"ADVANCEMENT IN PARALLEL HYBRID SYSTEM FOR CONVERTING THE EXISTING CONVENTIONAL BIKE IN TO HYBRID ELECTRIC BIKE"

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ABSTRACT

The concern over the environment with respect to pollution, conservation of fuel resources in the world, the automotive industry has entered into a new dimension in production of more fuel efficient, low emission vehicles and new technologies. One of the greatest innovations is Hybrid Electric Vehicle.
The goal of this project was to implement the most efficient and less polluting vehicle. In our project the hybrid electric vehicle model combines the internal combustion engine of a conventional vehicle with the battery and electric motor of an electric vehicle, resulting in twice the fuel economy of conventional vehicle. We implement this hybrid electric vehicle concept for two wheelers.

Keywords: Hybrid vehicle, Fabrication, Automobile efficiency, Pollution, Design

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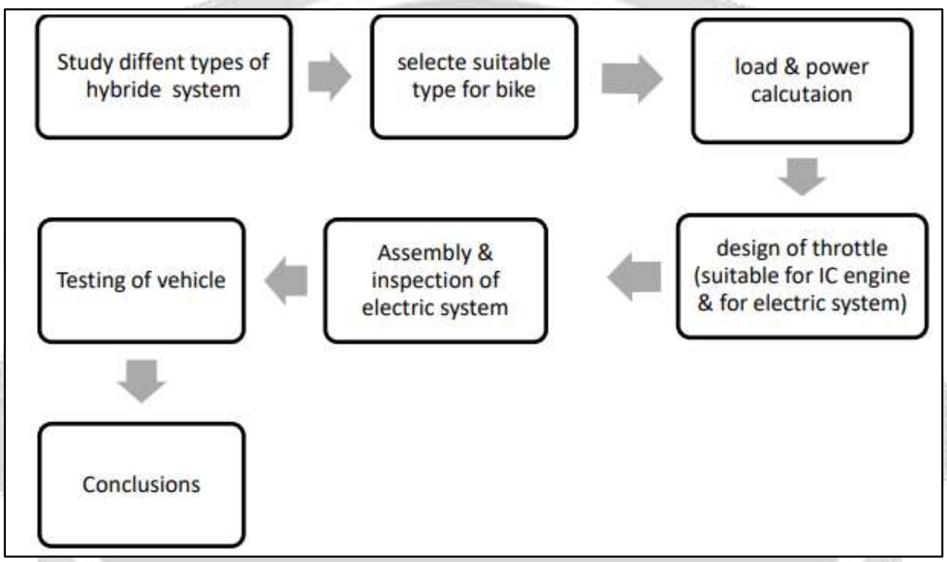
1 Introduction

The invention of internal combustion engine is one of the greatest inventions of mankind. The conventional vehicles with ICE provide a good performance and long operating range. However they have caused and continue to cause serious problems for poor fuel economy, environment pollution and human life. Reducing fuel consumption and emissions is one of the most important goals of modern design. The hybridization of a convectional combustion engine vehicle with an advanced electric motor drive may greatly enhance the overall efficiency and achieve higher fuel with reduced emissions. Considering the urban status in India, a well-organized and fuel efficient scooter has to be designed and developed. A 'gasoline-electric hybrid vehicle' or 'hybrid electric vehicle' is a vehicle which relies not only on batteries but also on an internal combustion engine which drives the wheels. It has great advantages over the previously used gasoline engine that drives the power from gasoline only. The objective is to design and fabricate a two wheeler hybrid electric vehicle powered by either on battery or on gasoline. It provides its owner with advantages to his willingness that he can drive his two wheeler with batteries powered and in case his battery exhausted he can switch to IC engine powered two wheeler. Hybrid electric vehicles combine an electric wheel hub motor, battery and control system with an internal combustion engine to achieve better fuel economy and reduce toxic emissions. In HEV, the battery alone provides power for low-speed driving conditions where internal combustion engines are least efficient. Thus the vehicle is best suited for the existing two wheeler to convert his bike to electric bike segregation, mechanical and physical properties, and therefore increases reliability and consistency. By manipulating the process and output properties, parts are held to exceptionally tight tolerances. These parts require only a few processes to produce a finished product. With these exceptional controllable properties and versatility, it is easy to see the importance of forged parts to almost every facet of industry.

2. Problem Statement

The dependence on oil or fuel as the sole source of energy for passenger vehicles has economic and political implications, and the crisis will inevitably become acute as the oil reserve of the world diminishes. The number of automobiles on our planet doubled to about a billion or so in the last 10 years. The increasing number of automobiles being introduced on the road every year is only adding to the pollution problem. There is also an economic factor inherent in the poor energy conversion efficiency of combustion engines. Alternative fuels have become of utmost importance in the current world scenario. But the sole reason that alternative fuels cannot replace the entire gasoline situation at a time renders the use of these fuels useless. Climate change has become a major concern as of late. Global warming has become a global threat, bringing the question of using combustion vehicles to the forefront. As such, hybrids have become the go-to for saving the now-dying world. If not acted upon soon, the situation may go out of hand. This is exactly where hybrids come of utmost importance. Electric vehicles may be the permanent solution to the problem, but electric vehicles are not an immediate solution. Hybrids, thus, become the bridge to establishing a solution.

3.Methodology:



3.1 Hybrid vehicles

Hybrid vehicles, by definition, are vehicles that have two or more different power sources. Hybrids are the future of the current automotive scenario. With the depletion of conventional fuels, it has become a necessity to opt for a feasible option. The hybrid concept provides just the solution for the problem. They manage to improve fuel economy with excellent performance.

3.2 Electric vehicle

The basic necessity for the implementation of a new method of transportation is its adaptability to the existing scenario. Such is not the case with electric vehicles. With the introduction of electric vehicles recently into the commercial market, problems are imminent. The sheer cost of the vehicle is overwhelming to the common man. There is a paramount change in the cost of living to accommodate the luxury of owning an electric vehicle. Due to relative simplicity in terms of the mechanical transmission components required, electrical vehicles allow for higher flexibility in terms of appearance of the vehicle and its interactive capabilities. "It is also important to find when the new technology should lead to redefining the existing products in some way." All of the major automotive manufacturers have production EVs, many of which are available for sale or lease to the general public. The status of these vehicle programs changes rapidly, with manufacturers suspending production frequently due to the small existing market demand of such vehicles. The manufacturers of EVs in the 1990s realized that their significant research and development efforts on ZEV technologies were hindered by unsuitable battery technologies. A number of auto industries started developing hybrid electric vehicles (HEVs) to overcome the battery and range problem of pure electric vehicles. The Japanese auto industries lead this trend with Toyota, Honda, and Nissan already marketing their Prius, Insight, and Tino model hybrids. The hybrid vehicles use an electric motor and an internal combustion engine and, thus, do not solve the pollution problem, although it does mitigate it. It is perceived by many that the hybrids, with their multiple propulsion units and control complexities, are not economically viable in the long run, although currently a number of commercial, prototype, and experimental hybrid vehicle models are available from almost all of the major automotive industries around the world. Toyota, Honda, and Nissan are marketing the hybrid vehicles well below the production cost, with significant subsidy and incentive from the government. Motivated by the growing concern about global pollution and the success of electric motor driven transportation in various areas, the interest is ever increasing for road EVs that can deliver the performance of ICEV counterparts. The major impediments for mass acceptance of EVs by the general public are the limited EV range and the lack of EV infrastructure. The solution of the range problem may come from extensive research and development efforts in batteries, fuel cells, and other alternative energy storage devices

3.3 Hybrid Two Wheelers

The automotive industry has seen the foundation and evolution of hybrids for over ten years now. But, the major progress that has happened from the automotive scenario is in the four wheeler base. Two wheelers are yet to make a significant progress on the road of developing hybrids. The condition with the two-wheeler phase is that the research is still on-going, rendering the mass production of two-wheeler hybrids as of yet, unavailable. Mopeds, electric bicycles, and even electric kick scooters are a simple form of a hybrid, powered by an internal combustion engine or electric motor and the rider’s muscles. Early prototype motorcycles in the late 19th century used the same principle. The difference between the two-wheeler and four-wheeler phase is the percentage increase in cost of production and the changes required to develop the hybrid system itself. The change in the cost of hybridization is higher in the case of four wheelers but the amount becomes considerably low when compared to the entire price of the vehicle itself. The same does not apply to two wheelers. The change in cost for hybridization causes a larger change of marginal cost in the production of the vehicle. As such, hybrid motorcycles are infamous as of now. The second major factor why motorcycles have not seen a proper hybridization scenario is the placement of the components required to convert the combustion to hybrid. Hybridization, basically becomes addition of electrical components to the already existing combustion power train. Quite simply, it requires more area. The current proposed designs result in a change of dimensions of the entire vehicle, making them wider and increasing their volume. Motors are the “work horses” of Hybrid Electric Vehicle drive systems. The electric traction motor drives the wheels of the vehicle. Unlike a traditional vehicle, where the engine must “ramp up” before full torque can be provided, an electric motor provides full torque at low speeds. The motor also has low noise and high efficiency. Other characteristics include excellent “off the line” acceleration, good drive control, good fault tolerance and flexibility in relation to voltage fluctuations.
A conventional two-wheeler is propelled by an internal combustion engine. The IC engine consumes more fuel and produces pollution. Several manufacturers are planning to move to electric vehicles. But there are quite a few hurdles to bring in the hybrid technology to two wheeler segment**.**

4. Design Calculations:

Gross vehicle weight (GVW) = 160+60 KG
= 220*9.81 = **2158.2 N**
Weight on each drive wheel (WW) = 2158.2/2 =**1079.1N**
Radius of wheel/tire (RW)= 0.22 m
Desired top speed (Vmax)= 60 Kmph
=16.66 m/s
Maximum incline angle = 12 degrees
Working surface= concrete (good)
Total tractive effort (TTE) requirement for the vehicle: TTE = RR + GR + AD
Where:

TTE = Total Tractive Effort [N]
RR = Rolling Resistance [N]
GR = Force required to Climb a Grade [N]
AD = Aerodynamic drag force [N]

The components of this equation will be determined in the following steps.

STEP ONE: DETERMINE ROLLING RESISTANCE

Rolling Resistance (RR) is the force necessary to propel a vehicle over a particular surface.

RR = GVW x Crr

= 2158.1 x 0.01 (good concrete)

= 21.58 N

RR= 2158.1 x 0.37 (mud)

= 798.49.08 N

Where,

RR = Rolling Resistance [N]

GVW = Gross Vehicle Weight [N]

Crr = Surface Friction (value from Table.I)

Contact Surface	Crr
Concrete (good / fair / poor)	.010 / .015 /.020
Asphalt (good / fair / poor)	.012 / .017 / .022
Wood (dry/dusty/wet)	.010 / .005 / .001
Surface Snow (2 inch / 4 inch)	.025 / .037
Dirt (smooth / sandy)	.025 / .037
Mud (firm / medium / soft)	.037 / .090 / .150
Grass (firm / soft)	.055 / .075
Sand (firm / soft / dune)	.060 / .150 / .300

Table 1: Rolling Resistance for Rubber Wheels

STEP TWO. DETERMINE GRADE RESISTANCE

This calculation must be made using the maximum angle or grade the vehicle will be expected to climb in normal operation.

To convert incline angle, to grade resistance.

GR = GVW x sin (Ө)

= 2158.1 x sin 12° = 448.69 N

Where,

GR = Grade Resistance [N]

GVW = Gross Vehicle Weight [N]

Ө = Maximum Incline Angle [degrees]

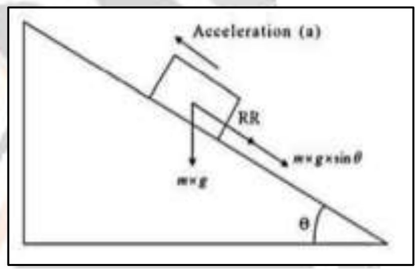


Fig. 01 Force Resolution at Ө degree

STEP THREE: AERODYNAMIC DRAG

AD = 0.5 x ρ x (Vmax)^2 x Cd x A.

Where,

AD = Aerodynamic drag Force [N]

ρ = Airdensity [Kg/m] = 1.225 [Kg/m^3]

(According to international standard atmosphere values)

Vmax = Maximum speed [m/s].

Cd = Aerodynamic drag coefficient

(For streamlines body Cd is 0.04)

A = Frontal surface area in m.

Aerodynamic Drag

AD = 0.5 x ρ x (Vmax)^2 x Cd x A.

= 0.5 x 1.225 x (16.66) x 0.04 x 0.942

= 6.4 N

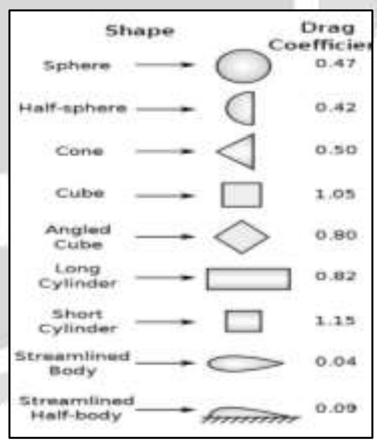


Fig. 02 Measured Drag Coefficients

STEP FOUR: DETERMINE TOTAL TRACTIVE EFFORT

The Total Tractive Effort (TTE) is the sum of the forces calculated in steps 1, 2, and 3.

TTE = RR + GR + AD

= 21.18 N + 488.69 N + 6.4 N

= 516.27 N

STEP FIVE: DETERMINE WHEEL MOTOR TORQUE

Required wheel torque (TW) based on the tractive effort.

TW = TTE x RW

= 516.27 x 0.22 = 113.57 Nm

Where,

TW = wheel torque [N-m]

TTE = Total Tractive Effort [N]

RW = radius of the wheel/tire[m]

Motor specification:

For required amount of the torque 2000 w brushless electric hub motor is selected with following specification
Rated Power - 2000W.
Torque - 63 NM.
Max Torque- 128 Nm.
Carrying Capacity 100 To 300 Kg.

Fig. 03 Hub Motor

Battery Calculation

To find the Amp rating of battery :-
Power =2000 W & Voltage = 72 V

$$P = V * I$$
$$2000 = 72 * I$$
$$I = 2000/72$$
$$I = 27.7 \text{ Amps}$$

Charging time Calculations :-
Time required to charge the battery by adapter 72V 10Ah
P= V x I= 72 X 27.7=1994.4 ≈ 2000 W
T= 2000 / (72 X10) = 2.77 hrs.
required to charge the battery by adapter 72V 6Ah

5. Modifications made in bike

1. Changes in the swing arm of bike.
As axle of motor is not removable like the axle of the conventional bike it is necessary to make changes in the swing arm.

2. Changes in rear brake system.
As the wheel of the bike is completely replaced by the hub motor. Drum brake system is removed with bike wheel. This drum brake is replaced with disk brake system.

3. Changes in throttle of the bike.
As it is the hybrid bike we required throttle which can be used on both petrol & electric mode. At present combine throttles are not available which can be used for both conventional system & for electrical system. We have combine unit of the throttle which can be suitable not only for the conventional system but also for the electric system.

Fig. 04 Swing Arm

Fig. 05 Rear Brake System

Fig. 06 Throttle of the Bike

6. Actual photos of bike

7. Experimental Results:

7.1 IC Engine Vehicle

1. Fuel cost (1 Lit) - 106 /-
2. Mileage (1 Lit) - 45 Km/Lit
3. Running cost of the vehicle per kilometer- 2.35 /-

7.2 Battery Vehicle

1. Fuel cost (1 Full charge Battery) - 7.20 /-
2. Mileage (1 Full charge Battery) - 45 Km
3. Running cost of the vehicle per kilometer- 0.16 /-

7.3 Hybrid Vehicle

1. Fuel cost (1 Lit and 1 Full charge Battery)- 113.2/-
2. Mileage (1 Lit and 1 Full charge Battery)- 90 Km
3. Running cost of the vehicle per kilometre-1.2/-

8. Conclusions

- The operation of IC engine & electric motor are controlled by the same throttling unit which results in to Comfortable handling of bike.
- Travelling cost of the bike reduced drastically which helps to improve fuel economy.

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