rs. Thus average of the vehicle increased up to 68% thus the emission of the vehicle is reduced to approx to half. Also the fossil fuel is depleting very fast so there is only limited amount of fossil fuel is available on the earth approx for 100 years. Thus by HEVS (Hybrid Electrical Vehicles) we can increase the efficiency of engine and can be used longer and Eco friendly vehicles.

There are further more modification can be done in the vehicle so that it can use the power from the engine which can be used to charge the battery of the D.C. Motor so that more efficient and economic performance can be obtain from the vehicle.

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