

Footstep Power Generation using Piezoelectric Material

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Abstract - Nowadays energy and power are some of the basic necessities regarding this modern world. As the demand for energy is increasing day by day, so the ultimate solution to deal with these sorts of problems is just to implement renewable sources of energy. In this project, we are harvesting energy with the help of piezoelectric material. we use piezoelectric materials in order to harvest energy from people walking and generating vibration in piezoelectric so that energy can be generated. This system can be installed at homes, schools, colleges, where population density is more. When people walk on the steps, power is generated by using the weight of the person. It can produce energy from vibration and pressure Like people walking (footstep pressure). It can be used to charge devices such as mobile phones, laptops, etc.

Key Words: piezoelectric, footstep power generation, pzt, energy harvesting, renewable energy

1.INTRODUCTION

In today's world electricity is a necessity for the human population. In day-to-day life, Electricity is the most commonly used energy resource. Its demand is increasing day by day. This technology world needs a huge amount of electrical power for its various operation and also at the same time energy is one of the most important issues around the world especially in countries where the energy crisis is a big problem.

we all know that nonrenewable energy resources will finish one day. Hence we have to explore new resources and shift our dependency on renewable energy sources. This will reduce the use of nonrenewable sources and produce clean energy which is renewable energy sources. These renewable sources include solar cells (Solar energy), windmills (Wind energy), geothermal power plants (Geothermal energy), tidal turbine (Tidal energy) and piezoelectric material, etc. This will use nonrenewable energy sources and produces clean energy. The problem with solar is that it required sunlight, windmills required fast-flowing winds, and thermal and geo-thermal are not as environmentally friendly so we use piezoelectric to produce energy. It can operate in bad weather, clean energy source, no pollution.

We can convert wasted energy into usable or resource full energy, walking energy is the most common type of energy wastage when we walk the vibration energy from

the surface is wasted. In our project, electric power is generated as a non-conventional method. And this wasted energy can be converted into electrical energy by using the principle called the piezoelectric effect. piezoelectric effect defined as some material that has a property when applied pressure generates electricity. the piezoelectric material has the ability to produce an electric current when pressure is exerted by moving people (pressure is applied on the piezoelectric plate). A tile is made from piezoelectric material. firstly when we will apply pressure on piezoelectric material through the tile. by that pressure, piezoelectric converts mechanical energy into electrical energy than that electrical energy is rectified with the help of a full-wave rectifier because piezoelectric material produces ac voltage and we need dc voltage to store in the battery. after that, we add a connection to the rechargeable battery through the rectifier by applying a diode so that voltage can flow from the piezo plate to the battery and its unidirectional current. we will measure voltage with the help of a multimeter, connecting the multimeter with a rectifier.

1.1 Research study

A. STUDY OF PIEZO MATERIALS

Piezoelectric ceramics are from a group of ferro electric materials. Ferro electric materials are crystals that are polar without applying an electrical field. The common piezoceramics are PbTiO₃, PbZrO₃, PVDF and PZT. The main component of our project is piezoelectric material.

So we have to use high output generating piezoelectric for our project. For this, an analysis on the 2 most commonly available piezoelectric material - PZT and PVDF, to determine the most suitable material to use. it is the research-based result the research is done on the materials so we are adding that to

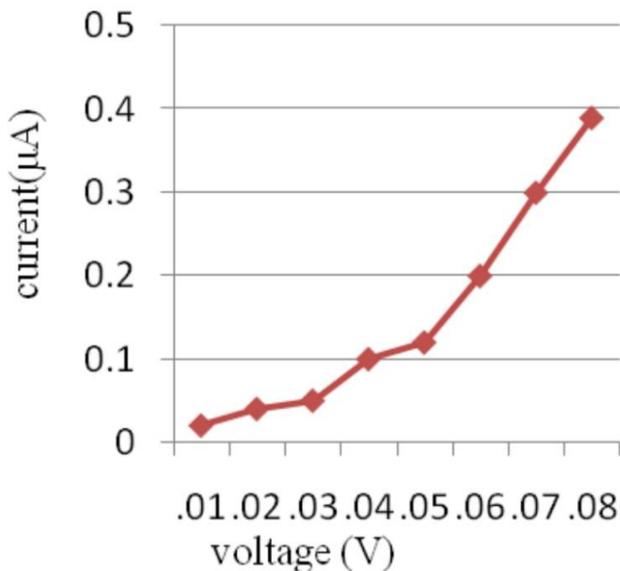


Fig 1: V-I graph of PVDF material

use it. The selection criteria were better output voltage for various pressures applied. To

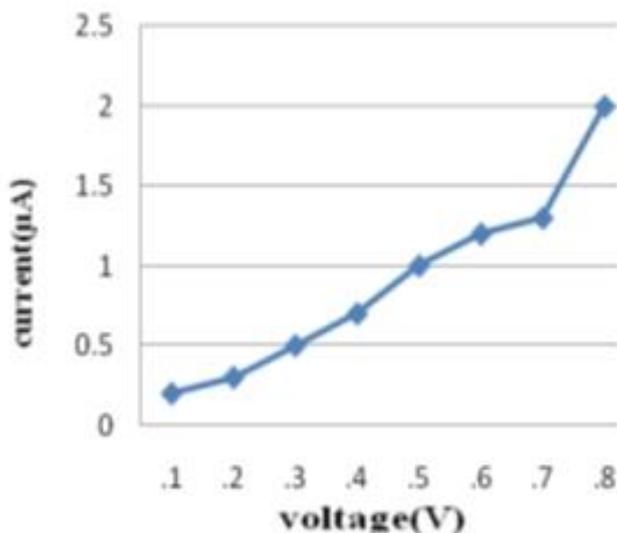


Fig 2: V-I graph of PZT

understand the output of the various forces applied, the V-I graph of each material namely,

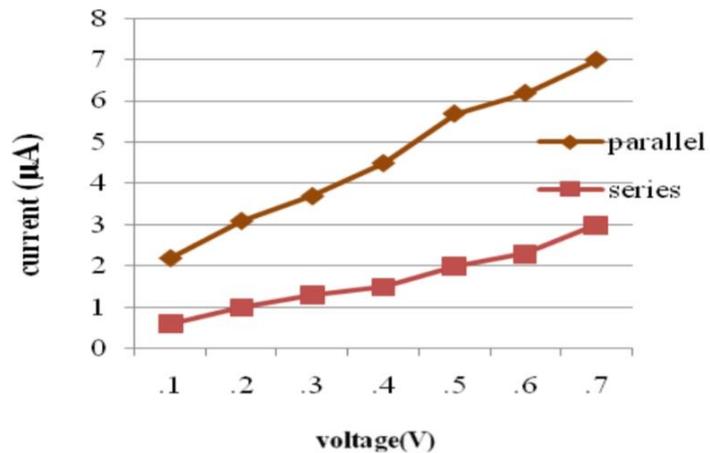


Fig 4: V-I graph of parallel and series connection

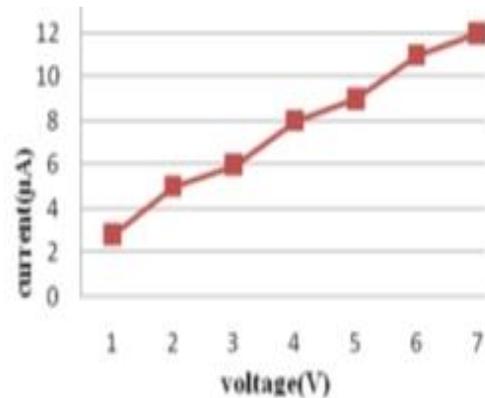


Fig 5: V-I graph of parallel and series combination

PVDF and PZT were plotted. For this, the Piezo transducer material is placed under force. Voltmeters are connected to both of them for measuring voltages and an ammeter is connected to measure the current. As varying forces are applied to the Piezo material, different voltage readings corresponding to the force are displayed. For each voltage reading across the forces, the voltage and current readings of the Piezo test material are noted. Fig 1: V-I graph of PVDF material The voltage from PZT is around 2 V whereas that of PVDF is around 0.4V. We can conclude from this research that PZT generates more output than PVDF.

B. STUDY OF CONNECTIONS

Next is to determine the connection that gives appreciable voltage and current necessary, three PZT are connected in series. A force sensor and voltmeter are connected to the series combination. as varying forces is applied on this series connection the corresponding voltage reading noted and also the current is measured. Similarly, the connections for parallel and series-parallel are done and the reading from each respective connection is noted and the graph is plotted that are shown in figure 3 and figure 4 respectively. It can be clearly seen that the graph of voltage from a series connection is good but the current is poor, whereas the current from a parallel connection is good but the voltage is poor. So this problem can be rectified with a series-parallel connection where the amount of voltage is good and also the current is also good.

1.2 Piezoelectric material

In recent years energy field is developing so fast. It is useful to find renewable sources of energy for the future scope. research on Piezoelectric materials is going on for their usefulness and specific property and also to generate more power from piezoelectric material. The piezoelectric materials can produce electrical energy from mechanical pressure or stresses or vibration. this is mostly commonly known as energy harvesting. In our project, we are converting wasted energy into useful energy.

These materials generate micro-level power but in the near future it can be a major source in energy harvesting. In the initial stages, solar panels also generate very less amount of energy but when more and more researches are started to begin then the energy generation increase by doing a lot of experiments, now solar contributes a major source in renewable energy. piezoelectric effects can be classified into two types direct and converse effect. In Direct effect, electrical energy produces when mechanical stress is applied on the surface of the material and the converse effect produces mechanical stress when electrical energy is applied to the piezoelectric material.

"PIEZOELECTRIC EFFECT" is can be defined as the property of some materials to produce electrical energy when mechanical stress is applied to it. "ENERGY HARVESTING" can be generating energy from energy sources like temperature, vibration or air flow. Piezo elements converts the kinetic energy from

vibrations or shocks into electrical energy.

1.3 Full Bridge rectifier

Full bridge rectifier used to rectifier the circuit. it converts ac output source from piezoelectric to dc voltage. so that we can store the energy in the rechargeable battery because the battery needs a dc source to store energy. rectifier circuit consists of 4 diodes.

1.4 Battery

LEAD ACID BATTERY :-

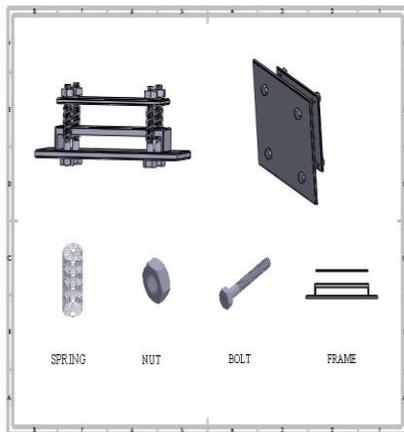
The battery is an array of electrochemical cells that are used for storing electricity. An electric battery made from a combination of one or more electrochemical cells. Battery converts chemical energy into electrical energy. The battery can store electrical energy in the form of chemical energy and then release that electrical energy from chemical energy. Battery types are:-

Primary battery:- primary batteries produce energy immediately after assembly. it can be used once and then discarded. Disposable primary cells cannot be reliably recharged, since the chemical reactions are not easily reversible and active materials may not return to their original forms.

Secondary battery:- Secondary batteries must be charged before use because they are assembled with active materials in the discharged state. Rechargeable batteries can be recharged by applying electrical current, which reverses the chemical reactions that occur during their use.

2. DESIGN AND FABRICATION OF FOOTSTEP POWER GENERATOR

Frame:- we created the mechanical frame with the help of solid works software. we make the structure with the help of woodplates. We created 3 layers of wood plates. The dimensions and structure is mention in above diagram. We place piezoelectric materials on the second layer of frame and then we apply pressure from 3rd layer which is connected to the base level with the help of spring and nut-bolt. When we apply pressure on 3rd plate spring will compressed automatically and that pressure applied to the second layer and then the pressure is applied on piezoelectric material. We place 18 piezoelectric material in the frame.



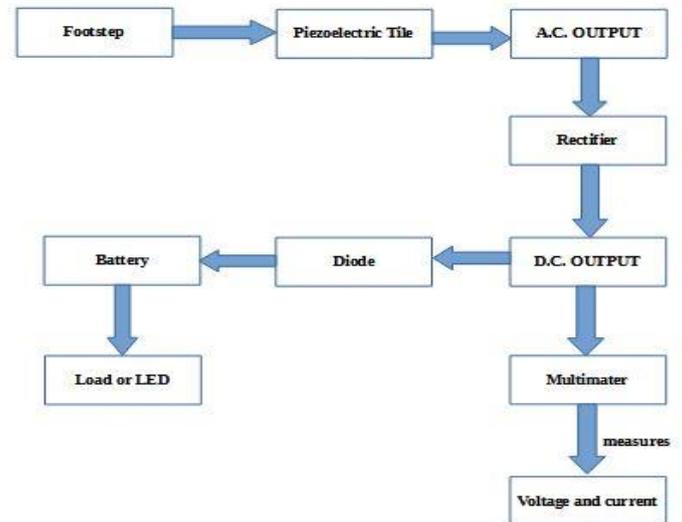
The connections for piezoelectric material is combination of series and parallel Then we use rectifier to correct the circuit output. And then we measure output with the help of multimeter and store that output in the battery. And from battery we will connect LED.

2.1 Working and Construction

2.1.1 Working:-

Piezoelectric material generate electricity when pressure or vibration or any kind of force is applied on the surface of piezoelectric material. We will apply pressure on piezoelectric material so that it can generate electricity. the output generated by piezoelectric material are in the AC voltage so to store output we have to convert it into DC voltage. For that we use rectifier that converts AC voltage to DC voltage and with the help of rectifier we will convert AC source to DC source. Then we will store that energy into battery by applying diode so that current can flow in unidirectional. And finally we use led to glow. And we also connected multimeter to the rectifier so that we can measure voltages and current generated from them

Flow chart Diagram

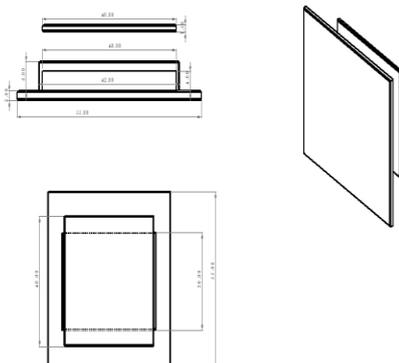


2.1.2 construction:-

we construct the piezoelectric tile with the help of wood block. On the surface 2nd layer of woodblock we place piezoelectric material. As we know by research study that pzt is best suitable for this project. We give connection to piezoelectric material series-parallel. We know from research paper so we use both series parallel connection so that the optimum amount of current and voltage can be generated. After the completion of frame setup and piezoelectric connection setup we will connect the two terminal of piezoelectric material to full-wave bridge rectifier circuit . So that the ac voltage from piezoelectric material can converted in dc voltage. The force on piezoelectric material can be moving people or vehicle or any kind of pressure or vibration. After the rectification we will measure dc voltage and current with the help of multimeter. And then the dc output is stored into the battery with the help of unidirectional diode so that current can flow in one direction i.e. from piezoelectric material to the battery.

3. CONCLUSIONS

We have seen that power output from piezoelectric material is very less. When the comparison between voltage and current is done we can say that piezoelectric material can generate good amount of voltage but current is very poor through the material. In today's time it generate very less power but in near future we think it can be great source for energy creation.



The weight applied on the piezoelectric tile and voltage is generatedxxxx is found that voltage and weight had a linear relationship, the higher the weight higher voltage, and vice versa. Non-conventional, non-polluting, renewable energy is achieved when applying a force on piezoelectric sensors.

India is a densely populated country. In India, there are many regions where people are continuously traveling by walking. And these regions are always busy with people walking, which means we can easily find the sources like vibration or pressure to produce electricity from piezoelectric material.

This can be used in street lighting. the energy can be used to supply low-powered electronics like wireless sensors, charging devices, and much more low-powered Microelectromechanical Systems devices. There is a wide scope of improvement of this type of harvesting technique because of the increased demand of portable micro-powered electronics. this principle can be applied in the speed breakers at high ways, where the vehicles rush too much so ultimate power generated is obtain

This piezoelectric material technology is in its initial phases or in its development phase. and in the near future if the material should have an addition of property or some modification in structure or addition of alloys to generate more and more current then this technology might be future leading renewable energy sources because it is easy to create, environmentally friendly and also low cost to implement.

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