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STUDY ON DESIGN AND DEVELOPMENT OF E-SCOOTER

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ABSTRACT:

After China, India has the world's second-largest population. India is also ranked second in terms of two-wheeler manufacturers and producers. Vehicles are no longer cost-effective based on fuel use due to rising gasoline and diesel prices. Replacing a traditional internal combustion engine with an electric engine can provide numerous benefits, including low cost, minimal maintenance, pollution-free, noiseless, smooth driving experience, and many others. With the advantages listed above, an electric scooter is a viable alternative to standard scooter bikes. In the last few years, the Indian two-wheeler industry has experienced phenomenal growth. By 2030, the Indian Electric 2-wheeler and related division is predicted to generate significant revenue. In a straightforward manner, this article depicts the concept and development of an Electric Scooter. The scooter's chassis is crucial since it serves as the vehicle's structural foundation. Because of its increased strength and lighter weight, structural steel was chosen. The goal of this project is to create a lightweight battery-powered E-Scooter with a BLDC hub motor transmission system. With a load-carrying capacity of 100 kg and a top speed of 60 km/h.

CHAPTER-1: INTRODUCTION

1.1 INTRODUCTION:

Electrical vehicle (EV) based on electric propulsion system. No internal combustion engine is used. All the power is based on electric power as the energy source. The main advantage is the high efficiency in power conversion through its proposition system of electric motor. Recently there has been massive research and development work reported in both academic and industry. Commercial vehicle is also available. Many countries, On the other hand, the hybrid electric vehicle (HEV) is alternative. It has been used extensive in the last few years. EVs first came into existence in the mid-19th century, when electricity was among the

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preferred methods for motor vehicle propulsion, providing a level of comfort and ease of operation that could not be achieved by the gasoline cars of the time. The internal combustion engine (ICE) has been the dominant propulsion method for motor vehicles for almost 100 years, but electric power has remained commonplace in other vehicle types, such as trains and smaller vehicles of all types.

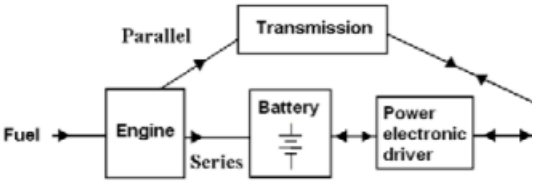

Fig 1: The series or parallel path of an HEV

As the name suggests Electric scooter is that in need of a scooter or vehicle that runs with help of electricity. Unlike traditional scooter runs supported petrol or gas, it doesn't require fuel for running. These are often recharged with help of A battery charger. Electric scooters are an environmental-friendly transportation medium that's going to be used by our future generation broadly. E-Scooters are green and economical which is a crucial factor for social and economical development nowadays.

An electric scooter consists of three major parts that are:

a) Battery

b) Controller

c) Motor

- The battery is used to store energy in sort of electricity, which can be employed by the hub motor.
- The controller gathers electricity from the battery and delivers the acceptable amount of electricity to the electrical motor
- The motor receives the facility from the battery and converts the electricity into mechanical energy.
- The wheel which is connected to the motor turns and thus the vehicle moves. The wheel which is connected to the motor turns and therefore the vehicle moves.

1.2 NEED OF ELECTRIC SCOOTERS

Faced with today's global environmental sustainability issues, air pollution has always been one of the problems people want to solve. In Taiwan, the government is also actively promoting electric scooters (E-Scooters) to replace traditional bikes to reduce the accompanying air pollution. The electric scooters are cheap, convenient and funny means of transport. Electric scooters are cheap and affordable as they do not consume gasoline or any petroleum-based fuels, so are environment friendly. These scooters are so compact designed that it could be stored in a small place anywhere in your house or wherever you go. You can even access public transport buses or trains with the electric scooters.

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With the rising cost of petrol and the increase in price that all BSVI compliant petrol scooters have seen, the wide price gap between e-scooters and petrol scooters appears to be closing. The average 110cc petrol scooter costs roughly Rs 85,000 while our prices start at Rs 80,000. In addition to this, electric scooters are much easier to maintain since they, like electric cars, have fewer moving parts. Electric vehicles (EVs), particularly electric scooters, look to be becoming more efficient with each passing day. Despite the fact that EV market penetration in India is far lower than in other countries (estimated at 0.12 percent), electric two-wheelers and three-wheelers are regarded as the most probable drivers of EV growth in India; although from the bottom up. With sales of electric two-wheelers reaching an all-time high (1,52,000 units) in the previous fiscal year (FY2020), domestic brands, both new and old, are feeling confident enough to expand their electric offers.

CHAPTER-2: METHODOLOGY

2.1 DESIGN:

The electric vehicle is rather simple in structure. The key components are the propulsion parts.

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2.1.1 Chassis:

Chassis is the structural foundation of a vehicle upon which all other components are getting to be fabricated. Everything related to the vehicle except its body is contained by the chassis and is consists of a frame, transmission system, wheels, and control system. The main function of the Chassis is to provide safety, carry the utmost load, and hold all the components during running.

2.1.2 Material Selection

Here Structural Steel is used for manufacturing the chassis. The main reason behind using structural steel here is because of its ability to absorb the impact produced in a collision, it is low cost compare to other

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materials. It has a better strength-to-weight ratio i.e it has high strength and less weight which results in improvements in the performance of the scooter.

2.1.3 Design Specification:

Mass of the vehicle = 100 kg

Weight of the vehicle = (100 *9.81) N = 981 N

Speed Of Vehicle = 60 km/h = 60*(1000/3600) = 16.67 m/s

(For Calculating Resistance due to motion)

1. Force due to climbing hills (F gradient)

Fh = W sin Φ (Angle of incline Φ is 2.5)

= Mg sin Φ

= 981x sin 2.5

= 42.79 N

2. Rolling resistance :

Fr = Cr W cosΦ (for asphalt roads Cr=0.004)

= 0.004 x 981 x cos2.5

= 3.92 N

3. Air resistance:

Fd= 0.5 ρ Cd A V2 (Cd value is 0.5 for frontal area A=0.7 m2

)

= 0.5 x (1.2) x 0.5 x 0.7x 16.672

= 58.35 N (ρ is density of air 1.2 kg/ m3)

Total Force on the Vehicle is, F = Fh+ Fr + Fd = 105.06 N

Power required for propulsion, P = F*V = 105.06*16.67 =1752 Watt

2.2 KEY COMPONENTS IN E-SCOOTER

2.2.1 Battery Charger

An Electric charger is a recharging device i.e used to charge the battery by providing electrical energy to it which gets stored in the form of chemical energy in the battery cells. In order to utilize the battery to its maximum capacity the battery charger plays a crucial role. The remarkable features of a battery charger are efficiency and reliability, weight and cost, charging time and power density. The characteristics of the charger depend on the components, switching strategies, control algorithms. This control algorithm can be implemented digitally using microcontroller. The charger consists of two stages.

First, one is the AC-DC converter with power factor correction which converts the AC grid voltage into DC ensuring high power factor. The later stage regulates the charging current and voltage of the battery according to the charging method employed. The charger can be unidirectional i.e. can only charge the EV battery from the grid or bidirectional i.e. can charge the battery from the grid in charging mode and can pump the surplus amount of power of the battery into the grid.

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2.2.2 Battery

Batteries are the components that store electrical energy, allowing for the motor of the vehicle in question to run. There is already an analysis between different kinds of batteries as seen in the table.1 below, The main materials that allow recharging are nickel cadmium, nickel zinc, nickel metal hydride, and lithium-ion/lithium-polymer, these are respectively listed as NiCd, NiZn, NiMH, and Li-ion/Li-Po on the battery analysis table. Specific energy is energyperunitof mass denotes a lighter battery as the value increases if the energy were to be kept constant.

2.2.3 Motor Controller

A motor controller is a device or group of devices that serves to govern in some predetermined manner of performance of an electric motor. A motor controller might include a manual or automatic means for starting and stopping the motor, selecting forward or reverse rotation, selecting and regulating the speed, limiting or regulating the torque, and protecting against overloads and fault. In this project we are using “sine wave vector controller”. The battery block is interfaced with the motor controller block. The motor controller controls all the functional capabilities and is the central component of the system. The basic requirement for the control is to regulate the amount of power applied to the motor, especially for DC motors. The motor controller can be adjusted to synchronize with other brushless motors. To drive and control the BLDC motor, the use of motor controller was implemented. The motor controller is an essential device for any motor driven device

2.2.4 Motor

A DC motor is one of the categories of rotary electrical machines that converts DC wattage into mechanical power. The high beginning torque capability of the DC Series motor makes it an appropriate choice for Simple AC-powered battery chargers usually have much higher ripple current and ripple voltage than other kinds of battery chargers because they are inexpensively designed and built. Generally, when the ripple current is within a battery's manufacturer recommended level, the ripple voltage will also be well within the recommended level. The maximum ripple current for a typical 12 V 100 Ah VRLA battery is 5 amps. As long as the ripple current is not excessive (more than 3 to 4 times the battery manufacturer recommended level), the expected life of a ripple- charged VRLA battery will be within 3% of the life of a constant DC- charged battery. traction application. the benefits of this motor are simple speed management and it can withstand a sudden increase in load. A DC motor's speed can be controlled over a broad range, using either a variable supply voltage or by changing the power of the current in its field windings. This makes it a feasible alternative for diverse

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applications. For our model, a DC motor with a rating of 24V 250W is selected.

2.2.5 DC-DC Convertor

A DC-to-DC converter is an electronic circuit or electromechanical device that converts a source of direct current (DC) from one voltage level to another. It is a type of electric power converter. The different configurations of EV power supply show that at least one DC-DC converter is necessary to interface the FC (frequency controller), the Battery or the Supercapacitors module to the DC-link. In electric engineering, a DC-DC converter is a category of power converters and itis an electric circuit which converts a source of direct current (DC) from one voltage level to another, by storing the input energy temporarily and then releasing that energy to the output at a different voltage. The storage may be in either magnetic field storage components (inductors, transformers) or electric field storage components (capacitors). DC-DC converters can be designed to transfer power in only one direction, from the input to the outputs

2.3 Rolling Resistance

Rolling resistance is the resistance offered to the vehicle due to the contact of tire with road. The formula for calculating force due to rolling resistance is given by equation:

F rolling = Crr × M × g

Where, Crr = Coefficient of Rolling Resistance,

M = mass in kg, g = acceleration due to gravity = 9.81 m/s2

For application consider, Crr = 0.004 as per below table And

weight of our scooter = 170 kg

2.4 Aerodynamic Drag

Aerodynamic drag is the resistive force offered due to viscous force acting on a vehicle. It is linearly determined by the shape of vehicle.

The formula for calculating aerodynamic drag is given by

below equation.

F aerodynamic drag = 0.5 × CD × Af × ρ × v

Where, CD=Drag coefficient,

Af =Frontal area,

ρ = Air density in kg/m3,

v = velocity in m/s

For application consider, maximum speed of our scooter is 35 kmph (given) that is 9.72222 m/s and air density is 1.1644 kg/m3 at 300 temperature and drag coefficient is 0.5 , frontal area is 0.7 as per the table shown below.

CHAPTER-3: BATTERY

3.1 Battery Management

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Batteries are electrochemical devices that store energy in form of chemical energy and convert it into the form of electrical energy.

3.2 Selection of Battery

We have to consider some factors before selecting battery type those are:

- Energy density (Total energy stored per unit volume or unit mass)
- Power density (Amount of discharge of energy per unit volume or unit mass)
- Efficiency
- Safety
- Lifecycle durability
- Cost

CHAPTER-4: SYSTEM OPERATIONS

Basically, electric motor drive circuit has DC brushless controller of 48Vwhich is powered by the battery of capacity 48V through MCB (miniature circuit breaker).The function of MCB is protect the circuit under over current/over voltage condition. The controller supply in a specified sequence is given to motor by controller. The hall effect sensor connected at the shaft of BLDC motor which gives signal to the controller and thus respective windings get energized as per position of motor shaft. The throttle or speed changer handle bar is connected electrically to the controller. Hence, variable speed can be obtained by accelerating the bar. Also, the braking system is connected electrically to controller. As soon as brakes are applied, it will open the circuit and then battery is disconnected from motor causes motor speed reduction and in a specified time, motor will stop

CHAPTER-5: FUTURE SCOPE

The future of Electric Scooters in India looks very promising.The electric bike market is seeing exponential growth. According to the latest predictions, the electric bike market is expected to grow by 45% by 2025. The main reason for this trend is that electric bikes solve city dwellers real and pressing needs. Air pollution is a huge problem for the urban areas, and the busy roads full of vehicles are a major contributor. What is needed is a sustainable, emission-free form of personal transportation that can reduce our dependence on more traditional fuel-based vehicles.That's where the electric bike comes in, a fast, affordable, and emission-free commute mode.

Here are a few of the reasons:

1. Fuel savings
2. Easy to maintain
3. Portability
4. License requirements
5. Eco-friendly
6. Affordability
7. More safety
8. Less noise

CHAPTER-6: CONCLUSION

Now a days, utilization of fuel vehicles are increased rapidly which result into more air pollution. To control this, utilization of EV is must because it's several advantages like

electric scooter is an eco-friendly product, It is more suitable for city as it can avoid the emission of harmful gases and thereby it can reduce the atmospheric pollution. Due to frequent increase in fuel prices, the electrically charged vehicle seen to be the cheapest one compared to the traditional vehicle. E-scooters are more suitable for rural areas where the numbers of petrol bunks are not adequate, so that the rural people can charge the vehicle with the help of electricity. To understanding the EV technology, this study helps to provide outline of EV (Scooter) and there various components. Now a days, Most of the vehicles used are based of fuel ignition principle for long as well as short run work. Hence, this have been resulting into greater air pollution which is harmful to human being. Thus, proposed paper researched on design and development of EV two wheeler. This given EV contained a lithium ion battery of capacity 48v, 25Ah and will charge within 5 hour using charger having capacity 48v, 5A. Thus EV can be charge up to 1150 to 1200wh using this charger, which will run up to 50 km in single charge with a appropriate speed of 35 to 40 kmph.

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