

Experimental Investigation and Design for Human and Electric Powered Parallel Hybrid Vehicle

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Abstract: Environmental pollution and declining resources of fossil fuels in recent year, have increased demand for better fuel economy and less pollution for ground transportation. For this Renewable energy sources such as solar, wind, tidal, geothermal and wave, etc. are used in recent day. One of the sustainable and renewable energy sources that has not been recognized is the use of human power. Human power as an energy source to power and control the electrical vehicles and the expected impact towards sustainability. The main objectives behind this project is to develop eco-friendly and reliable hybrid vehicle using Human and Electric energy paralleling as main power source. During paddling at rate of 40-50 rpm, generate shaft rotate about 385rpm through arrangement of chain sprocket and generator can develop power about 450W and current about 15 Amp. This current can be utilized to charge battery of rated current 33Amp and battery can fully charge in less 2.5 hour. Vehicle can be driven by electric motor then it can attain speed of vehicle about to 36 km/hr and with the help of paddling power required at time of starting period is easily available and reduced power required to drive vehicle.

Index Terms: Hybrid Vehicle, Parallel and Series Hybrid Vehicle, Analysis of process parameter.

I. INTRODUCTION

A hybrid vehicle utilizes at least two particular kinds of energy, for example, interior ignition engine to drive an electric generator that controls an electric motor, for example in diesel-electric trains utilizing diesel engine to drive an electric generator that controls an electric motor, and submarines that utilization diesels when surfaced and batteries when submerged [1].

Present day HEVs utilize proficiency improving advances, for example, regenerative brakes which convert the vehicle's motor energy to electric energy, which is put away in a battery or supercapacitor [2]. A few varieties of HEV utilize their interior burning engine to produce power by turning an electrical generator to either revive their batteries or to directly control the electric drive engines; this mix is known as a motor-generator. Numerous HEVs lessen inactive discharges by closing down the ICE out of gear and restarting it when required; this is known as a start stop framework [3]. A hybrid electric creates less emissions from its ICE than an equivalently measured gas vehicle, since a HEV's gas engine is typically littler than a similarly estimated, unadulterated gas consuming, vehicle and if not used to straightforwardly drive the vehicle, can be equipped to keep running at greatest productivity, further improving efficiency.

1.1 Parallel Hybrid Vehicle

This design interfaces both the ICE and the engine in parallel to the wheels [4]. Both of them or both partake in conveying the power. It tends to be considered as an IC engine vehicle with electric help. The energy stockpiles in such a vehicle can be charged by the electric motor by methods for regenerative braking or by the ICE when it creates more than the power required to drive the wheels.

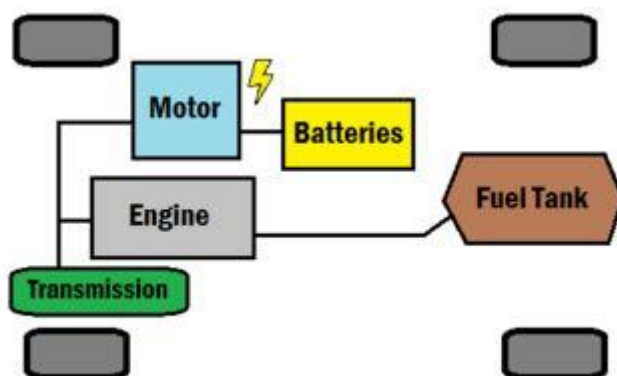


Figure 1 Parallel Hybrid Vehicle

1.2 Series Hybrid Vehicle

This configuration is the simplest one to make an HEV. Only the motor is connected to the wheels here, the engine is used to run a generator which provides the electrical power. It can be put as an EV that is assisted by an ICE generator.

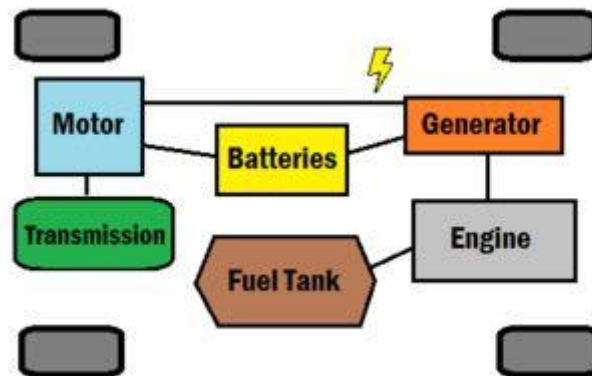


Figure 2 Series Hybrid Vehicle

II. Experimental Work

Frist model has been designed in cad software and based on that identify correct demotion of body and other part. Based on that purchase required material and component. It consists chasis of the body, flywheel, generator, battery etc. which is discussed in below.

2.1 Fabricated chasis

Fabricated view of hybrid parallel vehicle chasis shown in below figure.



Figure 3 design of chasis

Material Properties: - (6063 Aluminium)

Chassis Dimensions: -

Round Pipe (one-inch diameter -3mm thickness)

Overall Length (22998.2mm) or (75feet)

Rectangular cross section (4*1.75) inch & (3mm thickness)

Overall Length (14657.76mm) or (50feet)

2.2 Flywheel

Flywheel hand has specification show in below figure 4 and table 1 respectively.



Figure 4 Flywheel

Table 1 Specification of Flywheel

Outer diameter (mm)	274
Inner diameter (mm)	226
Material	Cast iron
Density	7300 kg/m ³
Weight	7.2 kg
Energy Stored	599.4 J

2.3 Generator

Generate and has specification show in below figure 5 and table 2 respectively.



Figure 5 Generator

Table 2 Specification of Generator

Voltage	24 V
Full Load Current	24 A
Base RPM	3000

2.4 Motor

Motor and has specification show in below figure 6 and table3 respectively.



Figure 6 Motor

Table 3 Specification of Motor

Type	Permanent Magnet DC Motor
Voltage	24 V
Power	450 W
Rated Torque	8.829 Nm

2.5 Battery

Battery and has specification show in below figure 7 and table 4 respectively.



Figure 7 Battery

Table 4 Specification of Battery

Type	Lead Acid
Voltage	12 V
Ampere	33 A

2.6 Final Driveline

Final drive of hybrids parallel vehicle after assemble all component such as flywheel, generator, battery, motor etc in chassis. Complete view of final drive show in below figure.



Figure 8 Final Driveline

III. Result and Discussion

a) Generator reading

While paddling is done at different speed, generator can produce different power according to paddling speed. Here we show four different speed of paddling and voltage and current produce in generator in following table.

Table 5 Generator reading

RPM	Voltage	Current	Power
30	23.6	11.3	266.68
40	24.8	12.3	305.04
50	28.9	14.7	424.83
60	26.6	16.8	446.88

Voltage Vs Speed of Vehicle graph indicate that Voltage of Battery is not changed drastically with respect to Speed of Vehicle for both electric mode as well as Hybrid mode of operation. Here, one line is overlapping to other line so only see one line in the graph only. As speed of vehicle is increases, voltage is slowly increasing.

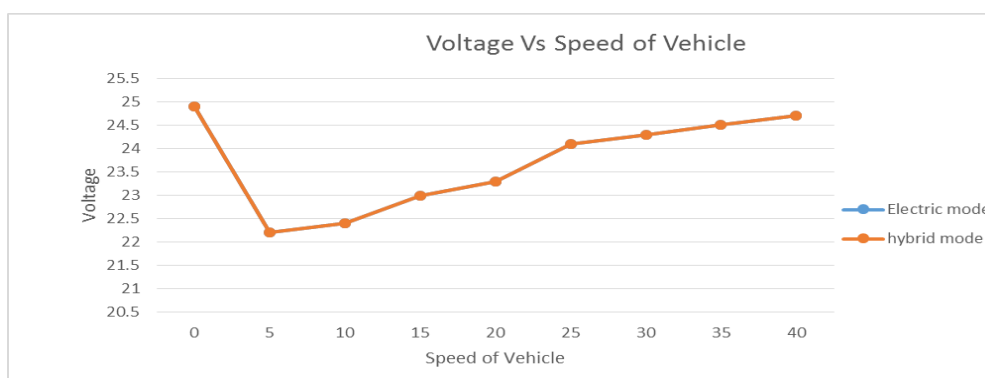


Figure 9 Voltage Vs speed of Vehicle

Current Vs Speed of Vehicle graph indicated that Current requirement in starting period is almost zero because during this period vehicle riding through paddling. As acceleration of speed is required extra current are taken from battery and this current also less compare to current required during electric mode at same Speed of vehicle.

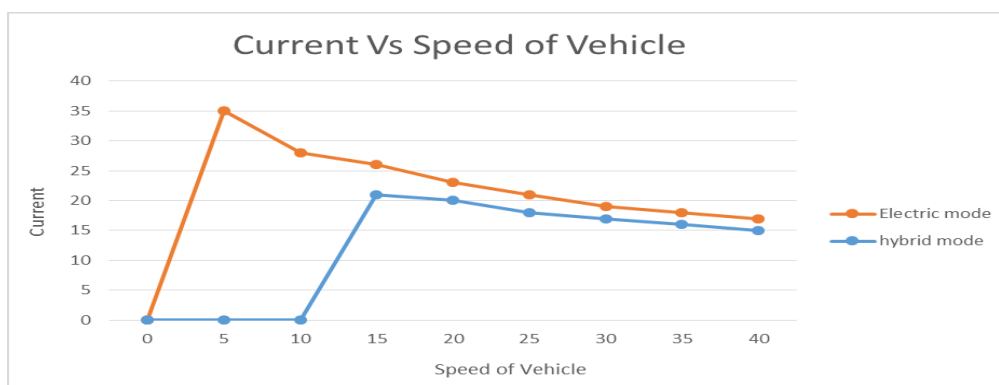


Figure 10 Current Vs Speed of Vehicle

Power Vs Speed of Vehicle graph represent that no power requires during starting of vehicle because of paddling action is worked during that time. After some speed achieves in order to increases speed of vehicle, take power from battery so vehicle now ride on hybrid mode. here, power required is lower in hybrid mode as compare to electric mode of operation.

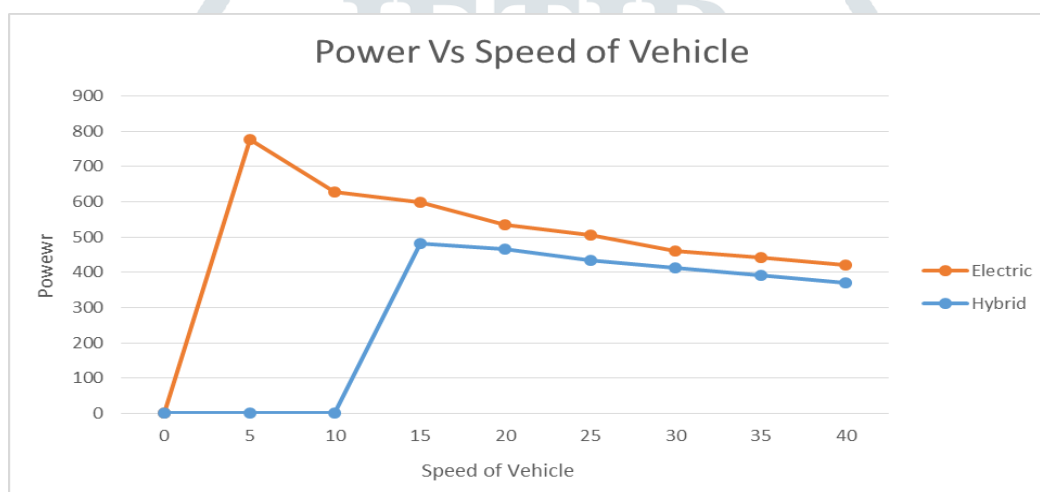


Figure 11 Power Vs Speed of Vehicle

Result Analysis

Paddling rate is about 50 rpm by normal person, with the use of chain and sprocket arrangement we can able to drive generator is at about 595 rpm [5]. Generator can able to produce 24 V and 450 W at speed of 480 rpm so more power is available to drive vehicle at higher speed. If Vehicle drive directly through paddling then speed of vehicle is about 10 km/hr. and vehicle drive by electric battery then this speed is at about three to four time higher than only paddling.

Torque required by vehicle to drive on flat rate is about 5.47 Nm, if we consider the total weight of vehicle is 200Kg and Rolling resistance coefficient for road and tyre (CRR) value is 0.01 [6]. If vehicle driven by paddling then net torque produce at rear shaft is about to 18 Nm, which is capable enough to drive the vehicle. Vehicle can operate by electric motor then torque at rear shaft is about to 16.5 Nm so this can also able to drive vehicle smoothly.

During paddling at different speed generator can produce different current value. If paddling speed is varying from 30 rpm to 50 rpm then current generated is about to 15 Amp. This amount of current easy to charge our 33 A battery in less than 2.5 hours of time.

IV. Conclusion

Through this research expected to plan the drive line of human electric parallel hybrid vehicle. The main objective of this research was to design the drive line which is able produce the power and use it to drive the vehicle on common road. We believed we accomplished this goal. The project results were shows that generator is energy supplier. Generator are able to produce 450 W power at speed of 480 rpm only and this speed we can easily produce through paddling around 40-50 rpm with the help of chain and sprocket mechanism. With the use of this power we can charge Battery in less 2.5 hour. By utilizing this power, we got rear shaft speed around 353 rpm and achieved speed of 200 Kg weighted vehicle is about 36 km/hr. If we drive Vehicle through Paddling then rear shaft speed is about 90 rpm and speed of Vehicle is around 9km/hr. If we drive vehicle through Battery and paddling then

power extracting from battery can be minimized and we can save energy also. So, human and electric powered parallel hybrid vehicle is best alternative of conventional fuel-based vehicle.

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