STUDY OF SOLAR HYBRID RICKSHAW

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ABSTRACT

Light utility vehicles are becoming very popular means of independent transportation for short distances. Cost and pollution with petrol and diesel are leading vehicle manufacturers to develop vehicles fueled by alternative energies. Engineers are directing their efforts to make use of sun as an energy source to run the light utility vehicles. The use of solar radiation for storing energy is a method that is not only efficient and clean, but also economical. The major problem with solar powered vehicle was the availability of solar energy in winter and rainy season and the cost of solar panel .But we are trying to reduce the problem with a alternative option i.e. series hybrid system. This paper briefly summarize the principle of technology, latest developments, advantages and problems in using solar energy as a source of energy to run vehicles. It is hard to believe that solar energy can be used to power the vehicles. However that is true, and the "solar rickshaw", as it is popularly known, has caught the attention of researchers worldwide. It has zero emissions and is ideal for city driving conditions. Although it seems to be an environmentally-friendly solution, one must consider its well to wheel efficiency. Nevertheless, the solar hybrid rickshaw will contribute to reducing urban pollution in the long run. The objective of this paper is to design a control scheme for the electrical drive of a conventional auto rickshaw that can be driven by a solar electric power system. This solar rickshaw will also impact the economy by facilitating a lower middle class person through effective use of green energy. This purposed model is consisting of mono crystalline solar panel, an efficient MPPT (maximum power point tracking) for charging system, charge controller for batteries, a rheostat speed control with resistance control method and DC series motor.

Key points:- D.C. Motor, Rheostat Control, Lead-acid batteries, Solar panel, Battery Cycle.

I. INTRODUCTION

Auto rickshaws are one of the most popular means of transportation in India and other countries. Although they have many benefits, including small size, lightweight, and low cost but auto rickshaws are very noisy, inefficient, expel a high degree of pollutants. Auto rickshaws are available in diesel, compressed natural gas (CNG), and liquefied petroleum gas (LPG) models. The operating costs of these are lower than rickshaws running on gasoline; however, the higher initial costs keep the fare of these rickshaws the same as its gasoline counterpart. Auto rickshaws are typically petrol driven, though the government is currently supporting the production and use of CNG (Compressed Natural Gas) driven rickshaws. This comes as a result of the government trying to reduce pollution and their foreign oil dependence. Even though CNG rickshaws resolve the pollution issue, India still has to import most of the CNG that is used in the country.

Electric rickshaws (also known as Tuk Tuk, e-rickshaw) have been becoming more popular in some cities since 2008 as an alternative to auto rickshaws and pulled rickshaw because of their low fuel cost, and less human effort compared to pulled rickshaws. They are being widely accepted as an alternative to Petrol/Diesel/CNG auto rickshaws. The use of alternative energy in transportation is being explored as a solution to the problems experienced with the auto rickshaw However, they are different because of their small size and ability to weave through traffic without being affected by the traffic rules. The team has come up with an alternative solution i.e. **series hybrid system.**History of Solar Vehicles The first combination of photovoltaic devices and electric vehicles happened in the late 1970's. Pressured by the oil crisis, engineers and environmentalists began looking for alternative energy sources and eventually turned to solar. To generate more publicity and research interest in solar powered transportation, Hans Tholstrup organized a 1,865 mi (3,000 km) race across the Australian outback in 1987. Called he World Solar Challenge (WSC), competitors were invited fromindustry research groups and top universities around the globe. General Motors (GM) won the event by a large margin,achieving speeds over 40 mph with their Sunraycer vehicle .In response to their victory, GM teamed with the US

Department of Energy (DOE) to hold the GM Sunrayce in 1990 . Approximately the same length as the WSC,Sunrayce is considered to be a more difficult race due to more diverse terrain and climates as well as more challenging road surfaces and traffic congestion. Further WSC events have been held ever three years along the original route from Darwin to Adelaide, Australia.

II. TECHNOLOGY

Mankind has been making use of rickshaw from centuries in different application viz., loading purpose, carrying more than 2 or 3 passengers etc. The use of series hybrid system is used for storing energy in a battery so that it is not only efficient, but also economical and now become new technology since the 20th century for carrying passengers alternately. Some major problems are arises with electric rickshaw. If once battery is discharged then first it is necessary to charge the batteries and then the vehicle is running. It is charged with the electricity if electricity is not available then we are not having any option to charge the batteries. In India there is lack of electricity. so to solve these problems our team has come up with an alternative solution i.e. series hybrid system. In series hybrid system we are using two power sources. First solar panel is used to utilize the available sun energy, when sun radiation falls on a solar panel it collect all the radiation to convert it into electrical energy and another an alternator is connect with the output shaft of I.C. engine which produce electrical energy when engine running its constant speed .The total electrical energy generated by both power sources are stored in batteries and this stored energy is used to drive the motor. This goes hand in hand with the objectives of the Indian government, as the technology is not only sustainable but renewable as well. To make this a reality, there are steps that have to be taken as well as necessary government support. The Indian government is pro-active about sustainable and renewable energies and is willing to support companies that will achieve substantial reduction in energy consumption as well as the use of alternative fuels including hybrids. Hybrid vehicle has many advantages in the current world where pollution is a big problem. This hybrid vehicle is not an engine less but the pollution generated by this engine is very less because engine is used in emergency case only. The

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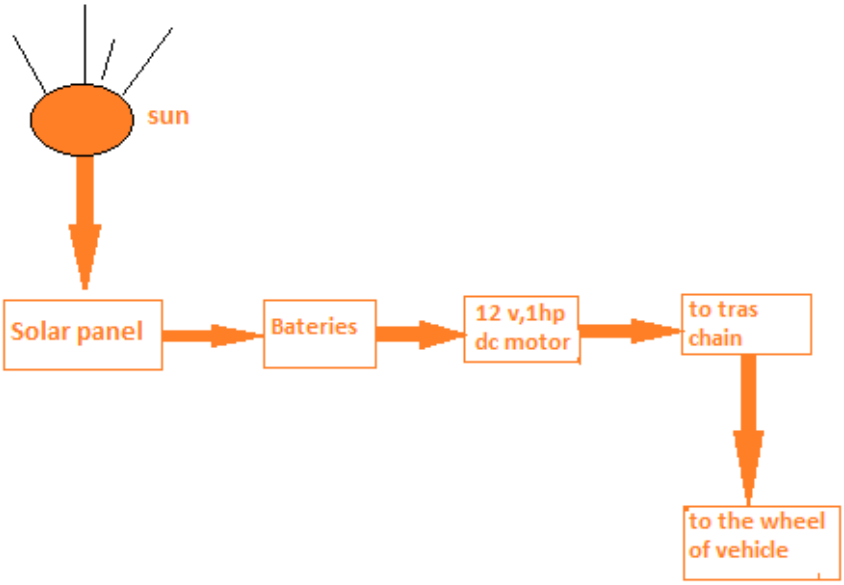
vehicle runs by means of dc motors which get their required power by means of the battery. The battery gets charged with the help of solar plates mounted on the vehicle and current through alternator of I.C. Engine

III. BASIC FUNCTIONAL DIAGRAM



The above diagram Represents the Basic block Diagram of Solar vehicle. The above diagram gives an overview of the working of solar vehicle. Sun is the main source of energy for the vehicle. Energy from Sun is captured by the solar panels and is converted to electrical energy. The electrical energy thus formed is being fed to the batteries that get charged and is

used to run 24 V DC high torques DC series motor. The shaft of the motor is connected to the rear wheel of the vehicle through chain sprocket. The batteries are initially fully charged and thereafter they are charged by panels. This helps in completing the charging-discharging cycle of the batteries, which is very important for proper working of batteries.

3.1 Detailed model description

The model consists of eight different subsystems, which are defined and assembled together, to make the full vehicle assembly. The subsystems are:

1. Fabrication
2. Chassis
3. Differential unit
4. Rear axle attached with differential unit
5. Suspension system
6. Motor
7. Controller
8. Battery

3.2 Fabrication

The process of creating or building parts from raw materials, or we can say that joining process that permanently bonds pressure, or a combination of those elements to make new parts.

After cutting the entire work piece according to our needs or requirement we join that cutting piece into each other to make the shape of our vehicle or we can say that convert the row material in finished product. For join the entire piece we use the arc welding, A welding process that uses the heat generated from electricity to melt filler metal and base metals to form an airtight weld. Robots are ideal for arc welding because it demands a high level of skill that is difficult to find in human workers.

Welding is the main focus of steel fabrication. The formed and machined parts will be assembled and tack welded into place then re-checked for accuracy. A fixture may be used to locate parts for welding if multiple weldments have been ordered. The welder then completes welding per the engineering drawings, if welding is detailed or per his own judgment if no welding details are provided.

Special precautions may be needed to prevent warping of the weldment due to heat. These may include re-designing the weldments to use less weld, welding in a staggered fashion, using a stout fixture, covering the weldments in sand during cooling, and straightening operations after welding. Straightening of warped steel weldments is done with an Oxy-acetylene torch and is somewhat of an art. Heat is selectively applied to the steel in a slow, linear sweep. The steel will have a net contraction, upon cooling, in the direction of the sweep. A highly skilled welder can remove significant warpage using this technique.Steel weldments are occasionally annealed_in a low temperature oven to relieve residual stresses. Such weldments, particularly those employed for engine blocks, may be line-bored after heat treatment.

IV. CHASSIS

Chassis is the main support to the vehicle. A chassis consists of an internal framework that supports a man-made object in its construction and use. It is analogous to an animal's skeleton.

During movement of a vehicle over normal road surfaces, the chassis frame, is subjected to both bending and torsional distortion. Chassis is the under part of a motor vehicle, consisting of the frame (on which the body is mounted) with the wheels and machinery. Chassis is the rectangular, usually steel frame, supported on springs and attached to the axles, that holds the body and motor of an automotive vehicle. Under such running conditions, the various chassis-member cross-section shapes, which find application, include.

(i)Solid round or rectangular cross-sections,

(ii) Enclosed thin-wall hollow round or rectangular box-sections,

(iii) Open thin-wall rectangular channeling such as ‘C, T, or ‘top-hat’ sections. The chassis side-members, which span the wheelbase between the front and rear axles must be able to take the maximum of the sprung weight. The sprung weight is the weight of the part of the vehicle supported by the suspension system.

The members must resist their natural tendency to sag. The use of either pressed-out open-channel sections or enclosed thin-wall hollow round or rectangular box-sections can provide the maximum possible bending stiffness of chassis members relative to their weight.

The main constituents of the chassis are

i. Side member joints

ii. Cross member joints

Cross- and side-members are joined together to form a rectangular one-piece frame. Open-channel sections are commonly used for cross members, but for special applications

Sometimes tube sections are also used. The individual channel members do not have adequate stiffness against twist, but when joined together they form a relatively rigid structure capable of withstanding both bending the torsional loading. The attachment of the cross members to the side channels needs special attention, because the junction points are subjected to maximum bending as well as torsional stresses.

Commercial-vehicle side-members are generally made from flat strip pressed into C channel of appropriate section. The web section of C-channel resists any vertical bending and the top and bottom flanges prevent the web from buckling along its length and provide additional resistance to both bending and torsional stresses. Since the flanges or the outer regions of the web are the maximum stressed parts of the channel, any attachment should, therefore, preferably be in the web section. In actual practice, jointsare made between flanges or a combination of both web and flange joints for convenience.

Rated Output Power	1000W
Rated Voltage	48/60V DC
Rated speed	2800 RPM
No load speed	3100 RPM
Full load Current	≤20.0/16.0A
No load Current	≤5.0/4.5A
Rated Torque	2.56 N.m
Efficiency	≥75%

V. DIFFERENTIAL UNIT:

When a three wheeler takes a turn, the outer wheel turns faster than inner wheel. Thus, there is relative movement between inner and outer wheel. The function of the differential is to permit the relative movement between inner and outer wheels when vehicle negotiates (takes) a turn. The torque transmitted to each rear wheel is equal in this case, although their speed is different. The differential is made up of a system of gears which connect the propeller shaft and rear axles. It is a part of inner axle housing assembly. The assembly consists of differential, rear axles, wheels and bearings.

Construction and Working

It consists of sun gears, planet pinion, a cage, a crown wheel and a bevel pinion. A sun gear is attached to inner end of each rear axle (half shaft). A cage is attached on left axle. A crown gear is attached to the cage and the cage rotates with the crown gear. The crown gear is rotated by the bevel pinion. Crown gear and cage remain free on the left rear axle. Two planet pinions are on a shaft which is supported by the cage. The planet pinions mesh with the sun gears. The rear wheels are attached to outer ends of two rear axles. When the cage rotates,

sun gears rotate. Thus, the wheels also rotate. In case one inner wheel runs slower than other when the vehicle takes a turn, the planet gears spin on their shaft, transmit more rotary motion to outer wheel. When vehicle runs in straight line, the crown gear, cage, planet pinions and sun gears turn together as a unit. Thus there is no relative motion.

MOTORS :

DC motor is a mechanically commutated electric motor powered from direct current (DC). The stator is stationary in space by definition and therefore its current. The current in the rotor is switched by the commutator to also be stationary in space. This is how the relative angle between the stator and rotor magnetic flux is maintained near 90 degrees, which generates the maximum torque.

DC motors have a rotating armature winding (winding in which a voltage is induced) but non-rotating armature magnetic field and a static field winding (winding that produce

The main magnetic flux) or permanent magnet. Different connections of the field and armature winding provide different inherent speed/torque regulation characteristics. The speed of a DC motor can be controlled by changing the voltage applied to the armature or by changing the field current. The introduction of variable resistance in the armature circuit or field circuit allowed speed control. Modern DC motors are often controlled by power electronics systems called DC drives.The introduction of DC motors to run machinery eliminated the need for local steam oriented combustion engines, and line shaft drive systems. DC motors can operate directly from rechargeable batteries, providing the motive power for the first electric vehicles. The motor used in our project is Brushless D.C. motor whose capacity is 1kw and 48 volt .

WORKING WITH SOLAR CONNECTION :

Solar panels can be used as a component of a larger photovoltaic system to generate and supply electricity .Solar panel refers either to a photovoltaic module, a solar hot water panel, or to a set of solar photovoltaic (PV) modules electrically connected and mounted on a supporting structure. Energy conversion devices which are used to convert sunlight to electricity by the use of the photovoltanic effects are called solar cells. A single convertor cell is called solar cell and combination of such cells designed to increase the electric powered called solar array. Each module is rated by its DC output power under standard test conditions (STC), and typically ranges from 100 to 320 watts. A photovoltaic system typically includes a panel or an array of solar modules, an inverter, and sometimes a battery and solar tracker and interconnection wiring. A solar collector is a device for collecting solar radiation and transfer the energy to fluid passing in contact with it. Utilization of solar energy requires solar collectors. These are general of two types:

i. Non concentrating or flat plat type solar controller.
ii. Concentrating type solar controller.

The auto rickshaws on streets are very polluting, even more than the four wheelers. Solar powered rickshaws will replace these polluting vehicles, thus providing a greener and carbon free environment. It is estimated that each such replacement can save upto 10 tons of carbon dioxide emission every year.

Principle of the Conversion of solar Radiation into Heat :-

Solar cells are made of semiconductors that generates electricity when they absorb light. As photons are received, free electrical charges are generated that can controlled on contacts applied to the surfaces of the

semiconductors. The silicon solar cell is most highly developed type. It consists of single crystal of silicon into which doping material is diffused to form a semiconductor.

Solar cell principles:-

The fundamental process now in general use for heat conversion is the green house effect. The name come from its first use in green houses, in which it is possible to grow exotic plants in cold climates through better utilization of the available sunlight. Solar modules use light energy (photons) from the sun to generate electricity through the photovoltaic effect. The majority of modules use wafer-based crystalline silicon cells or thin-film cells based on cadmium telluride or silicon. The structural (load carrying) member of a module can either be the top layer or the back layer. Cells must also be protected from mechanical damage and moisture. Most solar modules are rigid, but semi-flexible ones are available, based on thin-film cells. These early solar modules were first used in space in 1958.The principle forms of renewable energy suitable for places which lie in the tropics is the wind and solar energy. The solar panels seen on the roof tops are usually for producing hot water and should not be confused with those used to produce electricity which are photo voltaic panels. They are made of 2 thin plates of silicon containing slight impurities which when exposed to sunlight experience a stimulation of electrons. If positive and negative terminals connected by a wire are added, as in a battery, the electrons will flow round the wire producing electricity.

Steps Followed During Calculation:-

Formation of P-N Junction :- A p-n junction is formed by placing p-type and n-type semiconductors next to one another. The p-type, with one less electron, attracts the surplus electron from the n-type to stabilize itself. Thus the electricity is displaced and generates a flow of electrons, otherwise known as electricity.

1) Preliminary data collection of the existing solar technology and its analysis.

2) Assessment and locating suitable applications and niche areas for the technology.

3) Comparing different applications zones and locating the most probable areas where a three wheeler vehicle with the respective technology will work.

4) Identifying the existing vehicles and their characteristics in these selected scenarios for which the vehicle has to be designed.

5) User study through scenario building in the areas where the vehicle is to be used.

6) Developing a design brief.

7) Basic anthropometric requirements and an ergonomic study.

8) Initial ideation and concepts .

9) Visiting the engineers and the fabricators in Lajpatnagar market and discussing possibilities with structure and details.

10) Concept generation.

FEATURES :-

The Solar Rickshaw The introduced prototype and its features are as follows:

1. Self sufficient on solar energy
2. Capable of a speed of 25- 30 km/h.
3. Seat 5 people.

Solar cell :-

A solar cell is an electronic device which directly converts sunlight into electricity. Light shining on the solar cell produces both a current and a voltage to generate electric power. This process requires firstly, a material in which the absorption of light raises an electron to a higher energy state, and secondly, the movement of this higher energy electron from the solar cell into an external circuit. The electron then dissipates its energy in the external circuit and returns to the solar cell. A variety of materials and processes can potentially satisfy the requirements for photovoltaic energy conversion, but in practice nearly all photovoltaic energy conversion uses semiconductor materials in the form of a *p-n* junction.

cell structure The basic steps in the operation of a solar cell are:

- the generation of light-generated carriers;
- the collection of the light-generated carries to generate a current;
- the generation of a large voltage across the solar cell; and
- the dissipation of power in the load and in parasitic resistances.

When sunlight hits the semiconductor, an electron springs up and is attracted toward the n-type semiconductor. This causes more negatives in the n-type semiconductors and more positives in the p-type, thus generating a higher flow of electricity. This is the photovoltaic effect

Solar panels- (110 x 4) watt mono solar panels placed on the roof.

Motor --Brushless DC motor, which offers the best efficiency greater than 90 % and has a weight of only 9 kg. At 48 Volt the motor can run at 1 KW with 4 Batteries.

Batteries -The batteries mainly store the excess power from the solar panels to give backup for night hours use. They also supply the initial torque to start the motor. The batteries are 4 x 12 Volt Exide sealed traction, deep discharge batteries.

Solar Controller-The Solar controller is like a fuse which regulates the current from the panels to the motor.Solar energy descends into another major area of pollution in India. It is the three wheeled auto rickshaws this time. The auto rickshaws are very popular on the streets of cities in India and Asia and are used excessively by the common masses for commuting. Solar rickshaw were built as an alternative to gas-powered cycle and auto rickshaws. They were introduced as an environmentally-friendly mode of transportation in India in 2012.

How Does Solar Powered Rickshaws Work :-

Solar energy can be used as the source to power the batteries of the vehicle, or there can be PV units powering the battery charging stations. It is been estimated that approximately 600 MW power plants will be required to convert the existing 1 million auto rickshaws into the cleaner renewable energy transport systems .These rickshaws are called "**Soleckshaw**".

The large solar panel category includes solar panels (or modules) from 110 Watts . This category includes modules which are great for smaller 12V battery systems, 110 Watt 12 Volt modules.12 Volts was the standard nominal output for most panels, since battery charging was a common application. A 12 Volt nominal panel actually puts out more than 12 Volts, so the voltage is sufficient to charge a 12V battery. The real output of solar panels can be seen on the spec. sheets, by looking at **Vmp**, which is the voltage they operate at optimally. A 12V panel will operate optimally at around 16 or 17 Volts. This does vary significantly with temperature, which is one reason the rated voltage is quite a bit higher than the nominal voltage. Depending on construction,

photovoltaic modules can produce electricity from a range of frequencies of light, but usually cannot cover the entire solar range (specifically, ultraviolet, infrared and low or diffused light). Hence much of the incident sunlight energy is wasted by solar modules, and they can give far higher efficiencies if illuminated with monochromatic light. Therefore, another design concept is to split the light into different wavelength ranges and direct the beams onto different cells tuned to those ranges. This has been projected to be capable of raising efficiency by 50%. The charge controller regulates the electric current that is flowing into and out of the battery bank, motor, or pump. By controlling the rate of electric current, charge controllers prevent overcharging and can protect against over-voltage which could damage the battery or motor. A charge controller can also prevent totally draining ("deep discharging") a battery, or perform controlled discharges, depending on the battery technology, to protect battery life. Here we have used four battery and all are connected directly to controller to connect with Battery**.**

MPPT or PWM Charge Controller

Maximum Power Point Tracking charge controllers (MPPT) and Pulse Width Modulation (PWM) charge controllers are two types of charge "regulators" for renewable energy systems. They regulate the flow of electricity from the power generation system into the load or storage system. MPPT charge controllers are the most efficient type on the market but are also more expensive. Several charge controllers use both technologies, but adding MPPT circuitry to a charge control increases the cost. When choosing the right solar charge controller, we need to consider how many panels you are using, what our battery bank power storage capacity will be and how much load our power system will create. we should also consider how long we will need to run the system (years). The annual power gains from an MPPT charge controller can offset the cost savings of a controller only using PWM in many situations. But a properly matched PWM can be much more cost effective especially for smaller installations Why do MPPT charge controllers have the best performance? Because they allow solar panels to operate at their optimum voltage levels in varying light conditions; summer, winter, morning, noon, cloudy etc The MPPT charge controller takes the voltage output of the solar panels, and compares it to the battery voltage. It then figures out what is the best voltage to get maximum AMPS into the battery. Remember it's the AMPS that matter. Said another way, the MPPT controller tracks the best voltage level and then down converts it to connections can be combined to produce the voltage and AH that we require. the voltage of your system (12, 24, 48VDC). This "tracking" of the optimal power point improves performance by as much as 30%. PWM charge controllers on the other hand, reduce the voltage from the solar panel to that of the battery bank resulting in a decrease in efficiency. The efficiency loss depends on the size of the voltage mismatch between panels and batteries. Another benefit of MPPT charge controllers is that many can accept high input voltages (up to 120+V DC) and efficiently down convert the DC voltage to that of system (e.g. 12, 24, 48VDC, etc) which means we aren't losing any generated power and we are able to use what you generate more efficiently. Additionally, using a much higher DC voltage on the input side allows to use thinner wire, decreasing wire cost and making installation easier.PWM charge controllers are less expensive and it will find a wider selection of models available. They are ideal for smaller systems where price point is critical or where the additional power is not really needed. solar charge controller is an integral part of system..Battery Wiring – Putting it all together before buying batteries we need to figure out how many need. Wiring is going to play a major role in determining this number. The goal is to find a configuration that produces target AH and voltage.

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There are two methods of wiring components in a circuit: parallel and series. In a series configuration the battery voltages add up while in parallel, current adds up.Series and parallel

Series → voltage adds, current does not

Parallel → current adds, voltage does not

The AH rating depends on how wire together . Also it is perameter that if a used battery is connected in parallel to a new one, it will degrade the fresher battery decreasing the lifespan of the whole system. Some people say that ideally should we just use a long line of batteries connected in series for battery bank.

VI. SPECIFICATION OF SOLICKSHAW

1. Dimension of Rickshaw:

s.no,	Parameter	Value
1.	Length	2650 mm
2.	Width	970 mm
3.	Height	1000 inch.
4.	Clearance	300 mm.
5.	Roof shed size	2300 x 1000 mm.
6.	weight	680 kg.
7.	Battery	4 each of 90 A.H.
8.	Brake type	Hub (Foot)
9.	Daily distance driven	80-90 km. on full charge

2. Specification of Engine Used

S.No.	Parameter	Value
1.	Wheelbase	1305 mm
2.	Weight	121 kg.
3.	Displacement	112 c.c.
4.	Max power	12.8 B.H.P.
5.	Max torque	12.7 N-m
6.	Max voltage output with alternator	12 volt

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3. Solar Panel Specification

S.no	**Parameter**	**Value**
1.	Power output	110 watt
2.	Voltage at P max	17.0 volt
3.	Current at P max	6.4 amp
4.	Open circuit voltage	21.3 volt
5.	Short circuit current	7.3 volt

CALCULATION

1. Calculation for the vehicle torque and power :

Over all weight of the vehicle = 680 kg

Tractive resistance of the vehicle Rt = Rr +Rf +Rg +Ra +Racc.

The rolling resistance = Crmg

= 0.015*700*9.81

= 103.005

The frictional resistance = 132+50.5 m = 72.5

The acceleration resistance = Camv2

= 0.0230 * 2*20*20= 114

The gradient resistance = 0

Then tractive resistance = 103.005++184+0 = 219.505

So power required to propel the vehicle = (Rt*V*1000)/(3600) Nm/sec

= (219.505*20*1000)/(3600)

= 978 watt

Max .revolution of the crank shaft = 600 r.p.m

Then torque required= P*60/(2*3.14*N)

= 978*60/(2*3.14*600)

= 15.561 Nm

Wheel torque =T w = n*G*Te

= 0.9* 4* 15.561

= 56.62 Nm

Torque required by the transmission shaft, Ts = wheel torque / gear ratio

= 56.62 / 4

= 14.40 Nm

So for fulfill the requirement of torque we are using brushless D.C. motor (48v 1000watt).

2. A.Battery Calculation :

The vehicle uses four pieces of battery and each battery is 12V, 90Ah. Assume the depth of discharge (DOD) of a battery is 70%. The vehicle consume battery energy 4320Wh and it could cover 140Km in 6hour. So, the vehicle consumes 864.8W to covered 23.33Km in an hour. The power consumption calculation is given in below:

Battery capacity=90Ah

Battery voltage=12V

Total energy storage capacity = 90*12*4 = 4320Wh

Battery Depth of Discharge = 70%

Uses battery capacity =90Ah*70% = 63Ah

Total usable vehicle energy = (63Ah*12V)*4 = 3024Wh

Total distance covered per day = 140Km

Total driving time = 6h

Vehicle Consume power per hour = 4320/4 = 1080.8W

Distance covered in an hour = 140Km/6 = 23.333Km

VII. CONCLUSION

In major cities of India there are petrol and diesel powered three-wheelers called auto-rickshaws. They are some of the most polluting vehicles on Indian roads. They usually run on 2 stroke engines which are inherently more polluting than the regular 4 stroke engine. Data collected reveals that in traffic conditions prevalent in most inner city areas, these auto-rickshaws run only at 25-30 km/hr speed thereby producing even more pollution since they are designed to run efficiently at 30-45 km/hr. The pollution is further compounded by the fact that they continuously have to run in stop/start mode. The data also shows that on an average these auto-rickshaws travel about 50-60 km. during a day. Based upon this data it was felt that an electric rickshaw designed to run 60-80 km per charge at speeds of between 25-40 km/hr would be an excellent substitute for these IC powered auto-rickshaws. In a fair weather country like India, a silent and non polluting electric rickshaw with the above attributes could be a boon. China is also a booming transport region that could stem the imports of petroleum by adopting light weight electric sports vehicles that are at least solar assisted**.**It can be finally concluded from the above considerations that large research have done in the last 10 year as described in the text to be followed which have been utilized or to be utilized in the nearby the future .

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