ADVANCED HYBRID ELECTRIC VEHICLE

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ABSTRACT

This paper presents a hybrid electric vehicle which uses fuel power and electric power to run the automobile. With the help of this hybrid electric vehicle we are able to enjoy the driving even when conventional fuel is exhausted. The designed model aims at satisfying such a need. Often, when the fuel level comes to reserve, the driver has no other option than to refuel the vehicle. In such a case, the model can be incorporated in vehicles so as to provide an uninterrupted driving by automatic switching from fuel engine to electric drive and electric drive is run by battery. The battery is charged through dynamo which is coupled to the wheel.

Keywords- Hybrid electric Vehicle, Dynamo, Battery, Electric drive.

I. INTRODUCTION

Today we face the problem of dwindling fuel resources for vehicles. There is no doubt that the emission of carbon-dioxide from an automobile exhaust is also a pressing concern for the increasing rate of global warming. One of the optimistic solutions for such problems is the hybridization of the vehicle. Hybrid electric vehicle is a combination of a conventional internal combustion engine and an electric propulsion system. It implies that HEV can be driven on I.C. engine as well as on electric power. HEV produces less emission compared to a similar-sized gasoline car as the gasoline engine of the HEV can be geared to run at maximum efficiency. The significance of electric vehicle is that it runs with lesser power loss, hence improving the overall fuel economy. Encouraging hybridization of vehicles can reduce CO2 emission and thus the fuel costs. At present, hybrid electric vehicles are widely available as commercial vehicles, military vehicles and passenger cars.

A. Hybrid Electric Vehicle (HEV)

A hybrid electric vehicle uses both an electric motor with a battery and combustion engine with a fuel tank for propulsion and hence, a hybrid between an electric and a conventional vehicle. HEVs are of particular interest now, even as countries struggle with fuel quality. Hybrid passenger cars have been in the market since 1997, with hybrid buses and delivery trucks emerging in the last 3-4 years. Widespread use in industrialized markets is now leading to use in developing countries through second hand markets. Hybrid electric vehicles combine the advantage of gasoline engines and electric motors. The key areas to enhance efficiency or performance are regenerative braking, dual power sources and less idling. The new auto rail, built by the Canadian company Bombardier for service in France is diesel/electric motors using 1500 or 25000 V on different rail systems. Japan’s first hybrid train with significant energy storage is the KiHa E200 with roof mounted lithium ion batteries. Hybrid vehicles can be categorized as Series Hybrid and Parallel Hybrid vehicles.

Series Hybrids have been referred to as Extended-Range Electric Vehicles (EREV). As the internal combustion engine turning a generator is mechanically disconnected from the driving wheels, it gives an advantage of isolating the engine from demand. The electric traction system and combustion engine generator operate independently with each operating at its maximum efficiency. This allows a vehicle with engine to operate as a second stage, only when needed to drive the vehicle with the electric battery energy storage.

Parallel hybrid systems, which are most commonly produced at present, have both, an internal combustion engine and a coupled electric motor. If they are joined at an axis in parallel, the speeds at this axis must be identical and the supplied torques adds together. With the cars, the two sources may be applied to the same shaft, the speeds thus being equal and the torques adding up with the electric motor adding or subtracting torque to the system as necessary.

II. METHODOLOGY AND WORKING PRINCIPLE

The vehicle runs on two sources viz, Electric drive system and engine drive system. The Electric drive system consists of a BLDC motor connected to the hub in wheel assembly as shown below fig.1. It consists of a fuel tank, IC Engine, Dynamo, Battery. When the fuel is present in the tank, the hub runs with the rotations given by the fuel engine drive. While driving on IC engine, simultaneously the batteries get charged by converting kinetic energy of vehicle into electric energy.

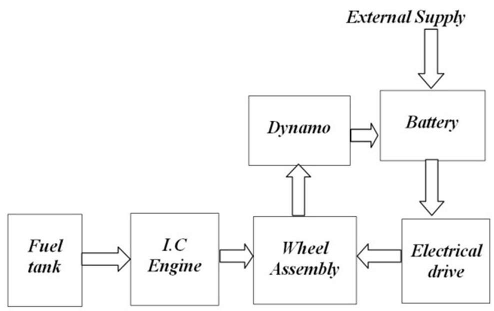

Fig.1 Block Diagram

When the fuel get exhausted or the battery is fully charged, manually we can change the switch from fuel engine drive to electric drive. This switch over is done through manual switch provided, so that the electric drive mode can be achieved manually. The dynamo is coupled to the front wheel of the vehicle. The electric drive system is run by lead acid batteries which are connected in series. There is also a provision to charge these batteries externally. The block diagram represents the implementation of model as shown in Fig.1. The block diagram describes the fuel engine being run by the fuel in fuel tank. The fuel engine is coupled to the wheel assembly to bring about the motion in the vehicle. Electric drive is also coupled to the wheel assembly to bring about the motion in the vehicle when fuel get exhausted or when battery is fully charged. The electrical drive is run by the battery and the battery is charged through the dynamo which is coupled to the wheel.

III. CONTROLLER USED FOR HYBRID ELECTRIC VEHICLE

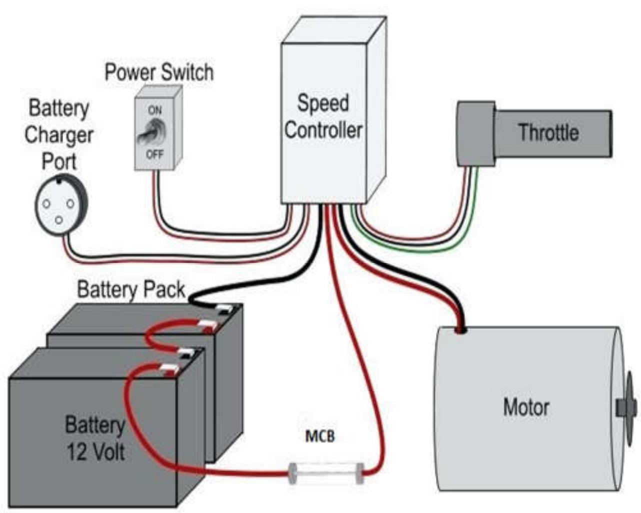

Fig.2 Block Diagram of Controller

Controller acts as the brain of the vehicle. All the processes will be done using this controller only and all the equipments are connected to this controller. Throttle is used as accelerator for varying or controlling the speed of the vehicle and the power switch is used to ON/OFF the motor or power supply. Battery pack and charger point is connected to the controller. MCB is used to avoid the short circuit problem.

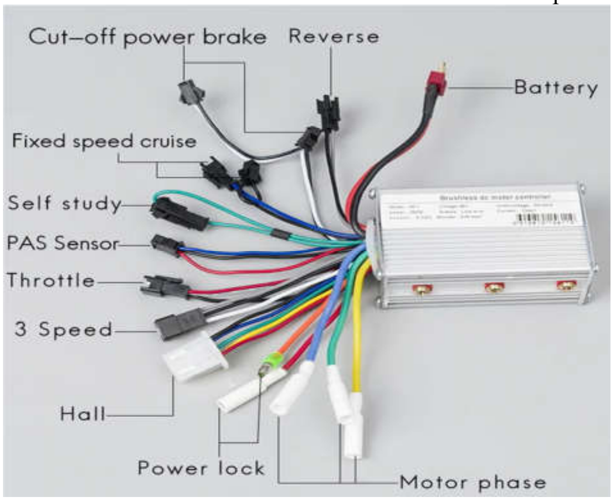

Fig.3 Controller Wiring Diagram

The mechanism of an electric speed controller varies depending on whether you own an adaptive or purpose build electric bike. An adaptive bike includes an electric drive system installed on an ordinary bicycle. A purpose-built bike, more expensive than an adaptive bike, provides easier acceleration and affords more features. The mechanism of electric bike speed controller varies in these two types.

IV.MATHEMATICAL CALCULATION FOR MOTOR AND BATTERY CAPACITY

A. MOTOR

Fig.4 Front wheel

Let,

- The gross weight of the vehicle considering the battery and one person weight
  Vehicle weight = 100Kg
  Battery weight = 20Kg
  Person weight = 60Kg
  Total Weight = 180Kg
- Required speed = 40Kmph

- Wheel size = 12inches = 30.48cm
- Radius of wheel(r) = 15.24cm = 0.152 m
- Efficiency = 75%
- Pulling resistance = 0.01 Ω

Now,

Area of vehicle = length× width

- Height(H) = 1133mm
- length(l) = 1781mm
- Width(w) = 710mm

Area = 1781

$=1.26m^2$

Then,

Linear distance travelled = 2πr

$=2 \times \pi \times 0.1524 = 0.95755$ m

Speed in m/sec $= \frac{40\times1000}{3600} = 11.11$m/sec

RPM = $\frac{\text{Total distance covered /hr}}{\text{Linear distance}}$

$= \frac{40}{0.95755\times60} = 696.2$ rpm

Power,

Power = (mass × acceleration due to gravity × velocity m/sec × R_a) + (Air density × coefficient of drag C_d × Velocity^3 × area of vehicle)

$= (110\times9.81\times11.11\times0.01)+(0.6465\times0.29\times11.11^3\times1.26)$

$=443.716$W

Torque,

Efficiency = 75%

P_{out} = efficiency × P_{in}

P_{out} = Torque × ω

Torque (T) × ω = 0.75 × 443.716

$\omega = \frac{2\pi\times rpm}{60}$

$\omega = \frac{2\pi\times696.2}{60} = 72.9058$ rad/sec

Torque (T) = $\frac{\text{Pin} \times \text{eff}}{\omega}$

$T = \frac{443.716 \times 0.75}{72.9058}$

T = 4.56 N-m

$P_{out} = P_{in}$ × efficiency

= 332.787 W

To satisfy above theoretical output power, we have chosen available standard motor rating of 350 W.

B. BATTERY

Let,

Assume,

When battery is fully charged, the vehicle will cover 80Km distance at average speed of 40Km/hr.

Output power of the motor = 332.7 W

Suppose in 1hour at 40kmph power consumption = 332.7 W

Power consumption per Km = $\frac{332.7}{40}$ = 8.31W/km

Now,

The battery rating depends on the motor, so we are considering the 48V battery for 350W motor.

Time required charging the battery (t) in Hours

$t = \frac{\text{Power of battery}}{\text{Output Power of motor}}$ Hr

Battery capacity = Voltage × Ampere hour

= 48 × 96

= 4608 WHr

Therefore,

$t = \frac{4608}{350}$ = 13.16 Hrs

So, time required to charge battery is 13.16 Hrs

By considering these all calculations, we decide the following ratings

- Voltage = 48V
- Rated Power of Motor = 350W

V. RESULTS AND DISCUSSIONS

The results and analysis of the designed model is given below. The designed hybrid electric vehicle uses 12V, 24Ah Lead acid battery and BLDC motor. Vehicle runs at the speed of 25-30km/hr.

Table 1: Results

Expected Results	Practical Results
Maximum distance travelled on the Battery: 45-50km	Maximum distance travelled on the Battery: 35-40km
Maximum Speed: 35-40kmph	Maximum Speed: 25-30kmph

The battery can also be externally charged which takes 4 hours to get fully charged. Battery is also charged through dynamo. When the vehicle runs up to 10 km distance, the battery gets charged up to 8 to 10%.

Fig.4 Designed hybrid electric vehicle

The advantages of designed hybrid electric vehicle over conventional vehicle are discussed below.

- Fuel consumption is low which leads to reduced air pollution. One of the best advantages of designed model over gasoline powered bike is that it runs cleaner and has better mileage which makes it environment friendly. A hybrid vehicle runs on twin powered engine (Gasoline engine and electric motor) that cuts fuel consumption and conserves energy.
- Less dependence on fossil fuels: The designed model requires less fuel to run which means less dependence on fossil fuels.
- Financial benefits: The designed model is supported by many credits and incentives that help to make them affordable. Lower annual tax bills and exemption from congestion charges results in less amount of money spent on the fuel.
- Uninterrupted driving: When the fuel level falls to reserve, the driver has no other option than to refuel the vehicle. In such a case, the designed model can be incorporated in vehicles so as to provide an uninterrupted driving by automatic switching from fuel engine to electric drive.
- Compared with the battery driven electric vehicle, the hybrid electric vehicles do not require the ground charge facility. The battery driven electric vehicles must be charged regularly by using external power supply whereas the designed hybrid vehicle do not require battery charging more frequently by using external power supply as battery also gets charged through dynamo when the vehicle is running.

VI. CONCLUSION

HEV technology for both light and heavy-duty applications is commercially available today and demonstrates substantial reductions in tail-pipe emissions and fuel consumption even when compared to other available low emission technologies. HEVs are particularly effective for urban travel, significantly lowering pollutant emissions and providing cost-effective CO2 reductions in personal mobility. Encouraging hybridization of vehicle fleets through enabling policies and incentive structures can serve to lower both conventional and CO2 emission, thus improving public health, energy security, and reducing fuel costs. Continuing innovation in hybrid technology and a growing demand for cleaner vehicles will mean that costs are likely to fall, particularly in second hand vehicle markets. In such a scenario where there is a need for an alternative, this system can be of a great help. And in future we can apply the different methods for charging the battery like Solar, regenerative breaking and Piezoelectric.

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