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Solar and Human Power Operated Vehicle with Drive Train

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ABSTRACT: It is highly essential to produce an alternative vehicle for students travelling for short distance in city. Bicycle is used for transportation, but possessing discomfort with physical exertion required pedaling over roads and uneven terrains. The traditional tricycles are arranged with extremely high gear ratio. A power assist will improve Bicycle comfort and easy for driver to drive it with comfort. This project deals with design and fabrication of bicycle powered by human and solar energy with drive trains having low gear ratio. This results to minimize the problems and constraints over the traditional bicycle and can be frequently used by school/college students.

KEYWORDS: Solar Energy, Bicycle, Tricycle, Drive Train

I. INTRODUCTION

Solar energy is use in various industries. Solar energy having wide range of application. It is unlimited source of energy that is why we have to utilize solar energy. Solar tricycle takes power from solar energy and paddle mechanism both. It may be called as hybrid tricycle. The main cause to develop this is to reduce the use of fossils fuels used by scooters in India. The solar rickshaws are already developed by researchers, but the hybrid cycle will be more compact and can achieve high velocity than other solar vehicle in same category. It will provide safety feature to student. Solar tricycle was built with the solar products which are use the solar power to operate.

II. LITERATURE SURVEY

The use motor in this cycle provides extra power which reduces the human efforts. The normal speed of paddle cycle is 10KM/hr. But the hybrid technology reduces mechanical effort and reduces pollution. The use of electrical energy can control the speed and torque. The maximum speed attainable by this vehicle was 20 to 25 kilometers per hour, to achieve this range of speed. 2*12v, 34amp-hour batteries were used. The vehicle had a provision of using 2 such batteries at a time. The vehicle could be charged by solar power. The structure of the vehicle may be made up of parts available locally. The vehicle may be made of components which were much stronger than those of ordinary cycle because the load carried in this vehicle is much more than an ordinary cycle and also the speed is much more. We used these cycle paddle power uses of drive train for increase of vehicle speed. Paddle speed is maximum 20kilometers per hour.

The components used are Solar panel 250watt, Solar charge controller, Battery (12v-34amp-hr), Dc electric motor (250w ,brush type) Brakes (disc and v-brakes),Throttle as shown in fig. a.

III. DESCRIPTION AND DESIGN

The description and detail of the project consists of a full sized solar tricycle. The various assumptions are made for full design is mentioned. The solar energy can be converted and stored in batteries and then it can be used to run the tricycle. Schematic diagram fig. a shows the basic components of the cycle.

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The solar powering system of the tricycle consists of:

1. Solar Array which collects solar energy and converts it to electrical energy
2. Batteries to store power.
3. Motor controller which adjusts the power input to the motor.
4. An electric motor which drives the vehicle.

Schematic diagram:

Schematic diagram of Solar and Human operated tricycle using drive is shown in fig. a

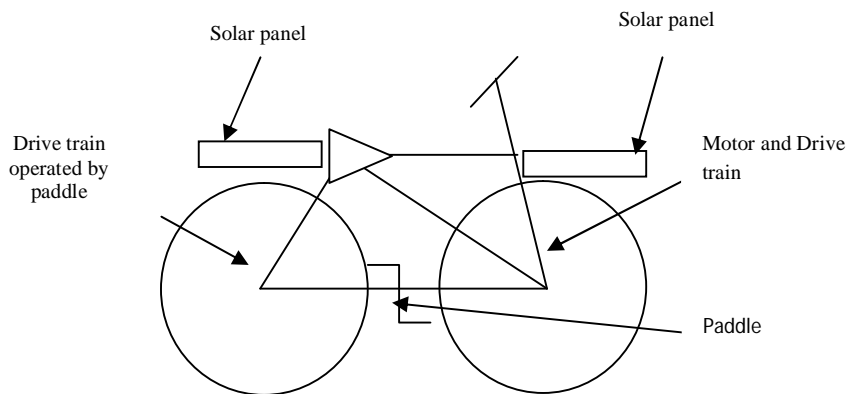


Fig. a, Solar and Human operated tricycle using drive train.

Specifications:

- Solar panel: 24 volt, 250watts
- Motor: brush dc motor, 24 volt, Power rating is 250 W, 300rpm.
- Battery: 12 V- 2 No's, 34 amp-hr.
- Charging time: 3.5 hr.
- Maximum speed: 20 km/hr.
- Frame: Steel in parts with high strength requirements.
- Wheels: Front 20 x 1.75. Rear 23 x 2.00.
- Tyres: Front 23 x 2.50. Rear 20 x 2.00 / 2.25 moped strength.
- Size: Length 2.3 M. Width - 1.2 M.
- Load Capacity: 90 kg
- Dimension of the tricycle: 2000mmX500mmX1000mm.

Wheel & Chain:-

- Wheel diameter is 26 inch. I.e. 0.66 m
- Chain type of ISO '08 B' used

Nomenclature:

D = Dia. of Tire (m)

V =velocity (m/s)

P = power (watts)

T = Torque (Nm)

N= Number of speed in RPM

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T_1 = Teeth no. on large gear at pedal
 T_2 = Teeth at axle shaft gear
 P_b = Power required for battery (W-hr.)
 I = Current for battery (A-h)
 F_s = Static frictional force
 F_r = Rolling resistance
 T_s = Static Torque
 T_r = Dynamic Torque
 μ = Coefficient of friction
 u = Gradient

IV. CALCULATION

For Motor Selection:

Velocity of front wheel drive by motor = 150 rpm

D = Dia. Of Tire = 26 inch = 66.04 cm

$V = \pi DN/60 = 3.14 \times 0.6604 \times 150/60 = 5.58$ m/s

Cycle weight + rider weight = 120kg

Power (Watts) = Total weight $\times g \times$ speed $\times u$

Power = $120 \times 9.81 \times 5.58 \times 0.03 = 196$ watts

Considering Losses let the power required approximately 250 watt.

Thus a DC 24 Volt, 250 W, 300rpm with reduction gear box, 8N-m motor may be selected.

Torque at motor shaft after reduction

$T = (60p) / (20N) = (60 \times 250) / (2\pi \times 300) = 8$ NM

For motor operated front wheel:

8 Nm torque is provided at motor shaft, with a gear of pitch=0.5 inch, 9-teeth.

Now no. of teeth of sprocket on the rear axle is= 18 teeth.

So velocity ratio= $N_1/N_2 = T_2/T_1$

$$300/N_2 = 18/9$$

$$N_2 = 150 \text{ rpm}$$

Torque required at front axle

$$\text{Torque} = (60p) / (2\pi \times N_2)$$

$$T = (60 \times 250) / (2\pi \times 150)$$

$$T = 15.92 \text{ Nm} \sim 16 \text{ Nm}$$

Case 1: velocity = $(\pi \times DN)/60 = (\pi \times 26 \times 0.0254 \times 150)/6 = 5.18$ m/s or

$V = 18.67$ km/h, this is the top speed of solar tricycle.

Case 2: Considering losses speed reduction from 150 to 70 rpm

$V = (\pi \times 26 \times 0.0254 \times 70)/60 = 2.42$ m/s or 8.71 km/h.

For Drive Train:

Tricycle and drive train will be manufactured as per design developed at our end. The drive train is main component which will make this tricycle very easy to drive at good range of speed from 100 RPM to 200RPM (Actual maximum speed is less).

Sprockets:

9 Teeth on Electric driver sprocket, 18 Teeth on Electric driven sprocket, 44 Teeth on Manual driver sprocket, 18 Teeth on Manual driven sprocket

T_1 = Teeth no. on large gear at pedal=44

T_2 = Teeth at axle shaft gear=18

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If a person pedaling about $N_1=80$ rpm then speed can be given as,

$$\begin{aligned} N_1/N_2 &= T_1/T_2 \\ 80/N_2 &= (18/44) \\ N_2 &= (80 \times 44)/18 \\ N_2 &= 195.55 \sim 196 \text{ rpm} \end{aligned}$$

Speed of tri-cycle- $V = (\pi \times D \times N)/60$
 $= (\pi \times 26 \times 0.0254 \times 196)/60 \times (18/5) = 24.4 \text{ km/h}$

Selection of Battery:

System voltage 24 Volt,

Estimate 3 hours of tricycle running per day

Power in W Hrs. / Power in W = time in Hrs. X / 250 W = 3Hrs

Power required for Battery = 750Whrs.

Required current for Battery = $750/24 = 32 \text{ Ah}$ (so two 12 Volt batteries are required)

Solar panel:

Power generation of solar panel is also in watts

Panel exposed to sunshine = 3.5hrs.

Losing factor = 0.85

Solar panel = 250 watt

Power supply to the battery = $250 \times 3.5 \times 0.85 = 743.75 \text{ Whrs.}$

Static Load condition:

figure b. shows static load free body diagram

Total load $N = mg = 120 \times 9.81 = 1177.2 \text{ N}$

Load on Each Wheel = $1177.2/3 = 392.4 \text{ N}$

Dry friction between Rubber and Asphalt = 0.9

Rolling friction between Rubber and Asphalt for cycle = 0.004

Static Frictional Force for Rear wheel

$F_s = \mu N = 0.9 \times 1177.2 = 1059.48 \text{ N}$

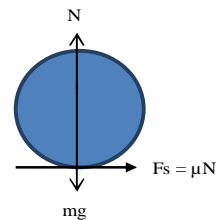


Fig. b, Static Load

Rolling condition: $F_r = 0.004 \times 1177.2 = 4.7088 \text{ N}$

Torque (Static Condition & Rolling Condition)

For 18 teeth Sprocket

$r = 6.25 \times 10^{-2} \text{ m}$

Torque

(Static Condition)

Torque

(Rolling Condition)

$$\begin{aligned} T_s &= 1059.48 \times 6.25 \times 10^{-2} \\ &= 66.217 \text{ N-m} \end{aligned}$$

$$\begin{aligned} T_r &= F_r \times r = 4.708 \times 6.25 \times 10^{-2} \\ &= 0.294 \text{ N-m} \end{aligned}$$

For 14 Teeth sprocket

$r = 2.75 \times 10^{-2} \text{ m}$

Torque (Static Condition)

Dynamic Torque

$$T_s = F_s \times r$$

$$F_s = T_s / r = 2407.8 \text{ N-m}$$

$$T_r = F_r \times r$$

$$F_r = T_r / r = 10.69 \text{ N-m}$$

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V.PROPOSED METHODOLOGY AND DISCUSSION

Motor Driven front wheel

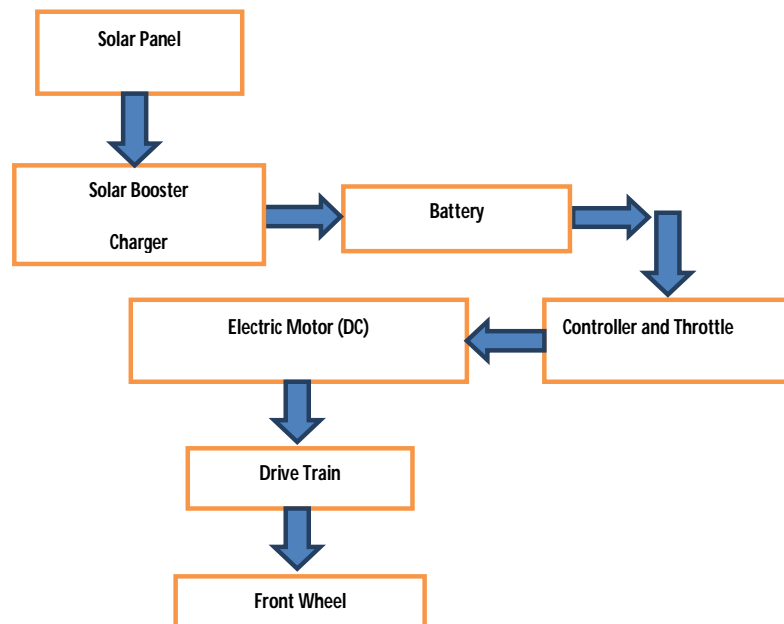


Fig. c, Power transmission methodology of front wheel

Human power driven rear wheel :



Fig. d, Human power driven rear wheel

Fig. c shows Power transmission methodology of front wheel and Fig. d shows Human power driven rear wheel. The whole system is unique which partially runs on paddle and partially runs on battery. The rider can use pedal power and solar power both easily, and when not in use, these solar panels continue to recharge the batteries. The motor's maximum speed is 25 kmph. Pedal power use in drive train for mechanical advantage these increase speed of pedaling power to 20kmph.

Possible innovations are making a solar based tricycle which are provided with solar energy and reduced man energy power and also provided safety features. We may provide better comfort improved efficiency by adding some features. Solar based compact tricycle design which will reduce man energy and power may be more popular among people travelling for short distance. The easy design and less cost will add new features to it and it will be easy to manufacture.

- Solar & Human Powered tricycles are more reliable.
- Solar powered Vehicles do not require any expense for running.
- Solar Vehicles are quite.
- Solar Vehicles require very low maintenance.
- Solar Vehicles produces no harmful emissions.
- Mechanical advantage to human power by drive train.

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VLEXPERIMENTAL CHARACTERISTICS CURVE AND RESULTS DISCUSSION

The following figures e & f represents the characteristics curve of Power produced by solar panel & Relation between power vs. Speed respectively.

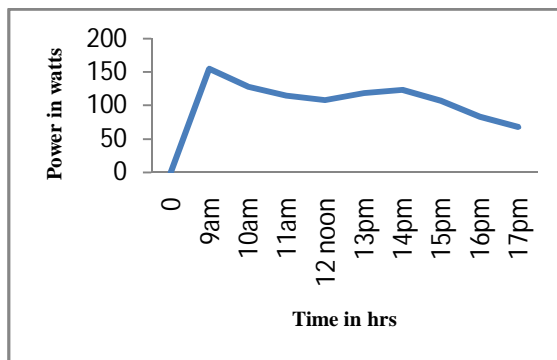


Fig. e, Power produced by solar panel

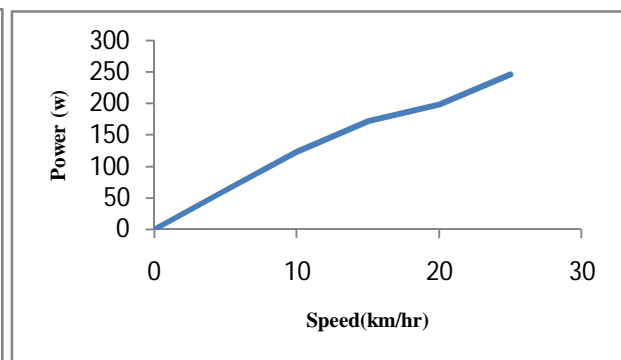


Fig. f, Relation between Powers vs. speed

Solar energy is available in abundance on earth. The Jalgaon is one of the hottest city of Maharashtra, 1200 w/m² solar irradiation is available in this region, it is one of the effective renewable energy. The solar panel performance is observed very well in this region. This project was taken as a prototype of using this solar energy a form of renewable energy. The tricycle worked on solar and human power in which speed and power two factors were considered. The result obtained is as per the design values discussed above.

VII. CONCLUSION

The traditional tricycles are arranged with extremely high gear ratio. A power assist will improve tricycle comfort and easy for driver to drive it with comfort. This project deals with design and fabrication of tricycle powered by human and solar energy with drive trains having low gear ratio. The results obtained as per speed and power was good. The maximum speed obtained is 20km/hr with motor. During travelling on inclined surface and weather problem the human power is used. Drive train is a big advantage to tricycle to enhance the power and support to motor power. The tricycle with motor and drive train drive is most suitable for Indian traffic in cities like Jalgaon. The concept of combine power needs more improvement. It will be most preferable by general people in India .The actual model is developed and tested on road.

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