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Generation of Electricity Using Piezoelectric Speed Breakers

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ABSTRACT

Man has needed and used energy at an increasing rate for the sustenance and well-being since time immemorial. Due to this a lot of energy resources have been exhausted and wasted. Proposal for the utilization of waste energy of pressure power with vehicle locomotion is very much relevant and important for highly populated countries like India where the transportation by land is overcrowded all over. The project is based on power generation through speed breakers. The projects aim to light the street lamps by converting the constant pressure on the speed breakers using piezoelectric transducers. And this power source has many applications as in home applications and as energy source for sensors in remote locations.

Keywords— Piezoelectricity, PZT, PVDF, Electric potential

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I. INTRODUCTION

At present, Electricity is a basic need for everyone. Its demand is increasing day by day. Modern technology needs a huge amount of electrical power for its various operations. But electricity reaches only 65% of the entire population and rest 35% still lives in darkness in India. That 65% population also doesn't get continuous power supply and we still face power cuts & Crisis. To satisfy all the needs we need to produce 81,08,76,150 MW.hr /year. Whereas ,the production is only 60,06,49,000 MW.hr /year. So we need 210,227,150 MW.hr/year , to reach the demand. We need to think of an alternative to solve this crisis. Presently there are many alternatives like solar , wind , tidal etc. All these years we have ignored a better alternative which is right under our feet that is Piezoelectricity. This technology is based on a principle called the piezoelectric effect, in which certain materials have the ability to build up an electrical charge from having pressure and strain applied to them. Piezoelectricity refers to the ability of some materials to generate an electric potential in response to applied pressure. We are going to harvest this energy. Piezoelectric material can provide the magic of converting pressure exerted by the moving people into electric current.

II. RESEARCH ELABORATION

A. STUDY OF PIEZO MATERIALS

We studied some research papers from which we got following info to follow : Ceramics with randomly oriented grains must be ferroelectric to exhibit piezoelectricity.The macroscopic piezoelectricity is possible in textured polycrystalline non–ferroelectric piezoelectric materials, such as AlN and ZnO.The piezoelectric effect is common in piezo ceramics like PbTiO3, PbZrO3, PVDF and PZT. An analysis on the 2 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.

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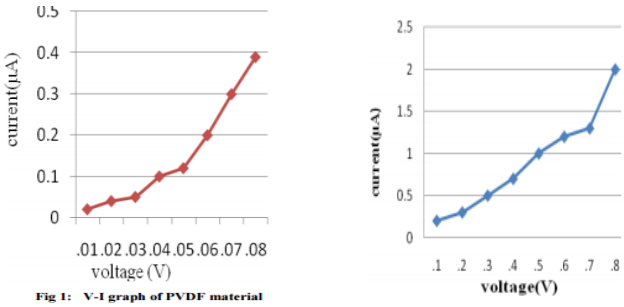

Fig.1: V-I graph of PVDF material

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.

B. STUDY OF CONNECTIONS

Assuming three piezoelectric sensors in parallel / series :

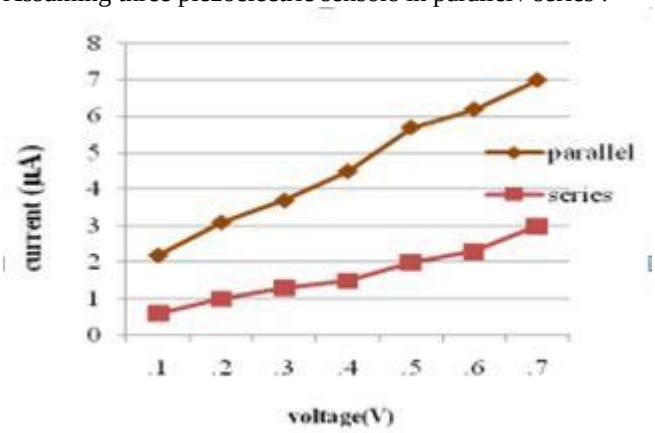

Fig .2: V-I Graph of Series & Parallel connections

The output voltage obtained from a single piezoelectric crystal is in millivolts range, which is different for different crystals. And the wattage is in microwatt range. So in order to achieve higher voltages, the piezoelectric crystals can be arranged in cascading manner.
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.

C. POSITIONING OF PIEZOELECTRIC SENSORS

Piezoelectric sensors has to be positioned parts where the maximum pressure is applied. Single sensor is capable of generating 3-5V on application of pressure consistently, in this work four sensors are connected in parallel in order to increase the probability of getting maximum output. Piezopolymeric materials are more advantageous to use than piezoceramic materials in case of sensor application, because polymeric films can be easily fabricated to different shapes. Even then piezoceramic sensor has been used in this work because it is commercially available at low cost .

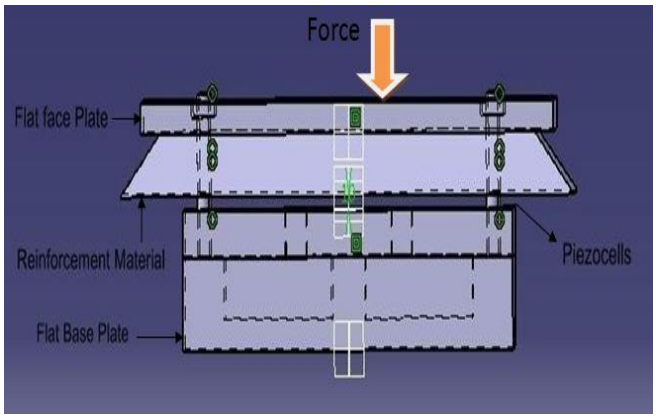

Fig.3(a): Crusade for Piezoelectric sensor

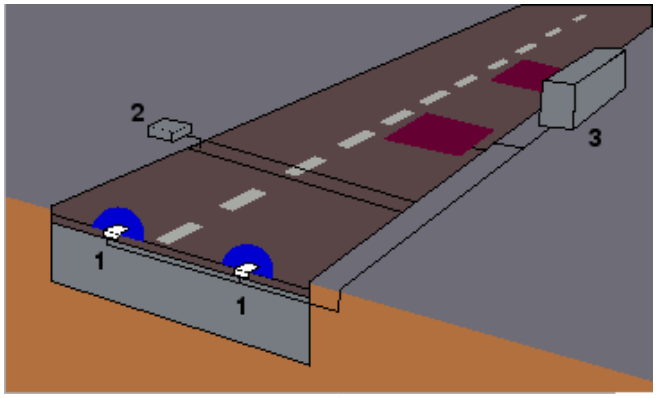

Fig.3(b): Position of Piezoelectric sensor

III. ANALYSIS DONE ON PIEZO TILE

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 plotted . From the graph 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.

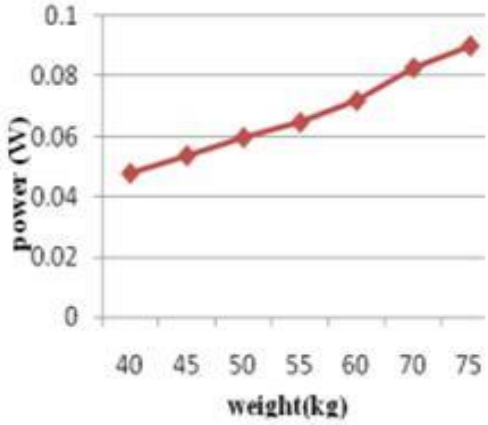

Fig.4:Weight Vs Power graph of piezo tile

IV. SCOPE OF WORK

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The storage of energy from piezoelectric transducers can be improvised using mosfet. System can be implemented in large amounts as an alternative energy sources apart from renewable sources. The proposed work portrays the concept of Piezoelectric Energy Harvesting and the results obtained after the implementation are very encouraging. Future work of the proposed idea encompasses further amplification of the crystal output to a greater extent. Future lies in the inclusion of advanced material used to design the piezoelectric crystal which further amplifies the crystal output in terms of voltage as well as current.

Industrial and manufacturing units are the largest application market, for piezoelectric devices, followed by the automotive industry. Piezoelectric devices embedded in highways are used for electricity generation. In the detection and identification of sonar waves also piezo electric elements find significant application.

V. CONCLUSION

The piezoelectric crystal arrays are laid underneath pavements, sidewalks and other high traffic areas like highways, speed breakers for maximum voltage generation. The voltage thus generated from the array can be used to charge the chargeable Lithium batteries, capacitors etc.

A piezo tile capable of generating 40V has been devised.

One method of performing power harvesting is to use piezoelectric materials that can convert the ambient vibration energy surrounding them into electrical energy. This electrical energy can then be used to power other devices or stored for later use.

The Rectifier, DC –DC converter and battery charging circuit used in the project contains minimum number of components and hence it is very compact, low cost and the future changes can be made without much difficultly in the hardware.

The weight applied on the tile and corresponding voltage generated is studied and they are found to have linear relation.

The amount of energy generated depends on the number of passing vehicles and the number of piezoelectric elements.

Vehicles that are moving slowly appears to generate slightly more energy than faster – moving vehicles, but further research is needed to confirm this piezoelectric power generation system works successfully. It has tremendous scope for future energy/ power solution towards sustainability.

A model to predict the amount of power capable of being generated through the weight of a vehicle and speed breakers through springs with attached piezoelectric elements.

This can be used in street lighting without use of long power lines. It can also be used as charging ports, lighting of pavement side buildings.

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