DESIGN AND FABRICATION OF HYBRID GO-KART

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Abstract - *IC engines produce harmful emissions and are less efficient at part loads. Electric drives have zero emissions, but have very limited range. Thus it is logical to combine the best aspects of both and the result is a hybrid vehicle. Then the best optimum strategy would be to use electric drive during slow moving city traffic, for acceleration and for hill climbing and IC engines at cruising speeds on highways. This would also results in reduced pollution in cities, along with improved mileage. Since last 2-3 decades the average temperature of earth increased by 3-4 degree Celsius because of the green house effect. Due to increase in the fuel prices and continuously depletion of natural recourses for the fuels caused fuel crises. This project aims at improving the mileage of the car using simple mild parallel hybrid technology with combination of electric motor drive and the petrol engine drive. We have used the straight open kart chassis design. The results show that alone a petrol engine gives best 35Km/lit, alone a electric motor gives 15kms on full battery charge. The combination of above two gives 50Kms.*

Key Words: hybrid go-kart, electric motor, parallel hybrid.

1.INTRODUCTION

A hybrid vehicle uses two or more distinct power sources to move the vehicle; for example, a conventional I.C. engine and a high voltage electric motor. It is most commonly referred as hybrid electric vehicles (HEVs), which combine an I.C. engine and one or more electric motors. A vehicle is said to be hybrid vehicle if it utilizes more than one form of onboard energy to achieve propulsion. Practically a hybrid vehicle will have a traditional I.C. engine and a fuel tank, as well as one or more electric motors and a set of batteries.

Electric motors use no energy during idle or during turn off and use less energy than I.C. engines at low speeds. IC-engines do better at high speeds and can deliver more power for a given motor weight. That means during rush hour to stop and to go, the electric motor works great and, as an added benefit, does not produce any exhaust thus reducing smog levels. At higher speeds, the IC-engines kicks in and gives that power feeling that many car owners look for when driving on the highway. Another benefit is to charge the batteries while it's running.

1.1 CLASSIFICATION OF HYBRID VEHICLES

1. Depending on Drive Train Structure.
2. Depending on degree of Hybridization.
3. Depending on nature of Power Source.

1.1.1 Depending on Drive Train Structure

1. Parallel Hybrids
2. Series Hybrids
3. Series-Parallel Hybrids

1.1.2 Depending on degree of Hybridization

1. Full Hybrids
2. Mild Hybrids
3. Power Assisted Hybrids

1.2 Parallel Hybrid

In parallel hybrids, the engine and the electric motor can simultaneously transmit power to drive the vehicle. Engine can also act a generator for recharging of the battery with help of a generator. Generally in parallel hybrid vehicles both the power sources IC-engine & the electric motor are connected to same transmission via torque convertor so that at any time only one of them is in action. Regenerative braking is also used to convert the vehicles kinetic energy into electrical energy which is stored in batteries.

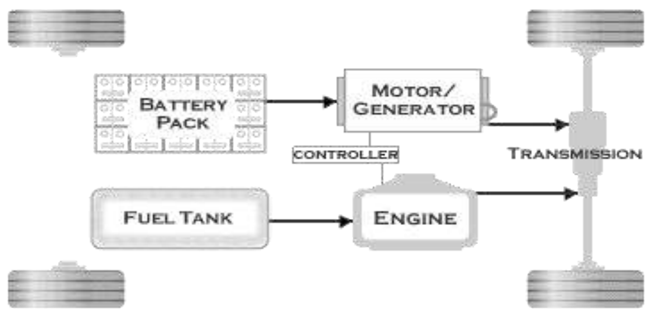

Fig -1: **Parallel Hybrid Arrangement**

Advantages of parallel hybrid vehicles:

- More efficient for highway driving than in urban stop-and-go conditions.
- Large flexibility to switch between electric and IC Engine power.
- Compared to series hybrids, the electromotor can be designed less powerful than the IC Engine, as it is assisting traction. Only one electrical motor/generator is required.

Disadvantages of parallel hybrid vehicles:

- Rather complicated system.
- The IC Engine don't operate at constant RPM range, thus efficiency drops at low rotation speed.
- As the IC Engine is not decoupled from the wheels, the battery cannot be charged at standstill.

2. About Go-Kart

Go-karts are a type of small, suspension less vehicle. They come in a variety of forms, from motor-less models to high-powered, high performance go-karts for competitive racing. The main components of the go-kart are chassis, steering & transmission.

2.1 Chassis

Chassis are classified in as 'Open', 'Caged', 'Straight' or 'Offset'.

- Open karts have no roll cage.
- Caged karts have a roll cage surrounding the driver; they are mostly used on dirt tracks.
- In Straight chassis the driver sits in the center. Straight chassis are used for sprint racing.
- In Offset chassis the driver sits on the left side.

We have used open kart chassis design. There are no suspensions used in the kart so the chassis must be able to absorb some of the jerks and vibrations, also it must be stiff enough not to break or twist during turning. In order to reduce the weight and cost, & due to lack of space availability differentials are also not used in the kart. Mostly problem is faced during turning due to lack of differential. The power is transmitted to the rear axle through chain drive, and both wheels rotate with same speed and equal torque is transmitted to both of them.

The chassis are generally made of square or round steel tubing's, or angle iron. We have built the chassis according to a standard tested design made by a leading manufacturer of go-karts STEPHEN BRUKE. We have used 40*6 angle iron for making the frame. All the pieces are cut to required length and welded by MMAW (Manual Metal Arc Welding).

2.2 Steering

Steering used in the Go-kart is a simple linkage type Ackerman steering. Ackerman Steering Principle describes the relationship between the front wheels of a vehicle as they relate to each other while taking a turn. The inner wheel travels in a small diameter circle than the outer wheel. All the wheels moves around a common point. The three main parts of the steering mechanism are King-pins, Yoke, Stub axles.

2.2.1 Kingpins

The kingpin is the main pivot in the steering mechanism of a car. It is simply a pin made to allow the front wheels rotate freely. It has been made from 30mm O.D MS tubing having 7mm wall thickness. Tapping of 3/7" is provided on both sides to assemble the pin with the Yoke with help of bolts. The Kingpin is directly welded to the chassis by providing some angles to it relative to the frame.

2.2.2 Yoke

Yoke is the C-shaped link that is connected with the kingpin. It allows the wheels to turn on the pivoted end. It has been fabricated from 40*6 mm MS bar.

2.2.3 Stub Axles

Stub axles are small rods attached to the front steering mechanism to support the wheels. It has been made from 30 mm MS bar.

2.3 SYSTEMS USED IN GO-KART

2.3.1 SPECIFICATION OF ENGINE

Type: - 2 stroke, single cylinder, air cooled OHC Displacement: - 98 cc

Max power:- 7.7 bhp @ 5600 rpm

Starter system: - self &kick

2.3.2 Braking System

The braking system is designed such that the stopping distance is minimum and the effort to be applied by the driver on the pedal is minimum. The brakes will work effectively when the contact area of the brake pads and the disc plate is maximum which will reduce the stopping distance. The area of the piston in the master cylinder has also effect on the braking of the vehicle.

Brake Pedal Force

Pedal Ratio=L2/L1 = 300/60 = 5.

Fd= Force Applied by Driver = 20Kg = 196 N.

Fbp=Force Output on Brake Pedal Assembly = Fd x L2 L1=196 x 300/ 60 = 980 N

2.3.3 Fuel Tank

Material = Sheet metal (Galvanized steel)

Capacity = 3 .75 Liter

2.3.4 Muffler

Material = Aluminum

Greater diameter of muffler = 100 mm

Total Length = 450 mm

Smaller diameter of muffler = 50 mm

2.3.5 Fuel Filter

Dust, particles of dirt or other unwanted particles might be present in the petrol. This petrol should be free from these particles. Therefore, the petrol filter is used.

2.3.6 Air Cleaner

Since the atmospheric air is highly cornices and contains dust and dirt particles, it is allowed to enter the engine intake manifold only through an air cleaner.

2.3.7 Spark Plug

It is an essential part of the ignition system. A sparking plug consist essentially of a steel body which bears the earthed electrode, an insulator, and a central rode which forms the other electrode, fed from the distributor.

2.3.8 BLDC Motor

48 volts **1500 watts** brushless direct current (BLDC) motor was used.

It's specifications are as follows:

Commutation	**Brushless**
Phase	Three Phase
No of Poles	8
Torque	5NM/18NM
Speed	3000 Rpm
Voltage	48 V
Power	1.5 KW

Table -1 Specification of Motor

2.3.9 Motor Controller

48 volts **1500 watts** brushless direct current (BLDC) motor controller of same specifications as motor was used.

2.3.10 Electric Hand Throttle

Electric hand throttle was used to vary the speed of BLDC motor.

2.3.11 Battery Pack

4 batteries of 12 volts 35 Ah each was used. The batteries were connected in series so that the total voltage accounts 48 volts.

Fig -2: **BLDC MOTOR**

Fig -3: **CONTROLLER**

Fig -4: **ENGINE**

Fig -5: **BATTERY**

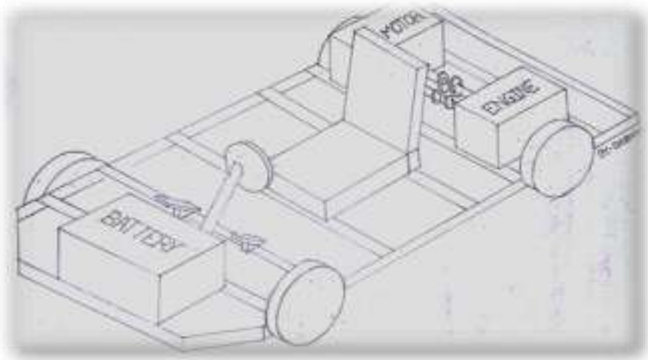

Fig -6: **Diagram of Components Arrangement**

Fig -7: **Model of Hybrid Go-Kart**

2.4 Working

Engine drive: A centrifugal clutch and a 2-speed automatic transmission is used with the engine so as to facilitate idling of the engine. The driving sprocket is mounted on the clutch and the freewheeling hub on the axle.

BLDC Motor drive: A same chain sprocket reduction is used between the motor and axle again to keep traction, but the sprocket on the axle uses a freewheeling hub to mechanically disconnect the electric motor from the drive when the engine is driving the axle, so as to protect the motor from any undesirable load.

Electric vehicle mode: During this mode the engine is off, and the battery provides electrical energy to power the motor during starting and at lower speeds because at lower RPMs torque of IC engine is lower but starting torque of a BLDC motor is high. If the starting torque of the motor is less then IC engine also starts to drive the kart and after starting the electric motor takes the charge.

Cruise mode: When the vehicle is cruising or accelerating and the motor cannot meet the load demand then the engine takes over and the motor switches off. The power from the engine is transmitted through the chain sprocket drive to the rear axle. The electric motor gets disconnected due to freewheeling hub.

3. RESULTS AND DISCUSSION

We have tested the kart for its fuel economy under three conditions.

1. Running on I.C. engine,

2. Running on electric motor,

3. Running on combination of both electric motor and I.C. engine (hybrid mode).

In our project we have used BLDC motor of 48 Volts and 1500 Watts with high torque during start up, but it gradually decreases to 10-12 amperes as it gains speed. We have not used Brushed DC motor as battery drains out quickly reducing the overall efficiency. Instead of this to improve the performance high efficiency DC brushless motor is used which have low current consumption. The IC-engine used is an old 98 CC, 2 stroke single cylinder having very less efficiency which reduces the overall efficiency.

MODE	FUEL	EFFICIENCY
I.C. Engine	Petrol	*35 Km/lit*
Electric Motor	Battery	*15 kms on full charge.*
Hybrid Mode	Petrol and Battery both	*50 Kms*

Table -2 Test Results

4. FUTURE SCOPE

'HYDRO-ELECTRIC' Hybrid Vehicle

We tried to use hydrogen gas as fuel instead of petrol. This can reduce emissions. Burning hydrogen gas emits only H_2O (steam). This increases efficiency of the vehicle to great extent. This can give rise to new type of vehicle i.e. **'HYDRO-ELECTRIC'** Hybrid vehicle.

Currently, Ni-Cd battery is used, which needs replacements after some period, but instead of these Lithium-ion batteries which are very reliable can be used. However the initial cost increases. Nowadays new bio-fuels are also made to reduce the exhaust emissions and cut down the fuel prices. Also use of CVTs in hybrids has proven that they are having better transmission efficiency than normal ones. Combining CVTs with the smart computer integrated circuits and smart sensors, the efficiency can be greatly improved. New inventions of lighter but stronger materials like carbon fibers, HSP (high strength polymers), etc. can help in reducing the overall weight of the car and thus smaller sized high efficiency engines can be used.

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