

# PEG- Piezoelectric Electricity Generator

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**Abstract** – Discovering, finding, and evolving alternate sources of renewable energy is the need of the hour. We never know, which alternate we discover, turns out to become much more energy efficient than the already existing ones. In this paper, I introduce a yet another revolutionary way of harnessing energy through the concept of Piezoelectricity. Piezoelectricity is producing electricity by applying pressure on a particular stone[1]. This paper delves into the application of this concept in harnessing electricity from tidal pressure with the help of results from the experiments conducted and the calculations made. Along with this, it also provides several other applications of this concept while explaining at the end, how this is going to be cost-efficient.

**Key Words:** Renewable Energy, Tidal Energy, Piezoelectricity, Tidal Pressure.

## 1. INTRODUCTION

A piezoelectric crystal produces a voltage generating AC current whenever a mechanical stress is applied to it.

Already creation of piezoelectric footpaths and footsteps is put in place where electricity is produced due to the mechanical stress applied by the action of placing one's foot in the special footpaths or footsteps made of piezoelectric material.

But this is not a very efficient way of producing loads of electricity.

I casually came up with a thought of harnessing tidal energy with this concept, the day when I experienced the strong force of waves at the seashore.

I have performed few experiments, trying to calculate and estimate, the extent of energy generation with this method.

In this process, I also came up with several other applications of Piezoelectricity which could also be significant in energy generation.

One such is a suggestion of a new design of water turbines.

### 1.1 Chemistry behind Piezoelectricity

Piezoelectric crystals are generally made of Quartz, and the mechanism involved is actually the movement of electrons due to application of stress[2].

Quartz is made up of a hexagonal structure of Silicon and Oxygen atom where one silicon bonds with two Oxygen.

Since Oxygen is more electronegative than silicon, the silicon-oxygen bond is polar.

In the hexagonal structure, the net electric charge gets developed in the center of the hexagonal structure.

However, when a mechanical stress is applied, there is a change in this hexagonal structure, and the net electric charge shifts its position.

This change in the position of electric charge produces a voltage[3].

The diagram given below shows the structure of Quartz.

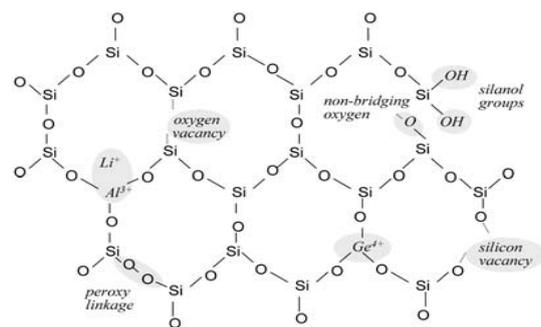


Fig -1: Structure of Quartz

## 2. The concept of PEG( in oceans)

PEG is a plate made of piezoelectric material, installed vertically upright on the sea floors, near the seashore.

It is placed in a such a way that the piezoelectric part of the plate is just on the surface of ocean so that impact with the waves could be made easily.

Whenever the oceanic waves will hit the PEG rhythmically, voltage will be produced.

This is therefore a cleaner and greener source of Energy.

Also, quartz, of which the piezoelectric disc is made of, also yields silicon which is used in making the Photovoltaic cells of solar panels.

Therefore, we may say that the infrastructure for the PEGs is already ready for us.

## 2.1 Experimentation and Results

To test the efficiency of this concept,

I conducted a test by preparing a PEG setup at a small scale and then using the principles of proportionality to find the results in real life scenarios, that is, oceans or seas.

For the test, I made a PEG plate of size  $375\text{cm}^2$ .

To replicate the dynamic of wave, I used a polythene full of water and dropped it from a certain height over the PEG to find the readings of Voltage in the multimeter.

This is how the calculations went-

Mass(of water)= 1kg  
 Height(of free fall)= 1m  
 Time of the free fall= 1s(approximately)  
 Area(of PEG)=  $375\text{cm}^2$

Potential Energy( $E_p$ )= mgh  
 $= 1 \times 9.81 \times 1 = 9.81\text{J}$

Considering that resistance offered by air was negligible, the entire Potential energy possessed by the water was only converted to kinetic energy exactly before the point it contacted the PEG.

Therefore,

$E_p = E_k$   
 $E_k = 9.81\text{J} = \frac{1}{2}mv^2$   
 $V(\text{velocity at the time of making contact}) = \sqrt{2 \times 9.81}^{1/2}$   
 $V = 4.43\text{m/s}(\text{approximately})$

$F(\text{force}) = \frac{\text{Change in momentum}}{\text{time}} = m \times \frac{\text{Change of velocity}}{\text{time}}$

Since, initial velocity was zero, change of velocity was equal to the final velocity and the time is the time taken for the freefall.

$F = m \times \frac{4.43}{1}$   
 $F = 1 \times \frac{4.43}{1}$   
 $F = 4.43\text{N}$

$P(\text{pressure}) = \frac{\text{Force}}{\text{Area}}$   
 $P = \frac{4.43}{0.0375} = 118.13\text{Pa}(\text{approximately})$

Hence, the setup I have made was exerting a pressure of about 118 pascals on the PEG I have made.

The corresponding values on the multimeter I obtained were as follows-

Maximum Case- 3V  
 Minimum Case- 0.5V

Now, interestingly, the average pressure of waves near seashore ranges from 10,000 Pa to 50,000 Pa.

If we consider the basic rules of proportionality, then if minimum value we get with 118 Pa of pressure is 0.5, so a 25000 Pa pressure will provide a voltage(minimum) of about 105.8V

Similarly, if the maximum case we get from 118Pa of pressure is 3 V, so a 25000 PA pressure will provide a voltage(maximum) of about 634.9V.

The ideal 220V value for India ranges between the minimum and maximum value hence is easily attainable.

Also, on increasing the no, of experiments, we may get even more accurate measure.

Given below is a diagram of a PEG. The yellow-black disc connected to a powerhouse is the PEG. The diagram shows a wave hitting the PEG.

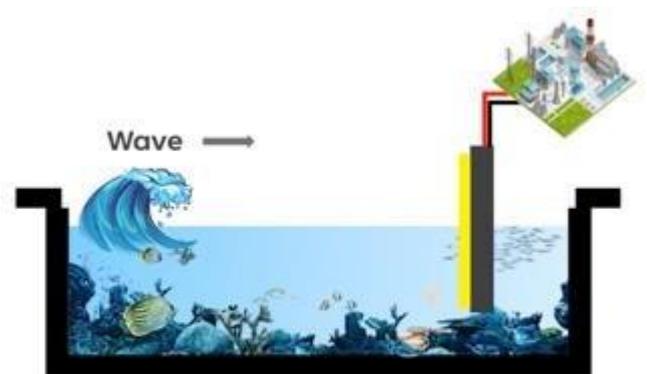


Fig -2: Before Contact

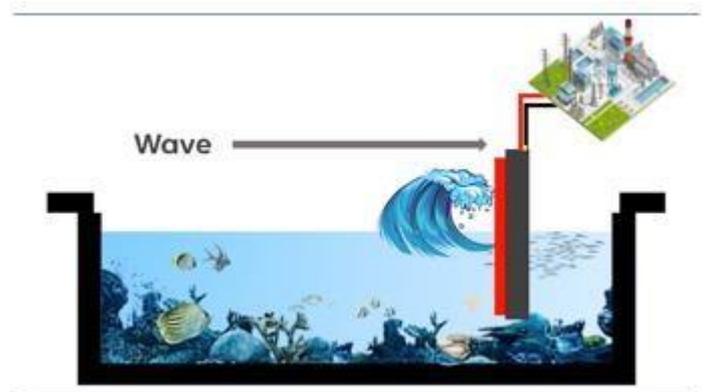


Fig -3: After Contact



**Fig-4: My setup**

### 3. New Design for Water Turbine

Water turbines are already effectively used as a renewable source of energy where the kinetic energy of water is used to turn the turbine to generate electricity. All present-day turbines used, have a flap like plates, placed one after another in a circular shape so that they can easily contact with the flowing water and therefore, could rotate, or rather revolve, to generate electricity.

I propose to fulfil a dual objective by making those flaps from piezoelectric material or install piezoelectric plates on the flaps so that whenever the flowing water hits the flaps, energy gets generated not only by the rotation of the turbine but also by the tidal pressure of the waves exerted on the piezoelectric plates.

This way, we can design a water turbine combining the concept of PEG, to harness even greater amount of tidal energy.

### 4. Concept of PEG in Scrap Yard

In the scrap yards, the metal scrap is compressed by being pressed by two metal plates help on opposite sides.

This compression generates immense amount of mechanical stress.

I propose to make these plates of piezoelectric material. This way, whenever these plates compress the metals i.e., makes a mechanical contact with the scrap, electricity could be produced with this mechanical stress.

This way, a way of processing waste, will start contributing to energy production as well.

### 5. CONCLUSION

Therefore, the concept of PEG can be used at an Industrial level to generate renewable energy. It offers two major benefits-

- Is cost efficient, since the infrastructure used for making PEG is quite like the one used to make Solar Panels, so not much resource has to be spent on research and development.

- Is energy efficient, since the piezoelectric crystals produce AC current which has low power loss factor and can be easily transmitted.

### REFERENCES

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