

Smart Piezo City

Yusra Wangde, Pranay Mendhe, Daniya Soparker, Vicky Gupta

(Department of Electronics and Telecommunications, Atharva College Of Engineering/Mumbai University, India)

Abstract: This work describes the recent advancements in piezoelectric energy harvesting concepts for smart city applications. Several works have been reported which discussed the detailed design and use of different piezoelectric materials to harvest energy from vibration. In the smart city context there are many opportunities to convert mechanical to electrical such as human motion, sounds, machines and streets. Researchers have studied the factors that affect the amount of the output generated power from various sources to determine its efficiency. Effect of harvester structure, material that is used in fabricating the harvester mobility of human in its location, and other factors have been studied. Efficiency of piezoelectric harvesters is an essential parameter to judge the performance of the prototype for the betterment of energy resources.

Keywords: piezoelectric, Energy harvesting.

I. Introduction

Now a day's energy is one of the most important issue around the world. Especially in Rural area energy crisis is a big problem. Renewable energy sources can be a great media to solve this energy crisis problem in rural area. As we know natural resources will finish one day. That's why researchers are trying to introduce substitute energy sources from nature. That must be green and not harmful for the environment. Energy harvesting is defined as harvesting minute amounts of energy from one or more of the surrounding energy sources. Human beings have already started to use energy harvesting technology in the form of windmill, geothermal and solar energy. The energy came from natural sources, termed as renewable energy. Renewable energy harvesting plants generate kW or MW level power; it is called macro energy harvesting technology. Moreover, micro energy also can produce from that natural sources, that's called micro energy harvesting. Micro energy harvesting technology is based on mechanical vibration, mechanical stress and strain, Thermal energy from furnace, heaters and friction sources, sun light or room light, human body, chemical or biological sources, which can generate mW or μ W level power. Micro power supply needs is increasing greatly with time as our technology is moving to the micro and nano fabrication levels. Our project is based on generating micro energy from vibration and pressure using piezoelectric material.

II. Block Diagram

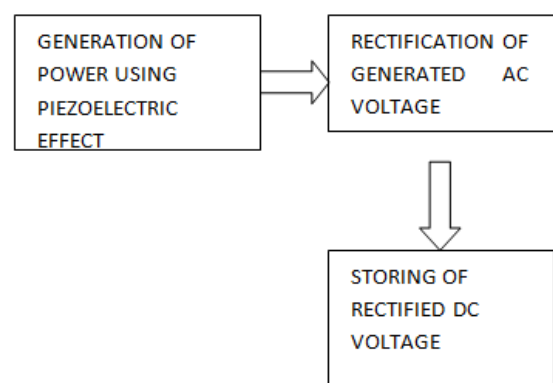


Fig. Block diagram of piezoelectric voltage generation

III. Block Diagram Description

The block diagram of the smart piezo city shows the generation of dc voltage and how it is stored due to the piezoelectric effect. The important factors of the block diagram are shown below.

The piezoelectric crystals are arranged in a manner that the generation of voltage could be easily measured and stored.

The voltage generated from the crystal is ac voltage for the voltage to be stored it should be dc voltage.

Also for the rectification process the ac voltage is automatically generate into dc voltage.

The voltage generation varies according the pressure applied to the crystals, although the more the pressure the more the voltage is stored in the batteries.

The minimum dynamic force applied is 0.25N (ideal) to max 0.5N while vibrating.

The min force applied on the material is from 6N to max 10N using a pressure head by clamping the sample on the both terminals(Polarities).

Then dc voltage is stored in the batteries which henceforth can be used for future purpose.

IV. Piezoelectric Crystals

Piezoelectric crystals are one of many small scale energy sources. Whenever piezoelectric crystals are mechanically deformed or subject to vibration they generate a small voltage, commonly known as piezoelectricity. This form of renewable energy is not ideally suited to an industrial situation.

Another common usage of a piezoelectric crystal energy source is that of creating a small motor; such as that used in a reflex camera to operate the auto focus system. These motors operate by vibration. The two surfaces are forced to vibrate at a phase shift of 90 degrees by a sine wave that has been generated at the motors resonant frequency. This forces a frictional force where the two surfaces meet and as one of the surfaces is fixed the other is forced to move.

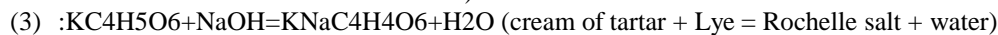
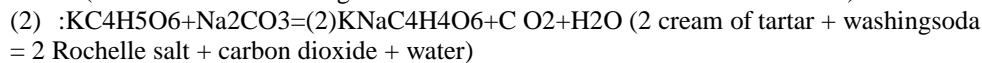
IV.1. Piezoelectric Crystal Formation

Rochelle salt, also called Sodium Potassium Tartrate Tetrahydrate, a crystalline solid having a large piezoelectric effect (electric charge induced on its surfaces by mechanical deformation due to pressure, twisting, or bending), making it useful in sensitive acoustical and vibrational devices.

Rochelle salt can be easily produced through at least these reactions;



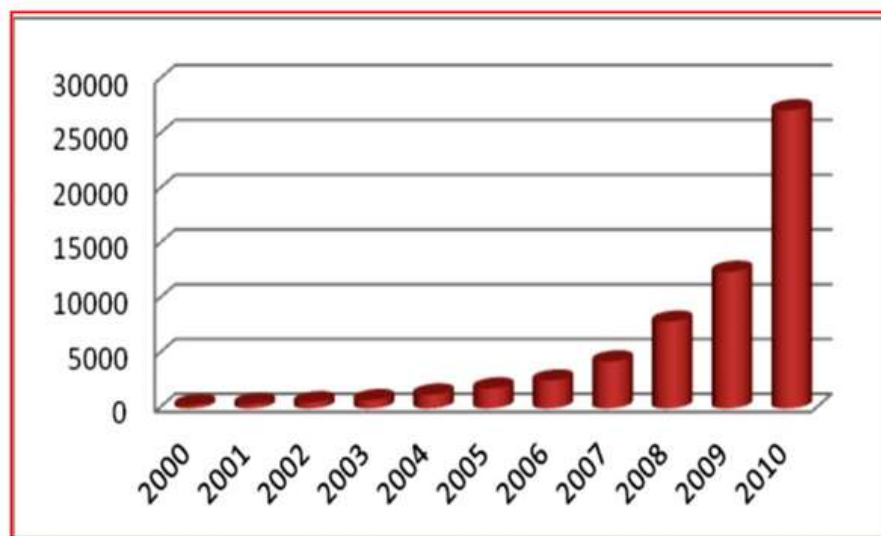
+H₂O (cream of tartar + baking soda = Rochelle salt + carbon dioxide + water)



Steps-

1. Heat a mixture of about 80 grams cream of tartar in 100 milliliters of water to a boil in a saucepan.
2. Slowly stir in sodium carbonate. The solution will bubble after each addition. Continue adding sodium carbonate until no more bubbles form and filter the solution through coffee/filter paper.
3. Chill this solution in the refrigerator. Crystalline Rochelle salt will form on the bottom of the pan.
4. Remove the Rochelle salt. If you redissolve it in a small amount of clean water, single crystals are formed.

V. Energy Harvesting



Energy harvesting is the area of collecting, typically, small amount of electric energy to operate mobile, remote or off-grid unit such as personal gadgets, Internet-of-things (IoT) devices, and similar electronic apparatus, where a standard power supply unit (PSU) would be expensive, impractical, infeasible, or the purpose would not be justified from e.g. cabling, PSU loss, heat dissipation. Piezoelectric energy is one of the typical methods to harvest energy along with photovoltaic (PV), thermo-electric (Peltier) elements, photo-chemical systems, rotary and linear dynamos, ram airturbines.

Piezoelectricity (from the Greek word piezein - “pressure” or “squeeze”) can enable a “process of extracting, converting and storing energy from the environment” and was discovered by Curie in 1880. Most current applications are as micro actuators in MEMS technology and piezoelectricity is not widely used to harvest kinetic energy.

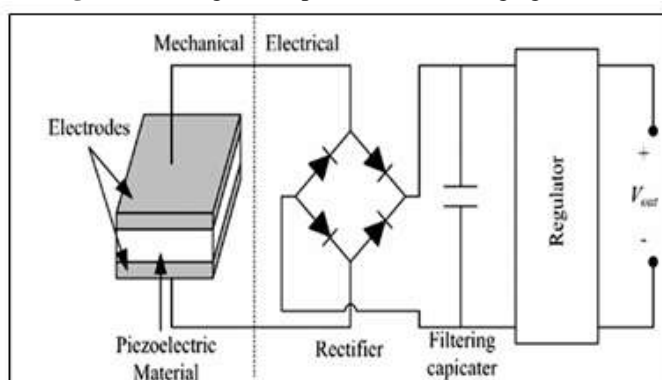
Zervos predicts the exponential growth of investments in piezoelectric energy harvesting and the increase of produced piezoelectric units from 2012 to 2022, what pushes the topic of this article in the focus of technology manufacturer and investors.

The amount of recently published scientific articles in the field of piezoelectric energy harvesting has been growing significantly in the last decade. Due to this, this paper explores the total academic interest in energy harvesting through piezoelectricity. With support of this gained knowledge, the authors present a technology foresight of this field.

Technology foresight is to identify and evaluate the emerging technologies, which will probably result in great economic and social benefits in the future. The purpose of this foresight is to present the future interest in this field. To fulfill the purpose of this paper and define its scope, the research question formulates as: How intense has the interest of energy harvesting through piezoelectricity been in the past and how intense will it be in the future?

VI. Circuit Diagram

Fig. Circuit diagram of piezoelectric voltage generation



By applying vibration or pressure on Piezo crystals, electricity is generated. The electricity generated by Piezo is then applied to a bridge rectifier to remove A.C. ripples and to pass D.C. signal. During this the capacitor is charged and this stored charge is applied to voltage regulator IC, here IC 7805 is 5volt voltage regulator which is responsible to pass 5Vdc constant to further battery.

The transistors are alternately switched on and off, periodically reversing the current in the transformer. Therefore, current is drawn from the line during both the halves of the switching cycle. The input current is supplied by both transistors which are switched on and off, so current is only drawn from the line during the half switching cycle.

VII. Future Scope

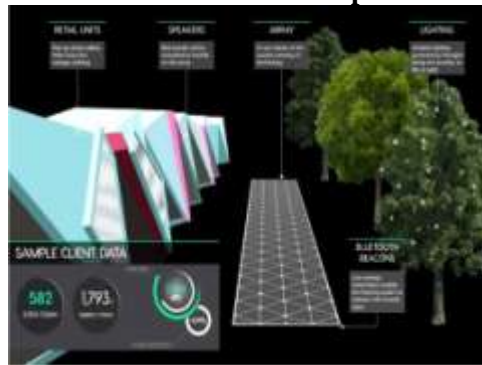


Fig. Future Scope for piezoelectricity

In this figure we see the piezoelectric cells are embedded on the whole road and these embedded piezoelectric cells are connected with external charge storing device with the help of connectors, and the charge so developed are then supplied to all the street lights as shown in the figure. Economically competitive with the traditional carbon-based energy production.

The electrical storage system, which is integrated in the roads, rail road's, and runways, does not take up any new public space and functions in all weather condition. Once embedded into road ways or railways, generators require minimal maintenance. These solutions can also serve as information gatherers in future smart roads! measuring a truck or rail car's weight in real time, send data back through a self-powered' wireless connection. These could be used in weighing stations.

VIII. Conclusion

Hence we have generated voltage using piezoelectric crystal. It uses phenomenon of piezoelectricity which takes 500 to 800 grams of weight to generate 5 to 6 volts of electricity.

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