DESIGN AND ANALYSIS OF HYBRID CAR USING TUBULAR FRAME CHASIS AND HELIUM GAS

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Abstract – *SSMB's Battery car is the four-wheeler car in which the motive power to the wheels is provided by the A.C. motor drive. The rpm of the motor can be varied using potentiometer. Here in our project due economy constraint we have used low capacity current inverting device, hence we will get single rpm because we are using the available current to its full extent. The D.C.current which drives the motor is delivered from the battery. We can drive the vehicle up to extent up to the charge holding capacity of the battery. Here we have used single battery. If we would have used couple of batteries we would have increased the capacity (our's being the low capacity sample model).For charging the battery we have used the inverting circuit. Which will receive the current from 250Volt A.C. main and make ionization in the battery by charging it, when there is availability of the electric and will deliver the charge from the battery by stepping up the current up required level to operate the D.C. motor. This paper showcases various methods of material selection, design optimization techniques and use of Helium Gas.*

Key Words: *battery car, ac motor, helium gas, dc current.*

1. INTRODUCTION

Electric vehicles have many benefits. Trolley busses and streetcars offer both low energy costs and low maintenance costs and their low pollution output is especially beneficial to the urban areas in which they are operated. Electric vehicles also do not produce a lot of noise pollution, because no combustion takes place. For electric car operators the high and unstable cost of motor fuel is avoided. Evens though the power output and lifespan of batteries is not sufficiently high at this time for wide application, battery technology and manufacturing methods are improving rapidly and practical and cost–effective production vehicles for many applications expected within a few years. Furthermore, since the energy used by electric vehicles is generated at stationary sources, there is far more potential for the use of renewable energy for transportation. This can be far more efficient than using energy converting biomass into ethanol, transporting it by tanker truck, and then burning it within an internal combustion engine.

Lifetime service costs are lower for a vehicle that is mainly electric, due on one hand to the lower cost of electricity compared to gasoline or diesel fuel, and on the other hand to the fact that the mechanical structure of an electric drive much simpler than for an internal-combustion engine drive, and maintenance costs will be lower.

2. COMPONENTS

"Battery automobile" is the electrically operated automobile consisting of the following different sub-components:-

- Electric D.C. Motor
- Frame
- Battery
- Drive

2.1. Electric D.C. Motor

The motor is having 5 B.H.P capacity with maximum 500 rpm with torque capacity of 50 Nm. Its specifications are as per the following:-

Current rating - 5 Amp

Voltage rating - 12 Volt D.C

Cooling - air cooled

Bearing - single row ball

Fig.1:- D.C.Motor

2.2. Frame

It is made from the casting body along with some of the forged components. Welded in rectangular hollow shape which serves as the base to hold all the accessories such as engine, weight of the load to be conveyed and the weight of the person driving the unit. Also it should be able to overcome the stresses, which are coming due to different driving and braking torques and impact loading across the obstacles in the traveling ways. It is with the linkage and wheels to propel it and the platform plates. It is drilled and tapped enough to hold the support plates.

2.3. Battery

It is the accumulator of electric charge. It must store the electrical energy produced by the generator by the electrochemical transformation and give it back again on demand. e.g. while starting.

Fig.2:- Battery

2.4. Generator

An electric motor turns because there is a torque on it due to the current. We would expect the motor to accelerate unless there is some sort of drag torque. Back EMF and Counter Torque:-

That drag torque exists, and is due to the induced emf, called a back emf. When a motor (refrigerator, air blower) turns on, you often see lights dim. This is because a large current is initially drawn until back emf builds up. A similar effect occurs in a generator – if it is connected to a circuit, current will flow in it, and will produce a counter torque. This Back EMF and Counter Torque; means the external applied torque must increase to keep the generator turning. Look at bicycle generator. Induced currents can flow in bulk material as well as through wires. These are called eddy currents, and can dramatically slow a conductor moving into or out of a magnetic field. The Pickup on an Electric Guitar A ground fault circuit interrupter (GFCI) will interrupt the current to a circuit that has shorted out in a very short time, preventing electrocution. (Circuit breakers are too slow.) Differently magnetized areas on an audio tape or disk induce signals in the read/write heads. A seismograph has a fixed coil and a magnet hung on a spring (or vice versa) and records the current induced when the Earth shakes. A changing magnetic flux induces an electric field; this is a generalization of Faraday's law.

3. Material Selection

The chassis undergoes various kinds of forces during locomotion, it has to stay intact without yielding, and it should be stiff to absorb vibrations, also it should resist high temperatures. The material property of the chassis is an important criterion while designing and manufacturing the car. A tubular frame chassis was chosen over a monocoque chassis despite being heavier because, its manufacturing is cost effective requires simple tools and helium gas could be easily filled. The two very commonly used materials for making the tubular frame chassis are Chromium Molybdenum steel (Chromoly) and SAE-AISI 1018. Both these materials were analyzed for different parameters and finally decided on to use Chromoly steel 4130 for making the tubular frame chassis because of several reasons. SAE 1018 grade steel is better in terms of Thermal properties but weaker than Chromoly in terms of strength. But the main priority of design is safety for the driver hence the material with better stiffness and strength was chosen. The material should not cause any failure even under extreme conditions of driving as defined in the rule book. Chromoly steel 4130 exhibits better structural property than SAE 1018 Grade steel hence the former was considered as the basic material for building a tubular space frame chassis. Even though the cost of Chromoly is marginally higher than that of SAE 1018 grade steel, the safety of the driver remains the utmost priority for the team.

Table -1: Material Properties

PROPERTIES [2],[3]	SAE AISI 1018	Chromoly 4130 Steel
Density (g/cc)	7.8	7.8
Young's Modulus (GPa)	210	210
Elongation at break (%)	19	19
Brinell Hardness	120	200
Strength to weight ratio at Yield (kN-m/kg)	38	100
Yield Strength (MPa)	360	480
Ultimate Strength (MPa)	420	590
Thermal Conductivity: Ambient (W-m/K)	50	42
Thermal Expansion: 20C to 100C (µm/m-K)	11	12

We have selected Helium gas as it is the second lightest element. As Helium gas has lifting property it is to to lighter thee total weight of the chassis. It also has low boiling point, low density, low solubility, high thermal conductivity, or inertness which are standard rule as per the SAE.

Table -2: Helium Property

Density	0.178 kg/m^3
Lifting force at sea level	1.314 kg/m^3.
The buoyant force for one m^3 of helium in air at sea level is	1 m^3 * 1.314 kg * 9.8 N/kg= 11.9 N

4. SIMULATION

Structural analysis of the chassis was done along with design optimization until a convincing design with sufficient rigidity was produced and it cleared all regulations by the FSAE Rule book. The static structural analysis was done in ANSYS Workbench under different constraints mentioned in the Article 4.0 in FSAE Rule book 2013 [1]. Application of loads over the chassis was in correspondence to the work of R.P. Singh, 2010 [5]. The maximum deformation is well within the permissible limit of not more than 25mm in any direction.

Mesh Structure: Fine
Minimum mesh element length: 1.79x10^-3 mm
Nodes: 43090
Elements: 20725
Young's modulus: 210 GPa
Poisson's ratio: 0.27

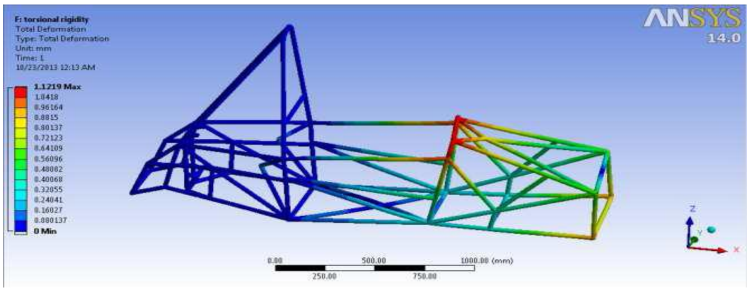

Fig-3: Torsional Rigidity using ANSYS Workbench

5. WORKING

The machine entitled " Battery operated Car-" Works on the principle that the motive force of an A.C. motor which receives the electricity energy stored in the d.c. battery converted with the help of D.C. to A.C. converter circuit.

5.1. Operating Procedure

Here prior to start the two wheeler starting switch, it ensured that whether the battery is fully charged. Unless it is charged using the inverter circuit, consisting transistorized integrated circuit.

5.2. Working medium

Here the chemical reaction which is taking place evolves the energizing current which is responsible for motivation of the prime mover. This chemical reaction takes place while discharging of the battery.
The sulphuric acid, being the working medium is separated into columns of positive H ions and negative SO_4 ions by mixing with water. If the poles of the cell are connected by a load (incandescent lamp), electrons flow from the negative pole to the positive pole. Due to the scarcity of electrons at the negative pole, bivalent positive lead is produced from the neutral lead which combines with the bivalent negative SO_4 group to form lead sulphate $PbSO_4$.

At the positive pole, bivalent positive lead is produced from the quadrivalent positive lead of the oxide through the electron supply. The combination with O_2 is therefore ruled out and combinations with SO_4 is introduced, lead sulphate $PbSO_4$, is likewise produced. The oxygen atoms released combine with the hydrogen atoms of the electrolyte to form water. The density of the battery acid decreases.

5.3. Operation

The switch is put on the electric energy in the form of electric current flows from the battery to the d.c. to a.c. converter circuit where the direct current waveform is made sinusoidal due to the operational transistorized d.c. to a.c. amplifying circuit. The small intensity a.c. current across the output is again amplified using the amplifier circuit. This amplified current is fed t3o the stator winding of the a.c. motor, which drives the circuit through the condenser. Condenser is the device, which acts as a storing the electrical energy and delivering it at the time of requirement type of device.

6. CONCLUSIONS

The technology exists to build with significantly lower dependence on oil and a cleaner, cooler atmosphere. With sufficient political will and automaker participation, this future can arrive in time to address these significant and growing problems. Hybrids can play an important role in realizing this future, filling the gap between immediate improvements through conventional technology and the long –term promise of hydrogen fuels cells and alternatives fuels. Buildings on a 40-mpg fleet that relies on existing conventional technology, Hybrids can help drive passenger vehicle oil consumption and global warming emissions from cars and trucks below 1990 levels.

SCOPE FOR FUTURE

The future of Battery electric vehicles depends primarily upon the availability of batteries with high energy densities, power density, long life, and reasonable cost as all other aspects such as motors, motor controllers, and chargers are fairly mature and cost competitive with ICE components. The most likely future for Battery electric vehicles (BEVs) currently appears to be the incremental improvements needed for hybrids. Hybrid EVs are a smaller step from purely Internal combustion engine driven cars (ICE) driven cars, yet share much of the same core technology as true BEVs.

The future of battery electric vehicles depends primarily upon the cost and availability of batteries with high energy densities, power density, long life, as all other aspects such as motors, motor controllers, and chargers are fairly mature and cost-competitive with internal combustion engine components. Li-ion, Li-poly and zinc-air batteries have demonstrated energy densities high enough to deliver range and recharge times comparable to conventional vehicles. Aluminum batteries offer exceptional theoretical performance and have been proposed as an international shipboard energy transfer mechanism.

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