

# HOW TO CONVERT VIBRATIONAL ENERGY INTO ELECTRICAL ENERGY

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**Abstract**— In upcoming time there is a serious threat on fossil fuels like diesel, petrol and natural gases, because all these fuels are non renewable forms of energy. These source of energy depleted very rapid rate and after some decades they completely exhausted, so we should have to prepare to face this challenges. Alternative energy will become increasingly important as fossil fuel supplies inevitably run out or environmental damage sparks consumer awareness. The search for a viable energy alternative will continue until these alternatives can address the dynamic demands of the electrical grid and storage limitations. Piezoelectric devices, used for harvesting the vibrational energy of roads and walkways due to traffic, can produce electrical energy that is predictable (based on traffic patterns), and locally storable. There is a piezoelectric material which used for converting mechanical pressure (vibration) into electrical energy. Piezoelectric material works on the principle of the charge output signal proportional to the applied force or pressure.

**Index terms**- Fossil fuels, Alternative Energy, Vibrational Energy, Piezoelectric material.

## I. INTRODUCTION

Every machine and vehicle vibrates with some frequency during operating and running time respectively. This vibrational energy goes into vain i.e. vibrational energy of motor and other heavy machine is completely useless. And as well as when huge number of vehicles passes through a bridge, bridge also vibrate with some frequency. But we can utilize this vibrational energy into our useful purpose and minimize the load of other power generation source. There is very useful material. which, when compressed or vibrate produce electricity due to piezoelectric effect called as piezoelectric material.

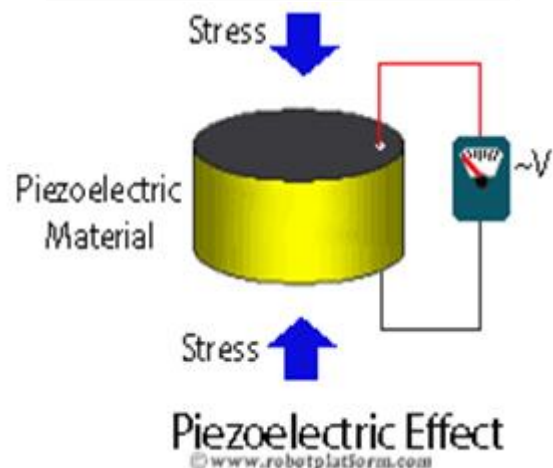
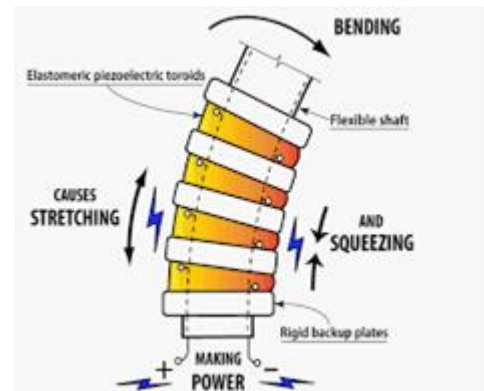
What is piezoelectricity?

The word “piezo” is derived from Greek word pierzin which means to squeeze or press so when piezoelectric material compressed or vibrate again and again it exert a electric field.

The piezoelectric effect manifests itself as a transfer of mechanical energy into electrical energy and vice versa.

So piezoelectric effect is a reversible process in that materials exhibiting the direct piezoelectric effect (the internal generation of electrical charge resulting from an applied mechanical force) also exhibit the reverse piezoelectric effect

(the internal generation of a mechanical strain resulting from an applied electrical field).



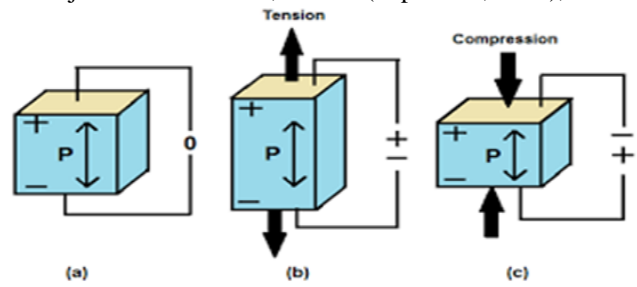
## II. PIEZOELECTRIC MATERIAL

Most piezoelectric material consist of ceramics with molecules compounds consist of Lead (Pb), Zirconium (Zr) and Titanium (Ti) i.e. PZT

Piezoelectric ceramic materials are ionically bonded and consist of atoms with positive and negative charges, called ions. These ions occupy positions in specific repeating units (called unit cells). If a unit cell is non-centro symmetric, i.e. lacking a centre of symmetry, then the application of a stress produces a net movement of the positive and negative ions with respect to each other and results in an electric dipole or polarisation.

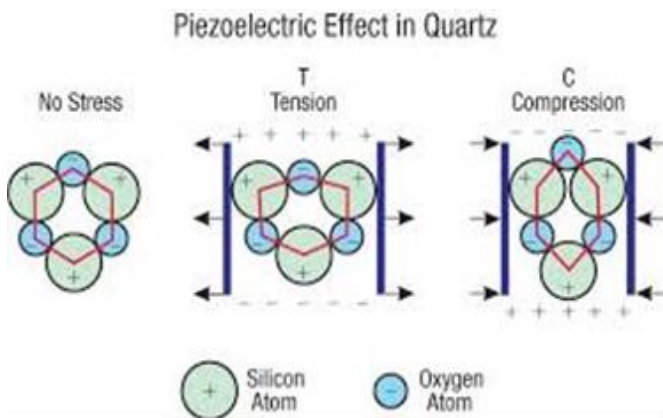
piezoelectric fibres The degree of polarisation is dependent upon the stress and whether tensile or compressive stresses are applied affects the charge produced. The dipoles, which are present due to the non-centro symmetric structure, form domains that are regions where neighbouring dipoles have the same alignment.

Initially the domains are randomly oriented and there is no overall polarisation of the ceramic and by applying heat and a strong DC field the domains are subjected to 'poling', causing the domains that are nearly aligned to the field to grow at the expense of those at differing alignments. After cooling to room temperature and removing the DC field, the domains are 'locked' resulting in an overall alignment and the material is now piezoelectric.



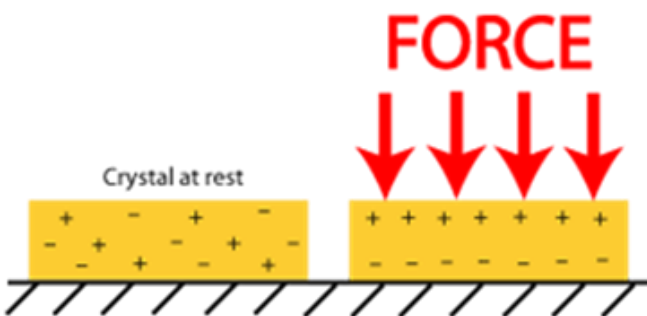
(Figure: Effect of stress on piezoelectric material)

The amount of accumulation charge is directly proportional to applied force when the applied acceleration can be calculated by applied Newton's second law of motion  $F=ma$ .



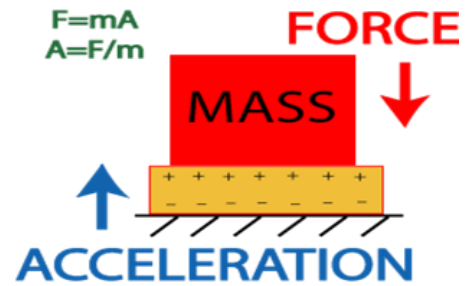
### III. VIBRATIONAL ENERGY TO ELECTRICAL ENERGY

The utilization of vibrational energy using piezoelectric material working on the principle of piezoelectric effect. When there is no force or no pressure applied on the piezoelectric crystal the material is in neutral state i.e. the positive and negative charge centers coincide each other and overall effect is cancelled out.



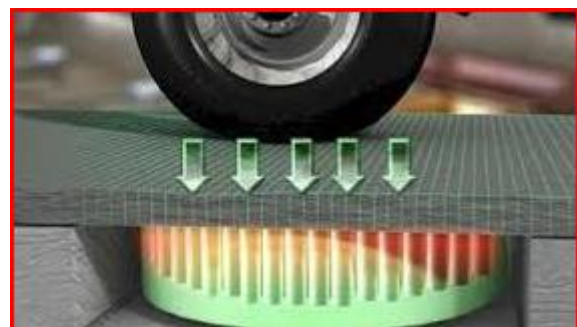
If we applied pressure on the crystal they change their internal structure and in this condition positive and negative charge separate each other and accumulate at two opposite surface of the piezoelectric crystal which result in generation of dipole which further result in polarized molecule.

It generates electric field whose intensity depend upon the quantity of vibration or displacement occurred and further this electric field generated transform mechanical energy directly into electrical energy. The a.c. voltage is generated here is then converted into d.c. voltage using rectifiers.



### IV. WHERE WE CAN HARNESS VIBRATIONAL ENERGY

1) On bridge or roads: the generating capacity of piezoelectric devices can be crudely over-approximated by assuming that the vibrations in the road are caused by traffic alone, and that each "vibration event" from one vehicle is independent of another (i.e. the vibrations are sufficiently dampened before the next vehicle passes. Under these assumptions, the total energy harvested by piezoelectric devices. Piezoelectric devices incorporated along with spring suspension at depth 0.5 to 1.5m from the above surface of the road. Now when traffic passes through the bridge/road spring continuously expands and contracts, which continuously come in contact with piezoelectric crystals which exert a pressure on the crystals. It result in deformation and movement of positive and negative charges which induce electric field and finally electrical energy. This output further utilize as a a.c. or d.c. according to need with the help of rectifier. The output obtained from a single piezoelectric crystals is in mili volts. So , we arranged many piezoelectric crystals in series in order to obtain higher voltage and received energy is stored in batteries.



2. In various type of industry workshop where heavy machine (rotating/reciprocating) used which produce high vibration. So , we can installed piezoelectric crystals device just below the machine in the ground for generating electricity.

3. if we mounted piezo device Underneath the seat of bike, we can generate sufficient electricity due to vibration caused by uneven road surface. Especially it is very useful in rural areas roads.

4. We can generate a huge quantity of electricity due to vibration on railway platform where passengers and trains coming and going randomly which create ample amount vibration on platform surface.

5. We can also used piezoelectric device for charging battery of electric car. We can also generate electricity by using vibration of trains and buses at large extent.

#### B. During rainy season

The areas where electricity cut off is a serious problem in rainy season can harness the power of rain water for generating electricity. Let me tell you how? The water is falling from the roof via pipe. We can increase the velocity of water by some mechanical means and just below the pipe we can place the piezoelectric device. And when there is raining water compress the device and generate sufficient electricity for lighting the house.

#### V. HOW TO MAKE PIEZOELECTRIC CRYSTALS

1) Necessary ingredients:- Baking soda(sodium bicarbonate ), cream of tartar(Potassium-bipartrate) and distilled water.

METHOD:- We have to need 500gm baking soda , 200gm cream of tartar and 250gm distilled water.

First we take baking soda in a flat container and spread uniformly and then heated into the oven in following way-

First hour at 65C, 2nd hour at 120C and 3rd hour at 175C and in 4th hour at 230C.

And in second pan put the cup (500ml) with mixture of distilled water and cream of tartar and filled this pan with water carefully so that cup would not sink into the water then heated and at the same time mixed the heated baking soda one by one spoon completely until the bubble formation is clogged completely and now heat this solution for 50 minutes. After heating store this cup in cool place for several days and after 2 weeks piezoelectric crystals ready to use.

#### APPLICATION

1. In California a piezoelectric road is made for electricity generation. A dance club in Netherland used suspension dance stage and below the dance stage spring and piezoelectric device is arranged for lighting the light of dance club.

2. To light up street light in this way we can save ample amount of other electrical energy.

3. In railway tracks a moving train produce huge amount of vibrations. Thus piezoelectric crystals are mounted near by to use those vibrations.

4. Power generating sidewalks the piezoelectric crystal arrays are laid underneath pavement where huge crowd passes creating vibrations.

#### CONCLUSION

Generating capacity and profitability are two important factors to consider in choosing this energy alternative. Vibrational energy treated as waste form of energy yet. Since electrical energy produced by other source is non-renewable source hence there is great need to save electrical energy efficiently and effectively. Harnessing this vibrational in the form of electrical energy we can save large amount of these conventional source of energy. Especially in India there is several place like village and other remote areas is still uncovered shed of light (Non-electrified zone). Piezoelectric material may paly crucial and vital role for supplying electricity in these places. Installment cost and maintenance coast is less as compared to other source of energy so this vibrational energy is best source of energy in future.

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