

Bicycle Power Generator

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Abstract: The aim of the current study was to analyze problems faced because of constant power cuts in cities and also understanding the need of finding a unique cost-effective solution for creating energy which can be used in the form of electricity in Indian villages where still there is lack of electricity. Many villages in India do not get any kind of electricity and due to that people face many problems. One of the efficient and cost effective technique of power generation is using a bicycle power generator to produce electricity. The concept is not new but is not widely used. Bicycle Power Generator is an Innovative technique of using the human energy by pedaling of the bicycle and converting it to produce electricity which can be used for daily needs and many other things.

Keywords: Electricity, Self-Power Generation, Bicycle, Generator, Battery

1. INTRODUCTION

1.1 Need of Self-Power generation

The world is filled with many energies and energy resources. To sustain our civilization, the most vital basic requirement is energy; so it should have a constant supply. A vital role is played by electrical energy in today's 21st century [1]. Electricity is the main energy which make the world run every day. With tremendous opportunities ahead, India's power sector is affected and have failed to complete its targets by enough margin [2]. In India, there are still 600,000 villages and many rural houses that are still without power.

There is a need in many Indian rural households to be self-dependent for producing power and using in form of electricity for everyday use and other many purposes. Nowadays people in cities also face constant power cuts due to some technical fault or power shortage. Many people who live in cities cannot afford to setup power inverters in their house so, at times of power cut they

face many challenges as daily lives are dependent on electricity power. Also, there are few people who can afford and have power inverters in their house. But, these inverters are backed up only for few hours and at times when there is power outage/technical difficulty; for some extra hours and sometimes days; the battery also discharges after some time. In that case also people feel the necessity of having alternative resource to electricity. So, whether it be villages or the people in living in different cities at some point there is always a need to be independent for electricity generation. So, our study discusses a way to be independent to produce owns' power.

1.2 Bicycle Power Generation

In terms of energy conversion and energy consumption one of the efficient way is a pedal power generator. One of the clean and sustainable alternative of energy generation is the pedaling energy which possess capability to supply electrical power to various low power devices. By the human; in mechanism of pedaling the energy generated is kinetic energy. But in today's world, day by day people started for looking solutions which are more comfortable, finishes faster and minimal efforts; so, the use of pedaling reduced significantly [3]. The pedal power generation can be seen as a good alternative for energy generation.

Bicycle power generation concentrates on the production of electricity with minimal cost and with available resources. Bicycle power generator is mainly used for producing the electrical power. It is a manually operated power system. Bicycle power generator is a project which uses human energy by pedaling of bicycle for electricity production. Here, a device will be used to convert the human energy by pedaling to convert it to produce electricity which in form can be stored in the battery for usage of daily needs, charging electronic devices, lights, fans, radio etc.

2. CONSTRUCTION

The design of bicycle power generation includes various components such as a bicycle, generator, battery, sprocket, power inverter, bicycle stand, solar charge controller, flat belt and chain. The user can easily sit on the set and start pedaling the bicycle with his force movement of legs. The back wheel of the bicycle is coupled with the rotor of generator through a flat belt. The belt is placed over the back wheel to the rotor of the generator. The solar charge controller, battery and power inverter are connected in series after the generator. The two terminals from the generator connected with the two terminals of the solar charge controller. The terminals from solar charge controller then are connected to both terminals (+ve, -ve) of the battery. The battery is used for storing the electricity for future use. As the current received from the generator is in the D.C form it can be directly stored in the battery. A solar charge controller is used in between the generator and the battery to prevent the battery from overcharging and to regulate the flow of current for safety purpose. Many household needs are powered by A.C. current but in the battery the power is stored in the D.C. current form. So, a power inverter is used to convert the D.C. current to A.C. current and then the produced power can be directly used for our purpose. Schematic diagram of the setup is shown in the Fig-1.

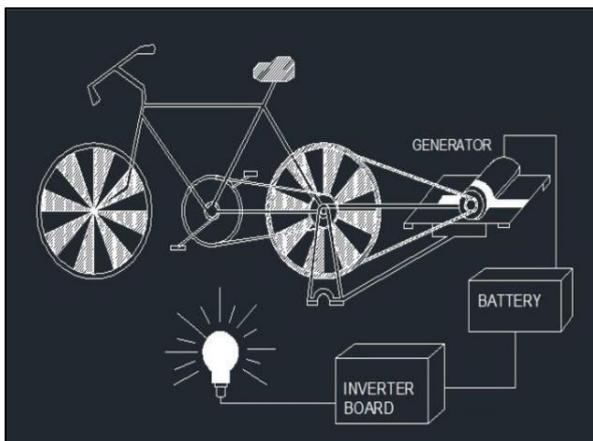


Fig-1: Schematic diagram of the setup [5]

3. MAIN COMPONENTS

3.1 Bicycle

A bicycle is a self-driven two wheel (one behind the other) vehicle and moved with force applied by an individual on the pedals of bicycle. There are two main types of bicycles used one is regular (gearless) and the other is a sports/racing bicycle (with gear mechanism).

Racing bicycles are more expensive than general bicycle. So, as our projects aim is to make a cost effective bicycle power generator we will be using a general bicycle. Racing bicycles are used only in the developed areas of India and not in villages. Also the general bicycles are most used in villages in India so it is the best choice for power generation purpose [6].



Fig-2: Regular Bicycle [6]

3.2 PMDC Generator

For power conversion (mechanical energy to electrical energy) either an alternator or a generator can be used in a bicycle power generator. The rotor speed and the field current is responsible for the output of alternator. This problem can be eliminated by using a permanent magnet generator (DC Generator) as the variation of speed is the deciding factor for its terminal voltage [6]. And also alternator is more expensive and not easily available as compared to a generator.

A rotating machine which is converting the mechanical energy to electrical energy is termed as generators. This converting of energies is the principle of the electromagnetic induction. The Faraday's law of electromagnetic induction states that an induced e.m.f is created in the conductor; when a conductor is placed in the magnetic field [7].

For bicycle power generation mechanism; for the conversion of human energy to electrical energy the most suitable and reliable component is a Permanent Magnet Synchronous Generator. In other generators the excitation field is provided by coil unlike in synchronous generators it is provided by permanent magnet [8]. The permanent magnets located in the stator and the windings in the rotor together make a Permanent magnet DC brushed motor (PMDC motor). A slipping contact is made with the stationary brushes by the commutator segments which are connected to the ends of the winding coils. DC Voltage supply across the motor terminals are connected to the brushes. The voltage polarity reversal leads to the change in direction of rotation. The magnetic poles are created in the rotor which interacts with the permanent magnetic poles by the current flowing through coils. The current flow must

be reversed when the rotor north pole passes the stator south pole for keeping the torque generation in same direction. The segmentation of slipping contacts is done for this purpose. This segmented slip ring is commutator [4]. As the back wheel rotates; in return the rotor of motor also starts rotating at high speeds thus producing proper output. Fig-3 shows the Permanent magnet direct current generator.



Fig-3: Permanent Magnet DC Generator

3.3 Battery

One or more electrochemical cells that convert stored chemical energy into electrical energy are electrical batteries. A device consisting of one or more electrochemical cells providing its external connections to power electronic devices are batteries. Batteries are mainly classified in two types; one is primary batteries (disposable batteries) which are made for one time use and disposed later. Other one is secondary batteries (rechargeable batteries) which are made for using for a long time by recharging them again and again [6]. At time when a battery is supplying electric power, Cathode is its positive (+ve) terminal and the Anode is the negative (-ve) terminal. The source of electrons is the negative (-ve) terminal which will flow towards the positive (+ve) terminal through an external electrical circuit [9]. Most popular batteries used in today's world are lithium ion and lead acid batteries. Lithium ion batteries are very complicated systems with many different degradation mechanisms and if not in use are subject to ageing.

The positive electrode in the lead acid battery are of lead oxide (PbO₂) plate and the lead (Pb) plate is at the negative electrode of the battery. The dissolved sulfuric acid (H₂SO₂) is lost by the electrolytes so; this battery is termed as lead acid battery. It was first invented in 1859 by a French physicist Gaston and also the lead acid battery one of the oldest rechargeable batteries. Supplying high surge current is one of the ability along with the low cost associated with it. In Automotive sector this battery is used in motor vehicles as they are capable of providing high currents which are required to the automotive starter motor. One of the most successful recycling program is currently after the lead acid batteries which is saving the nature and environment

from wastes caused by other batteries as they are disposed after one time use [4]. Lead Acid batteries have long life cycles, high discharge rates and are inexpensive. So, a lead acid battery is suitable and reliable battery to use in bicycle power generation. Fig-4 shows a 12V Rechargeable Lead acid battery.



Fig-4: Lead-Acid Rechargeable Battery

3.4 Power Inverter

A power electronic device or a circuit which changes the direct current (DC) to alternating current (AC) is an inverter or also called as power inverters. The device which is employed decides the resulting AC frequency. According to our application a particular device will decide the input voltage, output voltage and frequency and overall power handling. The DC source is responsible to supply power to inverter and the inverter is not responsible for the DC power generation [9]. A stable DC power source which is capable of supplying enough current is required by the power inverters for the power required by the system. The design and purpose of the inverter is the deciding factor for the input voltage. Fig-5 shows the 12V dc to 220V ac Power inverter.



Fig-5: 12V dc to 220V ac Power Inverter

4. WORKING

In this setup, manual load is applied on the bicycle pedal and due to the manual force, the largest sprocket starts to rotate. The largest sprocket is connected with the small sprocket in the back end by simple chain mechanism. Thereby the small sprocket also starts to rotate. So that the rotating motion of the center shaft transmitted to the back wheel there by the back wheel also rotate. The back wheel is coupled with the D.C generator through a flat belt. Now the motion is transmitted to the generator. The generator converts

this mechanical motion into electrical energy [5]. The current produced is in the form of D.C so it can be directly stored in the battery through a solar charge controller; to prevent overcharging of the battery. The power inverter is used to convert the D.C current into A.C current and then the A.C. current produced is sent to the supply port for multiple usage.

4.1 Power Produced

The environment of the person who is pedaling the bicycle is the deciding factor for the power levels. The stronger the person pedaling and the time duration he is pedaling continuously; more power can be generated. On an average a person can produce around 12 V to 40 V and the current increasing up to 2 amps. If the task is to be continued for a long constant time, more power can be produced by the person [8]. Regarding the power, we could produce a power of 60 – 100 Watt in hour of pedaling what enabled us to continuously power electronics such as MP3 players, an LED etc. We use energy also to enhance the workout experiences by providing incentive to continue running [10]. Below table shows power produced by a bicycle generator; it clearly shows that if it is used; power on large scale can be generated.

Bicycles	Usage (Hours)	Average Power produced (Watts-Hr.)
1	1	19.5
8	1	156
8	8	1248

Table-1: Power produced by bicycle generator [5]

5. CONCLUSION and FUTURE SCOPE

So, we have investigated an alternative renewable energy resource; one such alternative way of generating power is presented in this paper. The effective way of generating power is using a Bicycle Power Generator to generate energy in form of electricity in today's challenging times, when the problem of energy is rising. It is a remarkable solution for the problem of energy shortage [4]. At small levels as well it is possible to produce electricity using pedals of bicycle. At places of less or no power; bicycle power generator is useful to all and also the cost is comparatively low. The assembly is easy and maintainable. It is a standout solution of the problem regarding power which makes an individual independent for producing electricity. Further, pedaling the bicycle for some time is going to burn calories and make the individual healthy if done regularly as well as produce electricity and use for household purpose. In

gyms; instead of treadmills and cycles if a bicycle power generator is used, they can produce enough power which is required for all lights and fans inside the gym which can save money on the electricity bills on a large number. Also, this can promote people to stay fit and healthy by regular bicycling and also save electricity bills at the same time. So, to conclude the bicycle power generator is an easy solution to electricity generation, saving money and staying healthy and fit.

It can be further developed and possess future advancement by spending more funds. The size of the wheel (larger wheel) can be increased to provide a much greater speed to the rotor resulting in more output power generation. For flexibility to use the bicycle for transportation and easy maintenance a permanent joint (permanently welded) should be avoided. By connecting the same arrangement in series power can be tremendously increased. At the same time, if two back wheels act together to produce greater speed and the energy generated can be increased. A RPM Counter circuit can be made to observe the rpm value and to calculate the speed at which the wheel is rotating. An app can be developed for making the system advanced by using Arduino, Bluetooth module and send information directly to app for further calculation. Many things such as RPM value, speed of rotating wheel, calories burnt, duration of pedaling and all the information regarding bicycle power generator can be monitored through the app. User can track his fitness activities. Comfort level for children and aged people can be considered; by making the cycle frame adjustable so that everyone can pedal comfortably.

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