FOOTSTEP POWER GENERATION USING PIEZOELECTRIC MATERIALS IS AN INNOVATIVE WAY TO HARNESS ENERGY FROM HUMAN FOOTSTEPS

[1]Asst. Prof. Santhosh Kumar Sahu , [2]Sr.Lect Santhosh Kumar Bisoyee , [3]Lect. Monalisa Gouda,
[4]Asst. Prof. Bishnu Prasad Panda , [5]Asst. Prof. Amaresh Choudhury
[1,2]Dept of Electronics and telecommunication Engineering
[3,4,5] Dept. Of Electrical Engineering
Gandhi School of Engineering, Berhampur

ABSTRACT

Power generation and its use is one of the issues. Now-a-days numbers of power sources are present i.e. non-renewable & renewable, but still we can't overcome our power needs. Among these human population is one of the resources. In last few years low power electronic devices have been increased rapidly. The devices are used in a large number to comfort our daily lives. With the increase in energy consumption of these portable electronic devices, the concept of harvesting alternative renewable energy in human surroundings arises a new interest among us.

The use of piezoelectric materials in order to harvest energy from people walking vibration for generating and accumulating the energy. energy is nothing but the ability to do the work. In day to day life, Electricity is the most commonly used energy resource. due to this, number of energy resources are generated and wasted. Electricity can be generated from resources like water, wind etc. to generate the electricity from these resources, development of big plants are needed having high maintenance cost. As there is a tremendous increase in the human population, the demand for the energy is increasing day by day which is not affordable to common people. Some other energy resources are also costly and cause pollution. Now the gap between the demand and the supply of electricity made a path for the exploration of alternate sources of energy.

I. INTRODUCTION

Electricity has become important resources for human being hence, it is needed that wasted energy must have to utilize, walking is a common activity in human life. When a person walks, he loses energy to the road surface in the form of vibration, sound etc, due to the transfer of his weight onto the road surface, through footfalls on the ground during every step. This energy can be converted to the usable form such as in electrical form. Using the principle called piezoelectric effect.

Piezoelectric effect refers to the ability of some materials to generate an electric potential in response to applied pressure. Piezoelectric material can provide the magic of converting pressure exerted by the moving people into electric current. This project gives idea about how energy is used on stepping on stairs. The use of stairs in every building is increasing day by day even small building has some floors when we are stepping amount of this wasted energy is utilized and converted to electricity by Piezoelectric effect. This effect is the effect of specific materials to generate an electric charge in response to applied mechanical stress.

Meanwhile, electrical power has been used by various operation in the modern technology. The production of electricity leads to a huge amount of pollution. This drawback has been removed with the help of the footstep power generation system. The main principle of this power generation technology is piezoelectric effect. The piezo electric effect makes the materials to produce an electric charge when pressure and strain is applied to them. Thus when the pressure is applied the electric potential is produced by the materials with the help of the piezo electricity. The pressure exerted by the moving people is converted into electric current by the embedded piezoelectric material.

Today the major problem which is discussed rapidly energy crisis and ideal solution for this is adaptive renewable energy resources. Among all the energy sources like solar energy tidal energy, human population is also abundant energy resource that has not

been yet normally in used. Using this resource expected amount of energy can be generated thus it may be ideal to generate the electricity from human population. When people walk on the floor then electricity is generated due to weight of person as this system utilizes the parameter pressure to generate energy. This generated energy is stored in the batteries. This system will generate efficient outcome if installed in populated area. Implementation of this project will turn into boon in generation of electricity from the pressure by footsteps. The places in India where we can implement this system are roads, railway stations, bus stands where millions of people move round the clock. When people walk on the floor their body weight compresses the setup which rotates dynamo and generated energy stored in the battery to reduce external compressions responsive sub-flooring system is installed.

Piezoelectric ceramics belong to the group of ferroelectric materials. Ferroelectric materials are crystals which are polar without an electric field being applied. The piezoelectric effect is common in piezo ceramics like PbTiO3, PbZrO3, PVDF and PZT. The main component of the topic is the piezoelectric material. The proper choice of the piezo material is of prime importance. For this, an analysis on the two most commonly available piezoelectric material - PZT and PVDF, to determine the most suitable material was done. The criterion for selection was better output voltage for various pressures applied. In order to understand the output corresponding to the various forces applied, the V-I characteristics of each material namely, PZT and PVDF were plotted. For this the Piezo transducer material under test is placed on a Piezo force sensor. Voltmeters are connected across both of them for measuring voltages and an ammeter is connected to measure the current. As varying forces are applied on the Piezo material, different voltage readings corresponding to the force is displayed. For each such voltage reading across the force sensor, various voltage and current readings of the Piezo test material are noted. The voltage from PZT is around 2 V where as that of PVDF is around 0.4V.We can thus conclude that better output is obtained from the PZT than the PVDF.

Next to determine the kind of connection that gives appreciable voltage and current necessary, three PZT are connected in series. A force sensor and voltmeter is connected to this series combination. As varying forces are applied on this connection, corresponding voltages are noted. Also the voltage generated across the series connection and the current is measured. Similarly the connections are done for parallel and series-parallel connections are done. It can be seen from the graph that the voltage from a series connection is good but the current obtained is poor, whereas the current from a parallel connection is good but the voltage is poor. But this problem is rectified in a series - parallel connection where a good voltage as well as current can be obtained.

II. MODEL OF FOOT STEP ENERGY GENERATION

Figure 2.1: Storing Device for Foot Step Electric Energy

The working of the Foot Step Electric Converter (FSEC) is demonstrated in photographs in the right side photograph shows the foot touching the top plate without applying weight. The left side photograph shows the foot when full weight of the body is transferred to the top plate. A 6W, 12V bulb connected to the output of the alternator glows, to indicate the electric output when foot load is applied. The unit is designed to generate full power pulse when actuated by a person weighing nearly 60 kg. An experimental plot of voltage vs time was generated, by using an oscilloscope. Using voltage data and the load (a resistor), a typical plot of power vs. time was generated.

The power generated by the foot step generator can be stored in an energy storing device. The output of the generator was fed to a 12V lead acid battery, through an ac-dc converter bridge. Initially, the battery was completely discharged. Then, the FSEC was operated by applying foot load and energy was stored in the battery.

The piezoelectric material converts the pressure applied to it into electrical energy. The source of pressure can be either from the weight of the moving vehicles or from the weight of the people walking over it. The output of the piezoelectric material is not a steady one. So a bridge circuit is used to convert this variable voltage into a linear one. Again an AC ripple filter is used to filter out any further fluctuations in the output. The output dc voltage is then stored in a rechargeable battery. As the power output from a single piezofilm was extremely low, combination of few piezo films was investigated. Two possible connections were tested- parallel and series connections. The parallel connection did not show significant increase in the voltage output. With series connection, additional piezo film results in increased of voltage output but not in linear proportion. So here a combination of both parallel and series connection is employed for producing 40V voltage output with high current density. From battery provisions are provided to connect dc load. An inverter is connected to battery to provide provision to connect AC load. The voltage produced across the tile can be seen in a LCD [1].

The below figure shows the Schematic representation of the working model. People whose weight varied from 40kg to 75 kg were made to walk on the piezo tile to test the voltage generating capacity of the Piezo tile. The relation between the weight of the person and power generated is shown above. It can be seen that, maximum voltage is generated when maximum weight/force is applied. Thus, maximum voltage of 40V is generated across the tile when a weight of 75 Kg is applied on the tile.

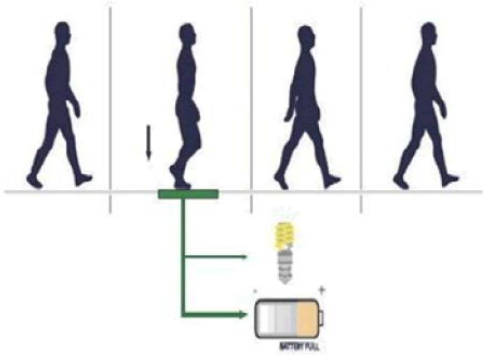
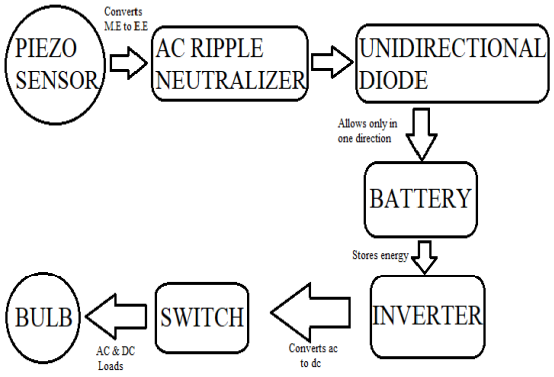


Figure 2.2: Schematic representation of the working model

III. BLOCK DIAGRAM AND WORKING PRINCIPLE



The piezoelectric material converts the pressure, stress applied to the material into electrical energy. The source of stress is from the weight of the people stepping on the stairs. As the output voltage from a single piezofilm was extremely low, thus combination of few piezoelectric is used. Two types of possible connections can be done parallel connections and series connections. The output of the piezoelectric material is not a regulated one, so variable to linear voltage converter circuit rectifier is used. Ac ripple neutralizer is the circuit used to reduce the ripples from the piezoelectric output. The AC ripple neutralizer consists of rectifier and ripple filter. Again AC ripples are filtered out using ripple filter and it is used to filter out any further variations in the output and then it can be pass through regulator in order to regulate. The output of the voltage regulator is given to the unidirectional current controller. Unidirectional current controller means it allows flow of current in only one direction. Mostly used unidirectional current controller devices are as follows:

1. Diode- It allows an electrical current in one direction. It acts like a switch. A specific diode converts AC into pulsating DC hence sometimes it also called as rectifier.
2. Thyristor- A thyristor is four layer semiconductors that are often used for handling large amount of power. A thyristor can be turned on or off, it can also regulate power using something called phase angle control.

The output voltage from this piezoelectric is then stored in a battery through ac ripple neutralizer which does exactly opposite job of the rectifier and filter which converts the stored direct

current (DC) energy in batteries back into alternating current (AC). An inverter is connected to battery to drive AC load. From this system we are generating energy by human footsteps using the piezoelectric effect. Piezoelectric effect is the effect which coverts mechanical stress, stain, pressure into electrical energy. This idea not only overcome the energy crises problem but also helps to maintain the eco- friendly environment for generating energy.

The power generated by the foot step generator can be stored in an energy storing device. The output of the generator was fed to a 12 V lead acid battery, through an ac-dc converter bridge. Initially, the battery was completely discharged. Then, the FSEC was operated by applying foot load and energy was stored in the battery. A 100 W, 230V bulb was connected to the battery through an inverter. The duration of lighting, the bulb for number of footsteps and corresponding energy stored. The piezoelectric material converts the pressure applied to it into electrical energy. The source of pressure can be either from the weight of the moving vehicles or from the weight of the people walking over it. The output of the piezoelectric material is not a steady one. So a bridge circuit is used to convert this variable voltage into a linear one. Again an AC ripple filter is used to filter out any further fluctuations in the output. The output dc voltage is then stored in a rechargeable battery. As the power output from a single piezo-film was extremely low, combination of few Piezo films was investigated. Two possible connections were tested - parallel and series connections. The parallel connection did not show significant increase in the voltage output. With series connection, additional piezo - film results in increased of voltage output but not in linear proportion. So here a combination of both parallel and series connection is employed for producing 40V voltage output with high current density. From battery provisions are provided to connect dc load. An inverter is connected to battery to provide provision to connect AC load. The voltage produced across the tile can be seen in a LCD [4]

.

3. MAXIMUM VOLTAGE GENERATED

When a force is applied on piezo material, a charge is generated across it. Thus, it can be assumed to be an ideal capacitor. Thus, all equations governing capacitors can be applied to it. In this, on one tile, we connect 3 piezo in series.10 such series connections are connected in parallel. Thus when 3 piezoelectric discs are connected in series, its equivalent capacitance becomes:

$$(1/C_{eq})=(1/C_1)+(1/C_2)+(1/C_3)$$

We know, $Q=C*V$

So, $C=Q/V$

Hence, $V_{eq}/Q=(V_1/Q)+(V_2/Q)+(V_3/Q)$

Thus, $V_{eq}=V_1+V_2+V_3$

Hence, the net voltage generated in series connection is the sum of individual voltages generated across each piezoelectric disc. Output voltage from 1 piezo disc is 13V.

Thus, $V_{eq}=V_1+V_2+V_3$

$=13+13+13 =39V$

Thus the maximum voltage that can be generated across the piezo tile is around 39V.

Output power

Let,

Mass of pedestrian = 65 kg

Distance travelled by plate = 8cm

So, work done on plate by impact =weight of body * distance = 65 * 9.81*0.1 J =63.765 J

So, power output =work done/sec =63.765/60 Watts =1.06275 Watts

This much power is generated just by one foot step, by calculating on an average of foot step impacts on the device we tabulated the data by taking a 100W bulb with 230V [4].

4. CONCLUSION

From this review its very easy to understand the basic comparison and design criteria that used for the methods to generate the power using the footstep. In the method only electrical part places major role. Thus the method is quite easy to implement and maintain .Thus to make the whole system for urban area application more design parameters should consider. The generation of energy and its use is one of the problems. Now-a-days numbers of energy sources are present, non- renewable and renewable, but we still cannot exceed our energy needs. Among these, the human population is one of the resources. Energy can be generated by walking down the stairs. The energy generated will be stored and then we can use it for domestic purpose. This system can be installed in installed in homes, schools, universities, where people move around the clock. When people walk on the rungs or

platform, power is generated using the person's weight. The control mechanism carries piezoelectric sensor, this mechanical energy applied in the glass in electrical energy. When there are some vibrations, the effort or effort force is exerted on foot on a flat platform. This concept falls under the subject of nonconventional energy resources, out of the many alternative energy resources one dependable source is solar energy. Therefore alternative cheapest source is to generate electricity from foot step. This technology proven here is the ultimate inexpensive source of all known forms of energy. When it is implemented practically, depending up on the size & traffic flow, each foot step may produce tens of kilowatts power every day, this power can be utilized for many applications. If we are used this project at very busy stairs palace then we produce efficient useful electrical for large purposes. One important advantage of producing energy through this technology is that it does not pollute the environment. Hence these foot step can be altered with this technology, there by all the street lights belongs to a particular city can be energized.

REFERENCES

[1] R. Amirtharajah and A.P. Chandrakasan, "Self-powered signal processing using vibration-based power generation," IEEE Journal of Solid-State Circuits, vol. 33, pp. 687-695, 1998.

[2] Boby Kiran, K Aleena Paul , C.V Anumol, Thomas Ann Josnie, K.K. Nimisha “Footstep Power Generation Using Piezoelectric Transducer”- International Journal of Engineering and Innovative Technology, vol.3, April 2014.

[3] Anil Kumar “Electrical Power Generation Using Piezoelectric Crystal” International Journal of Scientific & Engineering Research, Vol.2, pp. 2229-5518, May-2011.

[4] M. Umeda, K. Nakamura and S. Ueha, “Energy Storage Characteristics of a Piezogenerator Using Impact Vibration” Japan Journal of Applied Physics, Vol. 36, pp.3146-3151, 1997.