International Journal of Trend in Scientific Research and Development (IJTSRD)
International Open Access Journal | www.ijtsrd.com
ISSN No: 2456 - 6470 | Volume - 2 | Issue – 6 | Sep – Oct 2018

Application of Piezoelectric Sensors in Daily Life

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ABSTRACT
In this article efforts have been done to show how piezo electric sensors can be part of our daily life. Today's world is a digital world and we want to automatize all possible things. To fullfil this dream and to achieve this demand piezo electric sensors are playing the vital role. Now a day, everywhere we want some renewable source of power or energy, because all the resources whether natural or man-made are at extinction and are harmful for the environment, respectively. So, this piezo sensor has taken the interest of all the researchers for developing a device which can generate power with the physical distortion in shape. That's why we took this topic for our article to aware all the people about its spectacular behavior.

Keywords: *Piezoelectric sensor, Piezoelectric Effect, Renewable sources, Potential gradient, Environmental friendly.*

INTRODUCTION
We know, natural resources will finish one day. So, we should switch more to renewable energy sources which would solve our problem a some extend. That's why researchers are trying to introduce substitute energy sources from nature that must be green and not harmful for the environment.

Human beings have already started to use energy harvesting technology is form of windless, geothermal and solar energy. As we know renewable sources are those energy sources which are mostly natural. Renewable energy harvesting plants generate kilowatt or mill watt level power called macro energy harvesting technology. But energy can also be produced from those natural sources that are called micro- energy harvesting. Based on mechanical vibrations, mechanical stress and strain, thermal energy from furnace, heater, human body, chemical or biological sources, which generate milli watt or microwatt, level power.

The word piezo is derived from Greek word for pressure. The piezoelectric effect was discovered by Pierre and Jacques Curie in the latter part of the 19th century. They discovered that minerals such as tourmaline and quartz could transform mechanical energy into an electrical output. The voltage induced from pressure (Greek: piezo) is proportional to that applied pressure, and piezoelectric devices can be used to detect single-pressure events as well as repetitive events.

Still, the ability of certain crystals to exhibit electrical charges under mechanical loading was of no practical use until very-high-input impedance amplifiers enabled engineers to amplify the signals produced by these crystals.

Several materials can be used to make piezoelectric sensors, including tourmaline, gallium phosphate, salts, and quartz. Most electronic applications use quartz since its growth technology is far along, thanks to development of the reverse application of the piezoelectric effect; the quartz oscillator.

Sensors based on the piezoelectric effect can operate from transverse, longitudinal, or shear forces, and are insensitive to electric fields and electromagnetic radiation. The response is also very linear over wide temperature ranges, making it an ideal sensor for rugged environments. For example, gallium phosphate and tourmaline sensors can have a working temperature range of 1,000°C.

The physical design of the piezoelectric sensor depends on the type of sensor you wish to create. For example, the configuration of a pressure sensor, or a

shock (impulse) sensor, would arrange a smaller, but well-known mass of the crystal in a transverse configuration, with the loading deformation along the longest tracks to a more massive base (Figure 1). This assures that the applied pressure will load the base from only one direction.

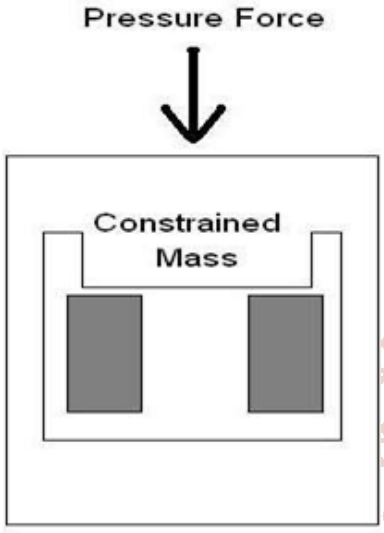

Figure 1: A constrained mass is allowed to deform the crystal sensor in one axis. This configuration is good for force and pressure.

An accelerometer based on the piezoelectric effect, would use a known mass to deform the sensing crystal part in either a positive or negative direction depending on the excitation force (Figure 2). It should be noted that you need a known modulus of elasticity in the sensor substrate.

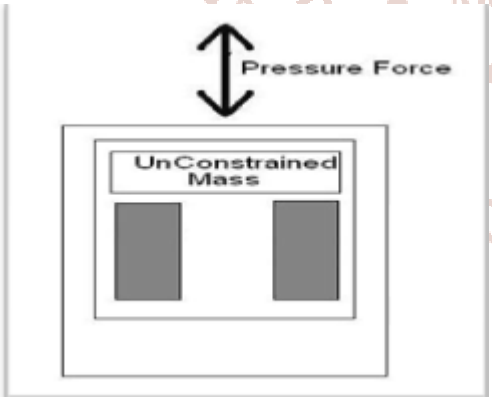

Figure 2: Because the modulus of elasticity is known for a substrate material, the unconstrained mass is allowed to move with vibration making this type of piezoelectric sensor ideal for detecting shock and vibration.

Review of literature

1. According to 'Pierre and Jacques Curie brothers' (1880), they examined the piezoelectric effect on crystal materials, (quartz, Rochelle salt) which Have the ability to produce electrical charges in response to external applied forces. This effect they named as "Piezoelectricity", after the Greek word "piezein", which means to squeeze or press.
2. According to 'Lippmann' (1881), he deduced mathematically the converse piezoelectric effect from the fundamental thermodynamic principles. This phenomenon illustrates that the application of an electrical field creates a mechanical stress.
3. According to 'Cady's' (1946), he worked on development of piezoelectric devices. These developments led to numerous ceramic materials with better piezoelectric properties. The discovery of piezoelectricity in PZT in the late 1960's increased the number of applications for industrial use.

Methodology:

Descriptive researches design is to focus and to identify the impact and effective implementation of piezo electric sensor in daily life and its dimensional aspects in society.

Objectives:

1. To know the effect of piezo electric sensor in the energy draining world.
2. How piezo electric sensor can be used as renewable source of energy?
3. How far the piezo electric sensor can be used?
4. Its bad impacts for the society.

Hypothesis:

1. It can be a blessing in the energy harvesting world.
2. It is reversible and renewable source.
3. It has its use, whether small or huge role in almost all area.
4. With all blessing it must be having some bad impact too.

Historical overview

If you've got a quartz watch, piezoelectricity is what helps it keep regular time. If you've been writing a letter or an essay on your computer with the help of voice recognition software, the microphone you spoke into probably used piezoelectricity to turn the sound energy in your voice into electrical signals your computer could interpret. If you're a bit of an audiophile and like listening to music on vinyl, your gramophone would have been using piezoelectricity to "read" the sounds from your LP records. Piezoelectricity (literally, "pressing electricity") is

much simpler than it sounds: it just means using crystals to convert mechanical energy into electricity or vice-versa. Let's take a closer look at how it works and why it's so useful!

How piezoelectricity works:

Here's shown how piezoelectricity occurs. It's somewhat simplified, but it gives you the basic idea:

1. Normally, the charges in a piezoelectric crystal are exactly balanced, even if they're not symmetrically arranged.
2. The effects of the charges exactly cancel out, leaving no net charge on the crystal faces. (More specifically, the electric dipole moments—vector lines separating opposite charges—exactly cancel one another out.)
3. If you squeeze the crystal (massively exaggerated in this picture!), you force the charges out of balance.
4. Now the effects of the charges (their dipole moments) no longer cancel one another out and net positive and negative charges appear on opposite crystal faces. By squeezing the crystal, you've produced a voltage across its opposite faces—and that's piezoelectricity!

Definition:

A piezo electric sensor is a device that uses the piezoelectric effect, to measure changes in pressure, acceleration, temperature, strain, or force by converting them to an electrical charge.

Piezo electric effect- it is the ability of certain, materials to generate an electric charge in response to applied mechanical stress. The word piezoelectric is derived from the Greek piezeinin, which means to squeeze or press, and piezo, which is Greek for “push”.

Principle:

The principle of operation of piezoelectric sensors is that a physical dimension, transformed into a force, acts in two opposing faces of the sensing element.

Characteristics:

1. One of the unique characteristics of the piezo electric effect is that it is reversible, meaning that the material exhibiting the direct piezoelectric effect (generation of electricity when stress is applied) also exhibit the converse piezoelectric effect (generation of stress when an electric field is applied).
2. They are not suitable for static or DC application, (because the electrical charge produced decay with time due to the internal impedance of the sensor).
3. Generates power up to milliwatt or microwatt level.

But still researches are going on for amplifying the voltage level and at some level we are succeeding.

Applications:

1. **Detection-** The detection of pressure variations in the form of sound, which is seen in piezoelectric microphones and piezoelectric pickups for electrically amplified guitars.
2. **Medical-** Piezoelectric sensors in particular are used with high frequency sound in ultrasonic transducers for medical imaging and industrial nondestructive testing.
3. **Engines-** it has helped in developing the better control system for engines by transforming certain parameters at very accurate value. Thus, efficiency can be improved.
4. **Depth sounder and sonar equipment’s-** helps in seeing underwater quite easily and accurately.
5. **Diesel fuel injector-** a single fuel injector may switch fuel flow with pressures exceeding 26,000 psi (1800 bar) on and off several times in rapid succession during a single power stroke. Such precise control of high-pressure fluid is made possible by using piezoelectric actuators controlling small valves within fuel injectors.
6. **Fast response solenoid-** piezoelectric actuators are often able to fill the niche as they provide fast response and low power consumption in small packages, compared to electromagnetic solenoids.
7. **Optical Adjustment-** Some optics need to be adjusted or modulated with a wide frequency response and with a minimum number of moving parts. Piezoelectric actuators are often employed in such applications
8. **Ultrasonic cleaning-** To perform ultrasonic cleaning, objects are immersed in a solvent (water, alcohol, acetone, etc.). A piezoelectric transducer then agitates the solvent. Many objects with inaccessible surfaces can be cleaned using this methodology.
9. **Ultrasonic Welding -** Many plastics can be joined together using a process known as ultrasonic welding. This type of process requires ultrasonic waves to be transmitted to a focused area where they can cause pieces of plastic to fuse together.

10. **Piezoelectric Motors -** One advantage of using piezoelectric materials is that their characteristics are precise and predictable. Thus, expansion and contraction of a piezoelectric actuator can be precisely controlled as long as the supply voltage is controlled.
11. **Defence**- by making more efficient micro robots and recently, DARPA invented a .50-caliber bullet that can change course in mid-flight Etc.

Conclusion

Thus, we can say with no doubt that the piezo electric sensor will become one day the most substantial, pronounced and appreciable and more considerable energy resource. This is a very unique material with such an extraordinary character of behaving as transducer i.e. converting energy from one form to other, here mechanical to electrical and vice versa.

Since it produces energy in such a form that doesn't produce any kind of pollution, thus will also be proven as environmental friendly. No doubt that sonly we are going to rely on it. some countries are already started its implementation hope India will soon become one of them, This will be going to be the one of the renewable resources.

Since we know piezo sensors are at the age of getting discovered and modified. Thus, the only thing we a see from it is its use, but as we know none of the things comes with only benefits, happiness or positive sides, all do have associated with them some harms, sorrows or negative impacts, respectively. I think the major problem we will face with this material will be recycling or decomposition, which may in future can become another way creating environment pollution. Thus, again we should think for the remedies of this side also. Also, piezo sensors are very small in size but still will be capable of full filling the need of us, but again it won't be able to fulfil the greed. So, use precisely and carefully.

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