International Journal of Advanced Mechanical Engineering.
ISSN 2250-3234 Volume 4, Number 5 (2014), pp. 497-502

http://www.ripublication.com/ijame.htm

Human CUM Electric Powered Vehicle

Sambhav Jain, Siddharth Dhapola and Nauman Khan

Department of Mechanical Engineering, Jamia Millia Islamia, New Delhi, India.

Abstract

This paper presents the design of a three wheeled hybrid human powered electric vehicle driven by two drivers. The main objective of this paper is to contribute to sustainable use of energy in the transport sector and transforms the transport sector by introducing electric tricycles with fast charging battery technology. The vehicle would be capable of being driven electrically as well as by a single driver and alternatively by two drivers. This vehicle further is designed keeping in view the future aspect by using regenerative braking as an innovative battery charging assist for city conditions. We have chosen Independent suspension system that allows each wheel on the same axle to move vertically (i.e. reacting to a bump in the road) independently of each other. Hydraulic brakes are equipped on real wheels for increased safety of the riders. It consists of two concentrically placed springs of different stiffness such that each of them is active according to the requirement. The design is validated using six different analysis tests for driver safety. This proposed vehicle will bring economic benefits from fuel savings or avoided costs on the importation of fuel which will bring positive impact to the environment and the health of the people through noise and air pollution reduction. This hybrid vehicle is driven by a motor that require less maintenance as compared with conventional vehicles that are driven by an internal combustion engine. It has been desired to be a kind of multi utility vehicle as it can be used as a mobile stall also with space provided for small installations or even in rural areas as fertilizer sprayers. Thus the vehicle is designed as an energy efficient, comfortable, economical vehicle with business option also and hence a perfect future ride for short distances.

Keywords: Hybrid; electric; vehicle; utility; sustainable.

1. Introduction

Most of the urban arrears in India face severe problems due to pollution. The main reason is the air and noise pollution caused by transport vehicles. In India there are presently close to 19 million petrol powered two wheelers and about 1.7 million petrol and diesel-powered three-wheelers and their population is growing at rate of about 15% per annum. Besides being a major hazard to people's health, these machines are guzzling huge amounts of petrol and diesel for which the country has to pay dearly in foreign exchange outflow. This increases the need for a more sustainable alternative for transportation, which will be helpful in economic front as well. We need an environmentally sound transport system which is cost effective. A tricycle paired with a efficient electric motor can provide us with a energy efficient and affordable option. The proposed vehicle adheres to the aspects of a green vehicle. It runs on human power and electricity and being a noise free, recyclable vehicle it contributes towards reduction of pollution. No emission of any greenhouse gases is an added benefit of this vehicle. Furthermore, lesser amount of resources is required for its fabrication. Moreover it also includes regeneration principle resulting in energy conservation. Also less power is required in production as the selected material is easy to weld. It can be used for various agricultural purposes such as weed removal and as a fertilizer sprayer and so is a help in making a green environment. Thus having an efficient design along with environment friendly features makes it perfect as a ride for future.

2. Technical Data

2.1 Technical Specifications

Vehicle Design	**Semi Recumbent Delta**	
Frame Material	4130 Chromoly Steel	
Vehicle Dimension	Vehicle Length-88" Vehicle Width-36" to 54"	
Expected Vehicle Weight	120 kg	
Load Carrying Capacity	4500 Newton / 458 Kgs	
Wheel Configuration	2 Rear 1 Front	
Wheel Size	Rear 26.5" * 20"	Front 22" * 1.5 " * 20"
Steering		
Steering Type	Direct Linkage	
Turning Radius	2.25 m	
Brakes		
Braking	8" Disc Rear (Hyd. Operated)	5" Disc Front (Mech. Operated)
Ground Clearnce	8"	
Suspension		
Suspension Type	Front: Telescopic Fork	Rear: Independent Dual Suspension

Suspension Travel	Front: 4”	Rear: 4”
Electrical System		
Motor	48 Volt, 400W, BLDC	
Battery Type	SLA (4 in No.)	

2.2 Frame Design

The function of the frame is to protect the drivers and support all operator control systems, front and rear suspension systems, and motor and drive train. The objective of the frame design was to satisfy these functions while meeting the FOS regulations with special considerations given to safety of the occupants, ease of manufacturing, cost, quality, weight, and overall attractiveness. Other design factors included durability and maintainability of the frame.

2.2.1 Material Selection

Criteria	1020 Steel	Score	4130 Chromoly Steel	Score
Tensile Strength	394.7 MPa	7	560 MPa	9
Yield Strength	294.8 Mpa	6	360 MPa	8
Elastic Modulus	205 MPa	8	205 MPa	8
% Elongation	36.5	7	28.2	8
Density (x10^3)	7.7-8.203	8	7.7-8.03	8
Hardness (HB)	111	8	156	9
Machinability	Easily Machinable	8	Easily Machinable	8
Weldability	Good Weldability	9	Good Weldability	9
Cost	Slightly Higher	8	Slightly Higher	7
Availability(India)	Easily Available	7	Easily Available	9
Total		76		83

2.2.2 Frame Type

2.3 Brakes

We will use disc brakes for all three wheels. The front wheel will have a disc rotor of 6”(mech. Operated) and the rear wheels will have a rotor of 8” each(hydraulically operated) . Disc Brake give a quicker response which is well needed in city conditions & also prove out be a weight saving.

2.4 Transmission

It is a semi individual front pedaling system. The front driver pedals a sprocket which delivers power to a smaller sprocket through chain drive. These sprockets work on Pawl and Ratchet Mechanism. They deliver power to a pair of sprockets driven by the second driver also. This further delivers power to the main axle. The motor delivers power to the axle with a reduction ratio of 2.5:1.

2.5 Steering

Castor Angle Θ = 18 degree
Steering Angle § =34 degree
Wheelbase w= 50.2 inch Turning Radius r= w/ (§*cos Θ) = 2.25 m
Head Angle A = 72 degree
Offset O= 4 cm

2.6 Suspension

The objective of the suspension system is to provide the vehicle with the means to keep all wheels planted on the ground with the maximum tire contact patch in any driving situation. The front and rear suspension must work as a unit to keep the tires on the ground as well as possible so that the drive train can continue moving the car with maximum efficiency and the driver can comfortably control the vehicle. Thus the suspension needs to find a good balance between stability and maneuverability. Caster angle of 18 degree was obtained by iterations done on Suspension Analyzer.

2.6.1 Rear Suspension

We have chosen **Independent suspension** system which is a broad term for any automobile suspension system that allows each wheel on the same axle to move vertically (i.e. reacting to a bump in the road) independently of each other. It consists of two concentrically placed springs of different stiffness such that each of them is active according to the requirement.

2.7 Ergonomics

Good ergonomic features increase safety, gives comfort and leads to higher productivity and performance. The vehicle has been designed so as to meet the maximum possible ergonomic needs. Seat is fully adjustable as per the need of driver. Handle is adjusted in such a manner that it can be controlled easily. The distance between seat and pedal is carefully calculated to make it comfortable for a wide range of driver's height. Wind shield has been incorporated to protect the driver from dust and to give a clear view of the track. The inclusion of electrical assistance and semi individual front drive allows the driver to take rest for a while. All these features make it a safe and comfortable vehicle to ride and at the same time increase its performance and productivity.

2.8 Technical Innovations

2.8.1 Alternate Differential Axle
A new innovative and cheaper differential axle is introduced.
2.8.2 Adjustable Seat-
Both front and rear seat are adjustable according to rider comfort
2.8.3 Innovative Rear Suspension
Two concentric spring of different stiffness is used for better suspension

2.8.4 Front Independent Pedaling
Semi individual drive is introduced by which front rider can pedal on his will.
2.8.5 Seat Belt Alarm
An alarm is installed which will ring if driver does not fastened his belt and the speed exceed 10 km/hr
2.8.6 Fertilizer Sprayer
A fertilizer sprayer is also installed in the vehicle to help the farmers.

2.9 Design Validation
Design validation is a very important aspect in designing and development of a product. The various parts of this vehicle will be validated after fabrication on the basis of certain pre laid criterions. The braking system will be validated on the basis of BSDT (Stopping Test). The criteria for passing this test have been set to be 5 meters. The Steering system will be set to a have a maximum turning radius of 3 meters. Safety comes first and so SAT(Safety Analysis Test) will be performed keeping in mind the ergonomics and seating comfort of the riders. The Seat belt will be tested here under the top speed of 29 KPH through the front impact destructive Test of the vehicle. The Chassis will be validated practically from the above SAT. It has also been validated through the results of ANSYS 14.0.

3. Conclusions
This paper presents a hybrid vehicle capable of being driven electrically (BLDC Motor) as well as by a single driver and alternatively by two drivers. The presented vehicle is designed keeping in mind the ergonomics and riders safety and comfort. This can be a viable options for engines powered by gasoline and diesel.

References
[1] Bicycles & Tricycles: By Archibald Sharp
[2] Gillespie, Thomas D *Vehicle Dynamics*, Warren dale
[3] Bicycle Design Richard's Cycle Book
[4] Theory Of machines Book By S.S. Rattan.
[5] Whitt, Frank R.; Jim Papadopoulos (1982). "Chapter 8". *Bicycling Science* (Third edition ed.). Massachusetts Institute of Technology.
[6] Watkins, Gregory K..*"The Dynamic Stability of a Fully Faired Single Track Human Powered Vehicle*"
[7] Peterson, Leisha A., Londry, Kelly J., (1986). "Finite- Element Structural Analysis: A New Tool for Bicycle Frame
[8] Design: The Strain Energy Design Method". *Bicycling Magazine*
[9] Sheldon Brown*"The Care Exchange: Material Assets.*
[10] *Titanium, Carbon Fibre, Aluminum or Steel - Which frame material is best for you?"*
[11] Sharp, R. S. (2008). "*On the stability and control of the bicycle*"
[12] Putnam, Josh (2006). *"Steering Geometry: What is Trail?*"
[13] Pacejka, Hans B. (2006). *"Tire and Vehicle Dynamics"*