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E – Zyklus

Suyant Dharwarkar
suyant26@gmail.com
Vishwakarma University, Pune, Maharashtra

Abdulhasnain Akodiyawala
abdulhasnainakd5253@gmail.com
Vishwakarma University, Pune, Maharashtra

ABSTRACT

The E - Zyklus is experimentation for converting the manually human powered vehicle, in this case a bicycle, into an electrically powered vehicle and optimizing its performance. The concept of E - Zyklus consist a Schnell Bicycle, in which the pedal and chain drive is eliminated. A 24 V Brush less DC motor is used with a simple chain drive in case of the manual chain drive. The battery pack used is 4 piece of lead acid gel battery. Also a speed controller is introduced which is of 24 V for the speed control of the BLDC motor, with a Throttle. The objective of the experiment is to optimize the power required for the vehicle to operate, to achieve top speed of 30 kmph and also get enough torque for all operation performed by the vehicle like drive on straight road and climbing up the slope and also achieve good traction on uneven surfaces. The other objective is to see whether a hybrid vehicle is feasible or not.

Keywords– *E – Zyklus, Electrically powered vehicle, Battery pack, Hybrid vehicle, Bicycle, 24 V Brush less DC motor.*

1. INTRODUCTION

The usage of carbon based fuel for powering vehicles is seen for around 100 to 200 years. Also it has leaded us to the technology we use today which seemed impossible at some point of time. But it won't take us any further.

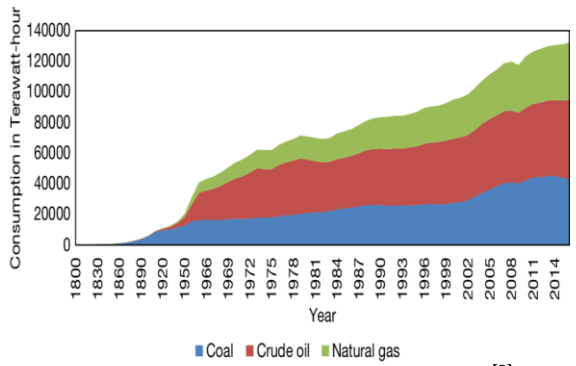

Fig. 1: Global fuel consumption chart [8].

The unchecked and wasteful use of these carbon-based fuel by humans has forced it to deplete rapidly and we are just standing on the verge of the total extinction of fossil fuels.

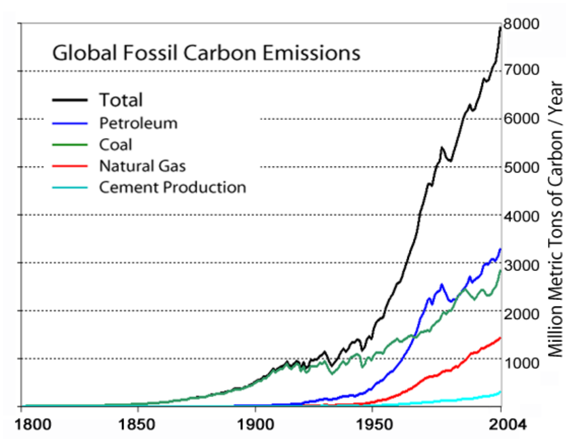

Fig. 2: Global Fossil Carbon Emissions chart [7].

This uncontrolled use of fossil fuels has lead to high emissions of carbon dioxide CO_2 which has fatal effects on all living being as well as Nature. The effects are like Global warming, Rise of sea level, melting of polar ice caps, Lung and Heart disease in humans, Climate changes, etc. These are all fatal effect and hence we need to stop the use of fossil fuels and find an alternate way of power generation and usage. The most feasible way that we can see now is the electrical power, which is easy to produce, and is clean, eco-friendly, can be stored. The electric power is the way, which leads us to our future.

The second point of view is that to reduce pollution, humans are shifting from fuels to manually powered vehicle. The best example is the bicycle. In many countries, the bicycle is preferred over the cars and bikes. In European countries we can see that the studying class uses it for day-to-day life. In Japan, the working class in factories use bicycle for travelling. Also in Indian villages, the bicycle is still used. The positive point of this technology is that it is simple in design, cost efficient and eco-friendly. The drawback is that it is manually powered, which can be very Exhausting and power consuming. So to eliminate the only drawback, the simple design of the bicycle and the clean electric power are combined to form a product which can be clean and cost efficient at the same time. The electric cycle is a typical bicycle available in market which is infused with an electric powered system. The electric powered system comprised of an electric motor, a speed controller and an electric battery pack.

2. LITERATURE REVIEW

Several research papers related to theoretical and practical experimentation and analysis of fully electrical or hybrid bicycles are reviewed thoroughly.

Fig. 3: Laufband Zyklus [1].

Suyant Dharwarkar, Amit Jadhav [1] Laufband Zyklus a German name for treadmill cycle is designed for those people who love to walk outdoor. Treadmill belt constructed on cycle and innovation named Laufband Zyklus' is made. Electronic parts are assembled and run smoothly on walking momentum. As the person walks on the treadmill belt, the belt starts up and the rear wheel starts propelling the bike in the forward direction. Laufband Zyklus is designed for walkers as the conventional treadmill; this project is the combination of best fitness device and travelling long distance without producing any of pollution.

Mitesh M. Trivedi et al [2] Modern world demands the high technology which can solve the current and future problems. Fossil fuel shortage is the main problem now-a-days. Considering current rate of usage of fossil fuels will let its life up to next five decades only. Undesirable climate change is the red indication for not to use more fossil fuel any more. Best alternative for the automobile fuels to provide the mobility & transportation to peoples is sustainable electrical bike. Future e-bike is the best technical application as a visionary solution for the better world and upcoming generation. E-bike comprises the features like high mobility efficiency, compact, electrically powered, comfortable riding experience, light weight vehicle. E-bike is the most versatile future vehicle considering its advantages.

C. Abagnale et al [3] a new model of power-assisted bicycle has been designed set up and tested. The main innovative solutions for the pedelec prototype are described in the present paper: the electric motor position; the new mechanical transmission; the low cost measurement system of the driving torque; the special test rig. Differently from a common approach, in which the electric motor is located on one of the three hubs of the bicycle, the idea of the pedelec prototype consists of an electrical motor in the central position that, by means of a bevel gear, transmits the torque on the central hub. The other innovative solution is represented by the motion transmission from the motor to the pedal shaft, achieved by two different gearboxes: the first one is a planetary gearbox and the second one is a simple bevel gear. The pedelec prototype contains also a new low cost measurement system of the driving torque based on a strain gauge load cell located on one side of the rear wheel, between the hub and the frame. Moreover, a commercial cycling simulator has been suitably modified in order to properly install the different sensors for the measurement of the performance of the pedelec. The test rig is able to reproduce an aforethought route or paths acquired during road tests, to measure the performance of the e-bike in terms of instantaneous power and speed. The experimental test rig can simulate the resistant torque of a predetermined track and it aims to test and to optimize the control strategy available on the electronic control unit. The authors have also conducted an environmental analysis of the developed pedelec, in particular comparing the e-bike with a thermal moped, in terms of environmental impact.

Sunikshita katoch et al [4] in this paper, we are concerning about the growing demand of energy all over the world, which motivate us to switch over renewable resource of energy. There are many different ways by which we can save energy in different sectors. Our main focus is on automobile sector where we are converting old petroleum bike to electric bike. In these electric bikes we use electrical motor (BLDC motor) instead of combustion engine as there is less pollution, low maintenance cost, reduces noise. These bikes utilize chemical energy stored in the rechargeable battery packs. This paper deals with the design and development of electric bike which make use of electric energy as primary source. There is a distribution for charging the battery emitting it from the main system.

Mayur Balakrishna Patil et al [5] Now day's bike or vehicle is very important our fast life for travelling and this is also play very important role in growth of economy but main drawback of this bike and vehicle is produce pollution in environment because of burning fuel. For this reason, increases global warming and also storage of fuel is limited. Due to that now day's need of eco-friendly technology for travelling. E-bike (electrical bicycle) this is nothing but one example of eco-friendly technology but this technology having some drawback to overcome the drawback of e-bike we have been design self-power generating electrical bike. This design overcomes all the drawback of e bike. Self-power generating electrical bike is nothing but e-bike that generates its own power supply by using some arrangement.

Kunal D Topiwala et al [6] we are concerning about the growing demand of energy all over the world, which motivate us to switch over renewable resource of energy. There are many different ways by which we can save energy in different sectors. Our main focus is on automobile sector where we are converting old petroleum bike to electric bike. In these electric bikes we use electrical motor (BLDC motor) instead of combustion engine as there is less pollution, low maintenance cost, reduces noise. These bikes utilize chemical energy stored in the rechargeable battery packs. This paper deals with the design and development of electric bike which make use of electric energy as primary source. There is a distribution for charging the battery emitting it from the main system.

3. PROBLEM STATEMENT

An Experimental Investigation on converting a manually powered vehicle to electrically powered vehicle by still keeping the product, cost efficient.

4. METHODOLOGY

a) Analysis of Problem Statement.
b) Literature survey.
c) Study of the mechanism.
d) Selection of Components readily available in market.
e) CAD Design.

f) Prototype of the mechanism.
g) Required calculations.
h) Actual Experimental setup.
i) Testing and Simulation of mechanism on working parameter.

5. OBJECTIVES

- Acceptation of the new electrical power train, over the manual power train, perfectly by the vehicle [bicycle].
- Achieve speed, which should be more than two times the maximum speed, which the vehicle can achieve previously.
- Achieving enough Torque, so the vehicle can have good traction on uneven and inclined surfaces.
- Overall cost of the vehicle should be less than 1.5 times the original cost of the vehicle [bicycle].
- Developing the simplest way to fuse the electrical and mechanical system, efficiently.
- Keeping the power storage method as power saving and light weighted as possible.
- Achieve a satisfactory amount of Mileage.

6. EXPERIMENTAL LAYOUT

Fig. 4: CAD Diagram of vehicle.

7. WORKING PRINCIPLE

- The E - Zyklus works on the principle of electric energy converted to mechanical energy by the means of a DC motor.
- The electric energy is stored in the battery packs in the form of chemical energy and the battery pack provides the energy to the motor by the means of an electronic control module (ECM).
- Further the motor starts to rotate and the rotation of the motor is given to the wheel of bicycle with the help of a simple chain drive.
- In this way the bicycle starts to propel forward.
- It is same as a human pedaling a bicycle, but in this case the pedaling action by human is taken over by the rotation of motor.
- Theoretically, no human efforts are required to drive the vehicle.

8. COMPONENTS

8.1 Bicycle

The bicycle used in the experiment is Schnell Adventure SR.SS 2016 model. It has Steel hardtail type frame, Single gear (no shifters), Suspension fork, Rim brakes, Alloy double wall rims, 24 inch wheels, hardtail suspension, steel handle bar. The body and the crankset are also steel. The cycle has average price range in market and readily available. Has a sturdy body and best durability the manufacturer can offer. The cycle is single gear option. Rim brakes can get the work done. The picture of the bicycle has been shown in Figure 5. Table 1 below shows the technical specification of the bicycle completely.

Fig. 5: Schnell Adventure SR.SS (24) (2016) [9].

Any other bicycle from different manufacturer and same specification can do the need full. Single gear cycle is important as the speed and the motor fulfills torque requirement.

Table 1: Technical specifications.

Model	Adventure SR.SS (24)
Manufacturer	Schnell
Year	2016
Frame	Steel hardtail
Fork	Suspension fork
Brakes	Rim brakes
Shifters	N/A
Wheel size	24”
Tires	Alloy double wall rims
Suspension	Hardtail
Rims	Alloy 24
Crankset	Steel
Stem	Steel
Handlebar	Steel

8.2 DC Motor

Fig. 6: 24V/250W BLDC Motor [10].

The most important component in the vehicle is the motor. It is just like the IC engine in the motorcycle. It is the heart of the vehicle. The basic function of the motor is to convert the electric energy to mechanical energy (rotational). It does not produce any type of by-product (gases), hence it is the most clean and nature-friendly system.

Figure 6 shows the motor used in the experiment. The motor is mounted on a specially designed mounting plate which in turn is mounted between the two rods extended to the rear wheels hub. The motor is mounted on the right side of the vehicle. The motor is 24 Volt, 250 Watt, 4 poles Brushless DC motor. Rated speed of motor is 3300 RPM. Rated current is 13.4 A. It is equipped with an inbuilt hall sensor. There is worm and worm wheel arrangement at the output shaft, so that the motor can be prevented to be rotated in the opposite direction by the load. A nine teeth sprocket is provided at the output of the motor. The specifications of the motor are given in below Table 2.

Table 2: Specification of motor

Model	MY1020Z2
Rated power (W)	250 Watt
Rated voltage (V)	24 Volt
Rated speed (RPM)	3300 RPM
Unloaded speed (RPM)	3850 RPM
Rated current (A)	Less than or equal to 13.4 Ampere
Unloaded current (A)	Less than or equal to 2.2 Ampere
Reduction ratio	9.78:1
Weight (Kg)	4.675 Kilogram
Dimensions (mm)	270 * 180 * 195 mm

8.3 Battery Pack

Fig. 7: 12V 7AH lead acid gel battery [12].

The battery pack is comprised of four pieces of 12 V 7 Ah lead acid gel battery. The lead acid batteries, used, are rechargeable. The motor requires 24 V to operate, so the two batteries are connected in series to achieve 24 V and this pair is connected in parallel to a same pair to obtain 14 Ah of battery life. The battery pack is connected to the ECM unit in specified ports. Any manufacturer's batteries can be used given that the output battery package should be always 24 V. The Ah can be determined according to the rated current of the motor. Battery package could be a single battery or multiple small or medium batteries connected in parallel or series to achieve the desired output. Battery pack over 24 V should not be used as it can damage the motor and, very importantly, the controller (ECM). Lithium ion battery pack can also be used which is light in weight but is not very cost friendly.

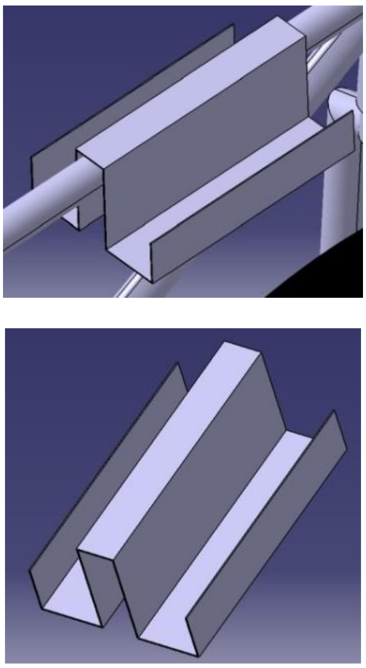

Fig. 8: CAD diagram of Battery pack holder.

A specially designed battery pack holder is shown in figure – 8.3.2 above. The holder is mounted at the middle of the bicycle for good weight distribution and low centre of gravity. The battery pack is tightly fasten for comport and less vibrations.

8.4 Electronic Control Module [ECM]

Fig. 9: Electronic control module [10].

Electronic control module, as the name suggest, is the control unit of the vehicle. It control the power sent to the motor. It also controls the auxiliary function like Head light, brake light, power cut-off to the motor. It is 24 V and has connection for all function performed. It controls the power to the motor. Head light power, brake light power, tail light power and throttling and battery charge count.

The different ports in the controller are for battery pack, motor, brake light, throttle, headlight, locking mechanism, charging port.

8.5 Throttle

Fig. 10: Throttle with horn [10].

The throttle is the device, which enables the rider to control the speed of the motor and therefore the speed of vehicle. The twisting throttle for the speed control of the motor is easily available in the market. The particular design used in this case has a built in horn. It has two ports, one for speed control and the other for the horn switch.

8.6 Brakes Levers

Fig. 11: Brake levers with auto cut off [11].

The brake levers, in the case, are like any other brake levers found in a bicycle. They have a unique quality, which is that they come with an auto cut off capability. It kills the power to motor as soon the brakes are deployed. The throttling will not have any effect as long as the brakes are deployed. The cut off signal is given to the controller with the help of ports provided.

8.7 Locking and Headlight Unit

Fig. 12: Locking and headlight unit.

Locking and headlight unit is an integrated unit, which does two jobs. The lock is simply a switch, which is switched ON by the key. The unit is connected to controller by two ports locking and headlight. It is a compact unit and is placed at the middle of the handle bar of the vehicle.

8.8 Wire Harness

Fig. 13: Wire harness.

Wire harness is the component which transports the signal from one component to another. Every basic electrical system required a wire harness for operation. The wire harness comprises of different wire with different colour set, bonded together in a plastic cover for durability. The colour is assigned to the wire for specific reason. It is easy to connect to the required device with colour discrimination. The wires are arranged in particular manner and have plugs (connectors) at both ends for correct connection. For example; the headlight is connected to the harness designated wire plug and the on the other end of harness the same colour wire plug is connected to the controller.

8.9 Charger

Fig. 14: Charger

The charger, used in this application, takes input of 230 V 50 Hz AC and gives DC output of about 12 V 5 A. In this case, fast charging is not used to keep the battery life as long as possible.

8.10 Procedure

a. A Theoretical idea was first put on a piece of paper in form of drawing while keeping in mind the original design of bicycle available. Then once the idea was finalized the specification of vehicle where put on table. The specifications like torque, speed, comfort, cost, etc.
b. After that according to the specifications required, a market survey was conducted in which the availability and cost of components required were reviewed. The components under desired cost and specification were selected. The first priority was to manufacture and manage the components. But own self as lack of resources can manufacture not all components. The components like motor, ECM, battery pack, etc were purchased and some parts were salvaged.
c. Several CAD designs were created and one was finalized. The CAD designs were for placement, management and proper work of vehicle to be studied properly. The CAD Software used for 3D modeling was CATIA V5R21.
d. The manufacturing started, the bicycle was stripped and on the framework the work was done. The operations like drilling, bending, fabrication, grinding, tapping, bolting, etc, were performed according to requirement. Motor mounting plate was first made with the help of 5 mm thick MS plate which was then welded between the driving and the driven sprocket, on the chain stay and seat stay pipes meeting at the rear wheel hub. The holes were drilled on the plate for proper mounting of motor making sure that the motor sprocket is perfectly aligned to the driven sprocket. The chain used was salvaged from the previous parts of the bicycle.
e. Then the battery pack holder were made by 2 mm aluminum sheet which was bended at 90º to achieve desired shape and once completed were bolted to the top tube of bicycle.
f. Once the hardware was fastened properly then the electric connections were started. The controller was fastened to the bottom of seat pipe and the headlight and locking unit at the middle of the handle bar. The wire harness was wound around the framework. The connectors of harness and the equipment were closed. The brake wire and the throttle were also mounted. All the assembly was double-checked.
g. The fully charged battery pack was connected for first time testing and the bicycle started. The motor was running on throttling. Minor changes were made after the bicycle was tested. There were problems but they were tackled.
h. Once the confidence was established that no further changes were required and the bicycle was safe to move. The testing was started to carry out experiments.
i. The speed was checked, the power was checked, the battery performance was noted, and the vibrations were seen and were isolated. Proper measurement devices were used. The calibration was done until the required specifications were met. The result were not very accurate but were approximate.
j. Detailed cost estimation was conducted and feasibility was checked by taking opinions from outside by providing them with test run of the E - Zyklus.
k. The opinion were noted and will be used in further development was promised.

9. DETAILED CALCULATIONS

9.1 Motor Calculation

Motor input = 24 Volt,
Motor rated output power = 250 watt,
Rated speed of motor = 3300 RPM,
Tyre size = 24 Inch (diameter).

Now, the motor has a preinstalled reduction gear where motor RPM gets reduced from 3300 RPM to 350 RPM, therefore now the driving has 350 RPM in total.

Hence,
RPM at driving sprocket = 350 RPM,
Number of teeth at driving sprocket = 9 teeth,
Number of teeth at driven sprocket = 18 teeth.
So find the gear ratio

$$\therefore \text{Gear ratio} = \frac{\text{Number of teeth on Driven gear}}{\text{Number of teeth on Driving gear}}$$

$$= \frac{18}{9}$$

$$= \frac{2}{1}$$

$$\therefore \text{Gear Ratio is } 2:1$$

So the RPM now at Driven gear will be reduced by obtained gear ratio that is as follows,
Let '$\varkappa$' be the RPM of Driven gear

$$\frac{350}{2} = \frac{\varkappa}{1}$$

$$\boxed{\varkappa = 175 \text{ rpm.}}$$

$\therefore$ RPM at Driven Gear is 175
Now, Calculating circumference of the tyre,

$$\text{Circumference } = \text{Diamater of tyre } \times \pi$$

$$= 24'' \times \pi$$

$$= 75.398''$$

$$\text{Circumference of Tyre} = 75.398''$$

Calculating speed of the Cycle,

$$\text{Speed } = \frac{\text{RPM of Driven Sprocket} \times \text{Circumference of Tyre}}{39370.076}$$

[Note: 39370.076 are the inches in a kilometre]

$$= \frac{175 \times 75.39}{39370.076}$$

$$= 0.3351 \frac{\text{Km}}{\text{Min}}$$

Now, converting it into km/h multiplying it with 60
We get,

$$= 0.3351 \times 60$$
$$= 20.106 \text{ km/hr}$$

$$\text{Speed} = 20.106 \text{ km/hr}$$

The Calculation done here is based on the maximum outcome from the motor to the tyre. The speed may vary from 15km/h to 20km/h depending on various losses like total weight on cycle, wind direction, uphill climb, downhill descent, tyre pressure, road gradient quality, etc.

9.2 Battery Calculation

Battery Specification: 12V 7Ah X 4 Nos.
Connecting Two Batteries in series,

$$12\text{V } 7\text{Ah} \times 2 \text{ Batteries} = 24\text{V } 7\text{Ah} \text{ .... (1)}$$

We know that, the Current remains the same in a series connection only voltage is multiplied by the number of batteries connected

Now, such above connection is done same with the other two remaining batteries that is,

$$12\text{V } 7\text{Ah} \times 2 \text{ Batteries} = 24\text{V } 7\text{Ah}\text{...................... (2)}$$

Now, connecting these two series arrangement in parallel we get,

$$24\text{V } 7\text{Ah} \times 2 \text{ series Connected batteries} = 24\text{V } 14\text{Ah} \text{..........From (1) \& (2)}$$

We know that, in parallel connection Voltage remains the same but current is multiplied according to the Number of batteries.
Now Total Output from these 4 batteries arrangement will give us 24V 14Ah.

9.3 Power calculation of battery and motor

Now calculating, total output power of battery,

$$\text{Power } = \text{Voltage } \times \text{Current}$$

$$= 24 \text{ V } \times 14 \text{ Ah}$$

$$= 336 \text{ Watt} - \text{hour}$$

$$\text{Power } = 336 \text{ Wh.......... (1)}$$

This means battery gives power of 336 watt per hour. That is, the battery will last for an hour if 336 watt is consumed constantly.
Rated motor Input = 250 W
Calculating power consumption for 1 km,
Motor gives rated speed of 20 kmph at 250 W,

$$\therefore \frac{250}{20} = 12.5 \text{ Watt per kilometer}$$

$$\therefore 1 \text{ km consumes} = 12.5 \text{ W} \ldots. (2)$$

We have in total 336 W of power in battery,

$$\therefore \frac{336}{12.5} = 26.88 \text{ km.....from (1) \& (2)}$$

The bicycle will travel almost 26 km once battery is fully charged.

9.4 Torque calculation of motor

Motor rated output power = 0.250 kilowatt,

RPM at driving sprocket = 350 RPM,
Formula for Torque is given by,

$$\text{Torque} = \frac{9.5488 \times \text{power (kW)}}{\text{Speed (RPM)}}$$

$$\tau = \frac{9.5488 \times 0.25}{350}$$

$$\tau = 6.82 \times 10^{-3}$$

$$\tau = 6.82 \text{ Nm}$$

9.5 Cost of battery charging

The cost of 1 unit is 8.57 rupees.

$$\text{Cost of electricity} = \frac{\text{Battery capacity} \times \text{Unit cost}}{1000}$$

$$= \frac{336 \text{ kWh} \times 8.57 \text{ rupees per unit}}{1000}$$

$$= \frac{336 \times 8.57}{1000}$$

$$\therefore \text{cost of electricity} = 2.88 \text{ rupees}$$

Battery charging cost is about 2.88 rupees.

9.6 Charging time calculation

The charger used is of 12 V 5 A.

Input given is 230 V AC 50 Hz.

$$battery\ capacity = 12\ V\ 7\ Ah$$

$$P = 12 \times 7$$

$$P = 84\ Wh \text{..........} (1)$$

$$charger\ output = 12\ V\ 5A$$

$$P = 12 \times 5$$

$$P = 60\ W \text{............} (2)$$

From (1) & (2),

$$Time = \frac{battery\ capacity}{charger\ output}$$

$$T = \frac{84}{60}$$

$$T = 1.4\ h$$

So, charging time for one battery is about 1.4 Hours.
Hence, for all four batteries to be charged it will take about,

$$1.4 \times 4 = 5.6\ h$$

So, the total time required for the battery pack to charge is 5.6 Hours.

10. RESULT AND SPECIFICATION

Table 3: Features

S no.	Features	Desired [Calculated]	Actual [Measured]
1.	Top Speed	20 kmph	18 kmph
2.	Wheel size	24 Inch	
3.	Weight capacity	100 kg	85 kg
4.	Range	28 km	20 km
5.	Charging time	5.6 hours	6.3 hours
6.	Comfort	Good	Satisfactory
7.	Cost of charging	2.88 per full charge	
8.	Motor	24 V / 250 W	
9.	Battery pack	24 V / 14 Ah	

[Note: the values in the table are approximated.]

The table 3 above represents the specifications of the E - Zyklus. It shows the desired parameters and the actual parameters seen. The E - Zyklus had satisfactory results on all the working parameters. The actual measurements were seen to be less than the calculated measurements which accounts for the losses. The efficiency of the E - Zyklus is about 60 %.

Fig. 15: E - Zyklus

11. APPLICATION

- The application of such a product would widely be seen in a person's daily life transportation.
- Working class transportation can be eased, due to the low cost of the product.
- The product can also be a solution to the parking and space problem in the industrial sectors.
- The same problem of space is seen in the business and I. T. sectors, which are located in the very heart of the urban cities. These problems can also be eliminated by use of the vehicle.
- Students using it for transportation on the daily basis in schools and colleges.

12. FUTURE SCOPE

- Future developments are to done in the near future. The design could be perfected. The speed and torque could be increased.
- A hybrid model is a possibility, which has a low power electric motor working as an electrical assisting system while the primary source of power will be pedalling.
- Regenerative braking is also a field of expansion. The battery charging with regenerative braking can also increase battery time and decrease the cost of the charging.

- A swappable battery pack can be introduced for easier working and efficiency. The lead acid could be replaced with lithium ion, which is long lasting and compact in size.
- There is a possibility of providing carriage space for haulage.

13. CONCLUSION

The paper provides an effective way of combining the electrical system with a bicycle, which will reduce human effort and will be environment friendly. There is procedure for the conversion, stated properly. The main aspects like torque and speed were seen as expected. The usage of a pre-manufactured framework saved time and also the designing cost. The electric system is simple to be understood with less part and clear as crystal connections. The charging time is less compared to other counterparts and the charging cost is also less. The weight of cycle is satisfactory as a low power motor was used for the work, due to that the battery weight also reduced, so the overall weight was reduced compared to other counterparts. The components used in the experiment are easily available in market. It has been proved suitable for people over the age of 45 as it does not require any human efforts. Any general used bicycle can be converted to the E - Zyklus jut by integrating the electric system shown and also in low cost.

14. ACKNOWLEDGEMENT

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15. REFERENCES

[1] Suyant Dharwarkar et al. "Laufband Zyklus"; International Journal of Advance Research, Ideas and Innovations in Technology, ISSN: 2454-132X, (*Volume 5, Issue 1).*

[2] Mitesh M. Trivedi et al. "Design & Development of E-Bike - A Review"; ICONIC RESEARCH AND ENGINEERING JOURNALS, © NOV 2017, IRE Journals, Volume 1 Issue 5, ISSN: 2456-8880.

[3] C. Abagnale et al. "Design and Development of an Innovative E-Bike"; Energy Procedia 101 (2016) 774 – 781

[4] Sunikshita Katoch, Rahul, Ranjit Kumar Bindal. "Design and Implementation of Smart Electric Bike Eco-Friendly"; International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-8, Issue- 6S4, April 2019

[5] Mayur Balkrishna Patil et al. "Self power generating electric bike"; International Journal of Advance Research, Ideas and Innovations in Technology, ISSN: 2454-132X, (Volume 6, Issue 3)

[6] Kunal D Topiwala et al. "Design and Fabrication of Electric Motorcycle"; International Journal of Engineering Research & Technology (IJERT), ISSN: 2278-0181 IJERTV9IS040294, Published by: www.ijert.org, Vol. 9 Issue 04, April-2020

[7] https://commons.m.wikimedia.org/wiki/File:Global_Carbon_Emission_by_Type_to_Y2004.png

[8] https://www.researchgate.net/figure/Historical-global-fossil-fuel-consumption-in-terawatt-hours-1800-2016-Adapted-from_fig7_329284985

[9] https://www.choosemybicycle.com/en/bicycles/schnell-adventure-sr-ss-27-5-2016

[10] https://robu.in/product/right-side-geared-ebike-kit-my1016z2-24v-250w/?gclid=CjwKCAjwx9_4BRAHEiwApAt0zrwWhvewxZYGJfeiaWHL5AJVWtfPjSlQrS06DqfK6Fx9MGNZ7K5eDRoC_EMQAvD_BwE

[11] https://m.shopclues.com/electric-bicycle-kit-145715578.html

[12] https://www.tanotis.com/products/apc-replacement-battery-cartridge-110?gclid=Cj0KCQjw6uT4BRD5ARIsADwJQ18Rj43_rOyqqcBBAKAB4_NNzFKesrZrtodXDxETDsQXRjGlIKKYSzMaAi94EALw_wcB

