Electricity Generation through Piezoelectric Material in Automobile

Arpit Bhatt[1], Chirag Nagar[2], Vihan Bhavsar[3], Yash Shah[4]
Department of Mechanical Engineering, Gujarat Technological University, Ahmedabad, India[1,2,3,4]

Abstract

The increase in energy consumption of portable electronic devices and the concept of harvesting renewable energy in human surrounding arouses a renewed interest. This project focuses on one such advanced method of energy harvesting using piezoelectric material. Piezoelectric material can be used as mechanisms to transfer mechanical energy, usually ambient vibration, into electric energy that can be stored and used to power other devices. A piezoelectric substance is one that produces an electric charge when a mechanical stress is applied. Conversely, a mechanical deformation is produced when an electric field is applied. Piezoelectric materials have vast application in real fields. Some of the application is used in our research.

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Keywords — *piezoelectric effect, electricity, automobile, mechanical vibration*

I. INTRODUCTION

As we know that the need of electricity is increasing day by day in every field of our life, besides this electricity is one of the biggest issue the third world countries are facing right now, so we are contributing some efforts towards this issue by our research. In our research, the vehicle is provided with piezoelectric device which is used to generate electricity. The piezoelectric material we used is Lead Zirconate Titanate. The piezoelectric material is placed between each coil spring or leaf spring. When the automobile moves on uneven road the compression stress produced is given to the piezoelectric material. The crystal will generate measureable electricity when their static structure is deformed by 0.1% of the original dimension. So we can generate electricity from automobiles besides the System is friendly and economical**.**

II. BASIC PRINCIPLE

The main principle of piezoelectric material is to produce a electric charges on the crystal surface like quartz, Lead Zirconate Titanate when they subjected to compressive force. The charge thus produced can be called as piezoelectricity. Piezoelectricity can be defined as the electrical polarization produced by mechanical strain on certain class of crystals. The rate of charge produced will be proportional to the rate of change of force applied as input. As the charge produced is very small, a charge amplifier is needed so as to produce an output voltage big enough to be measured. The device is also known to be mechanically stiff.

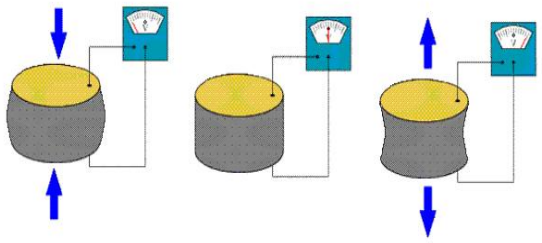

Fig. 1 Basic Principle

III. ACTUAL IMPLEMENTATION

The main aim of our research is to generate electricity by the waste of energy from mechanical vibrations and shocks; using piezoelectric materials, in automobiles the vibrations and shock are controlled or balanced by the suspension system, so these are the main fields of our work. I.e. The suspension system because any kind of vibrations will redirect affect the suspension and that will eventually help in producing electricity. This kind of energy generation require some prior set up and implementation to be followed up in order to get desired output which will be quiet useful for the society.

Now, let get back to the point of generating energy and its required process to be implemented. Piezoelectric materials are main components used in our project. They which on squeezing will produce EMF, so piezoelectric materials are transformed into required shapes and when stress acts on it, it will disturb the dipole moment in the material and net change will be formed. The piezoelectricity formed by the changing or deforming the dimensions of the material which is used for the charging battery of the vehicle. The energy is free from any kind of specific input which will increase the cost of the system. The Piezoelectric transducers which will convert any kind

of mechanical energy into electrical energy uses of piezoelectric materials.

This piezoelectric transducer is placed in the suspension system, where there is always a mechanical shocks or vibrations takes place. The transducer will get compressed or pressure will act on them when mechanical shock or jerk is transmitted to the suspension system while moving. These compression or indirect stress will cause the squeezing of piezoelectric material, as result the net changes on the transducer will also get changed and eventually produces the EMF.

The EMF generated is in the form of electric signals, which are of very low voltage and not enough to sustain long. The electric signals in the form of Alternating Current are produced from the piezoelectric transducers. Those A.C signals are made to flow in the diode rectifier bridge circuit. The main function of diode rectifier bridge circuit is to direct the flow of the charges in one direction. Its configuration provides the same polarity of output for either polarity of input. Its common application is used for converting the alternating current (AC) input into direct current (DC) output. The AC signal which was fed into the bridge rectifier circuit will convert them into the DC signals and passes to the capacitor.

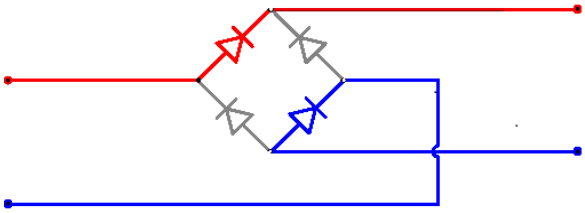

Fig. 2 Circuit connection

A capacitor is a passive two terminal electrical component used to terminate store electrical energy in a electric field. When there is a potential difference across the conductors, when a capacitor is attached across a battery, an electrical field always across the dielectric causing positive charge to collect one plate and negative charge to collect on the other plate. If the time varying voltage is applied across the field of capacitor, the displacement current flows. Hence, in such a way the capacitor connected with the rectifier bridge collects and the charge within it and when the switch is ON, the current flow through it to charge the battery of our Automobile.

The electric charge, which is flowing through the battery, is used for operating various purposes in the Automobile.

IV. RESULTS

We have gone through various kinds of data related to different frequencies that can generate low power energies with similar intensity. The information presented are based on resonance frequency of 19.9 Hz and other natural frequency of 2.8 Hz. The figure below shows the voltage generated on experimental piezoelectric generator system and measured with an oscilloscope.

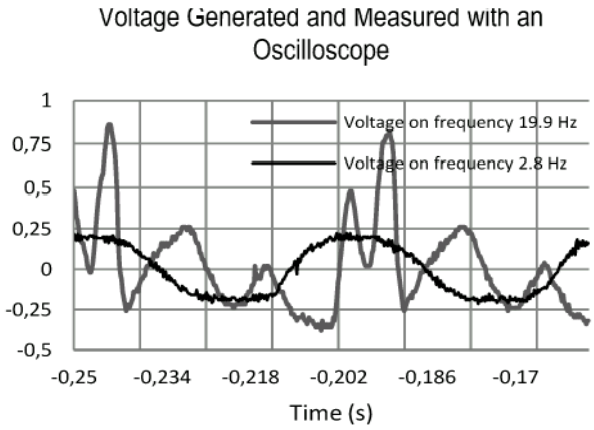

Fig. 3 Voltage generated and measured with an Oscilloscope

It was inferred from the above graph, that waveform frequency of 2.8 Hz was periodic. The next figure represents the acceleration of the system with accelerometer.

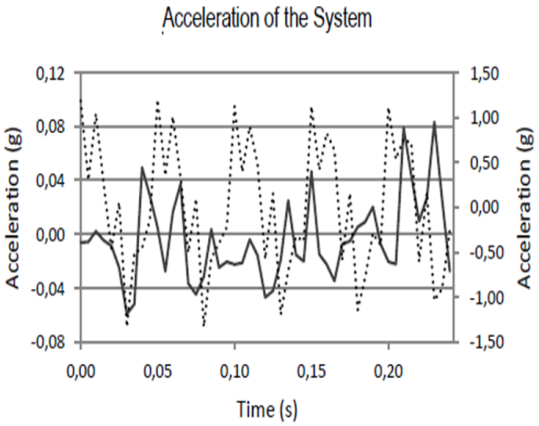

Fig. 4 Acceleration of the system

The magnitude of acceleration to gravity is higher in resonant frequency shows that the periodicity of the signals is good in 2.8 Hz. Energy harvesting is more easily captured the lower signals not requiring specific frequencies for operation of the system.

A. Graph of Frequency Response:

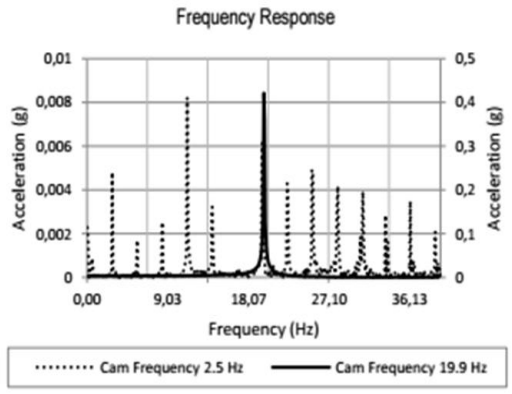

Fig. 5 Frequency Response

The system is oscillating at 2.5 Hz the another studied the effect of system generator. The graphs that the signal amplitude at 19.5 Hz is greater than 2.5 Hz. This comparison is valid because the system operates in the frequencies which are not destructive to mechanical parts.

B. Graph on Power Generation:

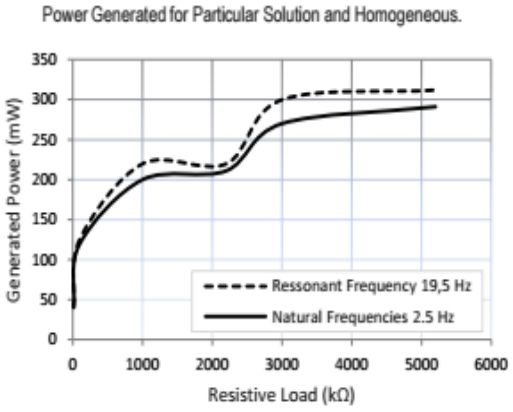

Fig. 6 Power Generation

From the above graph we get following Table:

Table: Results of Power Generation graph

Resistive Load	Generated Power at F_R (19.5 Hz)	Generated Power at F_N (2.5 Hz)
10 kΩ	41 mW	40 mW
100 kΩ	126 mW	120 mW
1 kΩ	220 mW	200 mW
2.2 kΩ	220 mW	211 mW
3 kΩ	300 mW	270 mW
5.2 kΩ	312 mW	291 mW

C. Graph for the Charging Time:

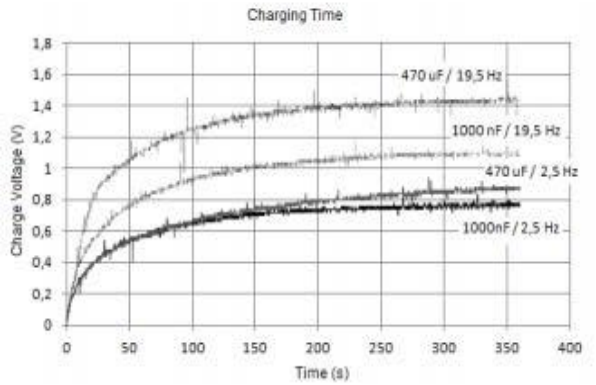

Fig. 7 Time vs Voltage

Table: Results of Charging Time

Capacitor	Charging Time at F_R (19.5 Hz)	Charging Time at F_N (2.5 Hz)
1000 nF	**208.2 s**	**161.0 s**
470 µF	**183.4 s**	**276.2 s**

Now here are some results obtained from the above graph:

V. CONCLUSION

The result obtained from the above analysis and search from different search engine we are able to produce the electricity by using piezoelectric materials, the energy obtain from such kind of sources has a very high and quick response, but of law voltage behaviour, the electric generation capacity outside the resonant frequency range, i.e. other natural frequency. It is very important to note that the method extends the life of system operating in non-resonant frequency without non-destructive mechanical parts.

The power output does not comprise power out. The mean power generated in resonant frequency at 19.5 Hz of structure in 220MW. The main conclusion from above graph is that the piezoelectric material is able to generate energy in natural frequency.

Some experiments proved to be able to charge capacitor with the average time of 200 seconds regardless to the frequency in the system.

It is also to be noted that it is capable of charging batteries of portable electronic devices.

In our research, energy from piezoelectric material will pass on the electric signals in the form of AC-signal to diode Rectifier Bridge to convert it into DC- signal, will eventually store in capacitor by large

amount and it will use to transfer to the battery for future usages.

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