GENERATION OF ELECTRIC POWER FROM WASTE NOISE ENERGY USING PIEZOELECTRIC TRANSDUCER

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ABSTRACT

Waste form of sound energy can be converted and used for some productive purpose. Random sound energy or unwanted noise around us can be treated as a source of electric power after their efficient conversion using suitable transducer. A device is used to measure and store the sound pressure level. Transducer is used for conversion of sounds into electric energy. Produced output from the transducer is boost up by using signal conditioning device. The resultant electric power will be used to charge a rechargeable DC battery so as to store this energy. The proposed idea can give a new source of green energy and can contribute in global search for renewable energy. A portable system which designed that generates power from the noise energy using transducers in a closed environment.

KeyTerms : Noise Dosimeter, Noise Energy, Piezoelectric Transducer, Power, Signal Conditioning Device.

I. INTRODUCTION

In this 21st century electric power has very deeply indulged in our society. It is really very hard to imagine our life without these electric appliances and all these appliances require electricity to operate and as fast as these world population is rising and also due to the drastic progress of mankind day by day the electric consumption is increasing drastically on the other hand the production of electric power is limited and it is not increasing to that extent, due to which there is a huge scarcity of electricity not only in India or particular region but across the whole world as development is taking place in very high range. The METI long term vision, proposed in 2005, the final energy which is mainly supplied by electricity towards 2050 for a low carbonated society. Actually today, the demand of electricity is continuously growing in this world and set to be doubled by 2030, so it is necessary to increase the supply of electric power. This electric power is very essential for us to find other alternative methods to produce electric-energy. When we think of another method of solar, wind , hydro and thermal energy but we forget about the sound energy. This property of sound pressure allows to change sound energy into kinetic energy by transferring the sound energy on to the vibrational diaphragm and change the kinetic energy into electrical energy by using vibrational nature of kinetic energy. In this century the most

common thing we encounter everywhere (roads, airports, industries, etc...) is noise pollution and irritatings. This waste form of noise could be converted and used for some productive purpose. The project aims to design a portable system that generates power from the noise energy using piezoelectric transducer in a closed environment . In this work, a less explored source of green energy is proposed and random sound energy around us can be treated as a source of electric power after their efficient conversion using suitable transducer is used to producing usable electric power from available random sound energy is presented here. In simple words, sound is the vibration of any substance can be air, water, wood, or any other material. The only place in which sound cannot travel is a vacuum. When these substances vibrate, or moving back and forth, they produce sound. Sound can be sensed through various types of sound sensors. Piezoelectric material is one of the most effective sound sensors. Piezoelectric transducers are used for conversion of sounds into electric energy. The word piezoelectricity means electricity resulting from pressure. Piezoelectricity is the charge that accumulates in certain solid materials (notably crystals and certain ceramics) in response to applied mechanical vibration. This piezoelectric effect is understood as the linear electromechanical interaction between the mechanical and the electrical state in some crystalline materials with no inversion symmetry. The piezoelectric effect is the process of internal generation of electrical charge resulting from an applied mechanical force. The resultant electric power was used to charge a rechargeable DC battery so as to store this energy. In this way, random sound energy from numerous sources around us can be stored as electric energy which can be used later to deliver electric power to drive compatible small loads. This proposed idea can give a new source of green energy and can contribute in global search for renewable energy. Piezomaterial converts mechanical strain into electric energy. This property of piezomaterial could be used to make a portable device which would be able to sustainably convert the sound energy.

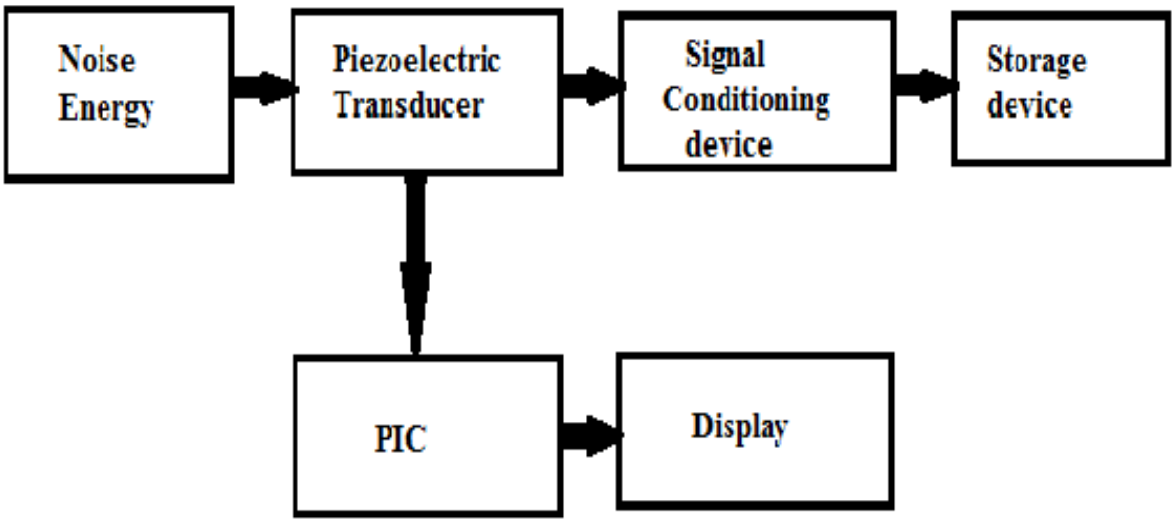

Fig1. Block diagram of Noise-Power conversion

This block diagram consist of noise energy, piezoelectric transducer, signal conditioning device, and storage device. The sound is naturally a mechanical wave which causes the vibration or Mechanical stress on piezoelectric crystal. When a piezoelectric material subjected to a mechanical stress which produces the voltage.

Output from the transducer is boost up by using signal conditioning device. The resultant voltage will be stored in a storage device like battery which can be further used to power up small devices.

TABLE 1

SOUND PRESSURE LEVEL – SPL

Sound Pressure Level	Sound pressure
115 Db	11.2 Pa
112 Db	7.96 Pa
109 Db	5.64 Pa
106 Db	3.99 Pa
103 Db	2.83 Pa
100 Db	2.00 Pa
97 Db	1.42 Pa
94 dB	1.00 Pa
91 dB	0.71 Pa
88 dB	0.50 Pa
85 dB	0.36 Pa
82 dB	0.25Pa

Law of thermodynamics mechanical energy could be converted into electricity. Piezomaterial converts mechanical strain into electric energy this property of piezomaterial could be used to make a device which would be able to sustainably convert the sound energy to electric energy as piezomaterial convert sound energy to electric energy. Transducer is used to convert Mechanical energy to electric energy. It can convert sound energy to electric energy. The simple use of transducer to convert sound to electric and vice versa is in speakers, headset...also it could be converted into electric energy.

II. METHODOLOGY

A number of piezoelectric transducers collected from acoustic electric guitars are used for conversion sound into electric energy. As these type of piezoelectric transducers are small enough, the produced voltage across the transducer using medium range of sound is also very small. In this experiment, a small buzzer was used as sound source which was operated by a 6 volt, 2 KHz sinusoidal wave. The resultant buzzer sound produces around 200 mV across the transducer. As this generated voltage is in ac form and noisy in nature, so as 1 farad super capacitor is used in parallel to the piezoelectric transducers for both filtering and storing the produced electric energy. The super capacitor, also known as electrical double layer capacitor is a relatively new technology. Super capacitors have the highest capacitance values per unit volume and have the greatest energy density compared with other capacitors. With their high capacitance values, super capacitors with up to 100F of

charge storage, are emerging as an alternative to batteries in applications where the importance of power delivery trumps that of total energy storage. One important feature of supercapacitor is, they can be charged very quickly whereas discharge slowly because of their much larger value in farad than conventional capacitors. This feature will be utilized in our proposed method for producing electric power from sound energy. Due to its quick charging characteristics, super capacitors can effectively store momentarily produced electrical energy through piezoelectric material from available sound energy. Due to its slow discharging characteristics, it can hold this stored electric energy for a longer time than usual capacitors, hence output from multiple super capacitors can be added easily.

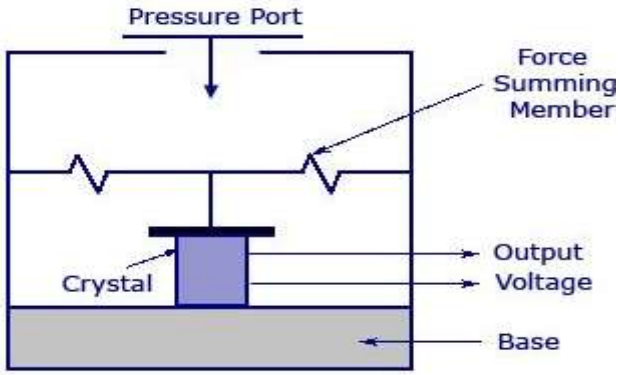

Fig.2 Piezoelectric Transducer

The principle of a piezoelectric transducer is that a kinetic force, when applied on the quartz crystal, which produces electric charges on the crystal surface. The charge that produced can be called as piezoelectricity. Piezoelectricity effect can be defined as the electrical polarization produced by mechanical strain on certain crystals. The rate of charge produced will be proportional to the rate of change of pressure applied as input. As the charge produced is very few amount, a charge amplification is needed so as to produce an output voltage large enough to be measured. The device is known to be mechanically stiff. For example, if a force of 20 KN is given to the transducer, it may only deflect to a maximum of 0.005mm. But the output response may be as high as 100KHz. This shows that the device is best applicable for dynamic measurement.

Piezoelectric transducer with a piezoelectric crystal kept between a solid base and the force summing member. If a pressure is applied on the pressure port, the same force will fall on the force adding member. Thus a potential difference will be generated on the crystal surface due to its property. The voltage produced is proportional to the magnitude of the applied force.

The conversion of electrical pulses to mechanical vibrations and the conversion of returned mechanical vibrations turned into electrical energy is the basis for ultrasonic testing. The active element is the most important part of the transducer as it converts the acoustic energy to electrical energy, and vice versa. The active element is basically a piece of polarized material (i.e. some parts of the molecule are negatively charged, while other parts of the molecule are positively charged) with electrodes fixed to two of its opposite faces. When an electric field is charged across the material, the polarized molecules each will align themselves with the electric field. In result, the induced dipoles inside the molecular or crystal structure of the material. The

alignment of molecules will cause the material to change dimensions. This phenomenon is also known as electrostriction. In addition, a constant polarized material such as quartz (SiO2) or barium titanate (BaTiO3) will produce an electric field when the material changes dimensions as a result of an imposed mechanical stress. This phenomenon is also known as the piezoelectric effect. Additional information on certain materials produce this effect can be found in the linked presentation material, it was produced by the Valpey Fisher Corporation.

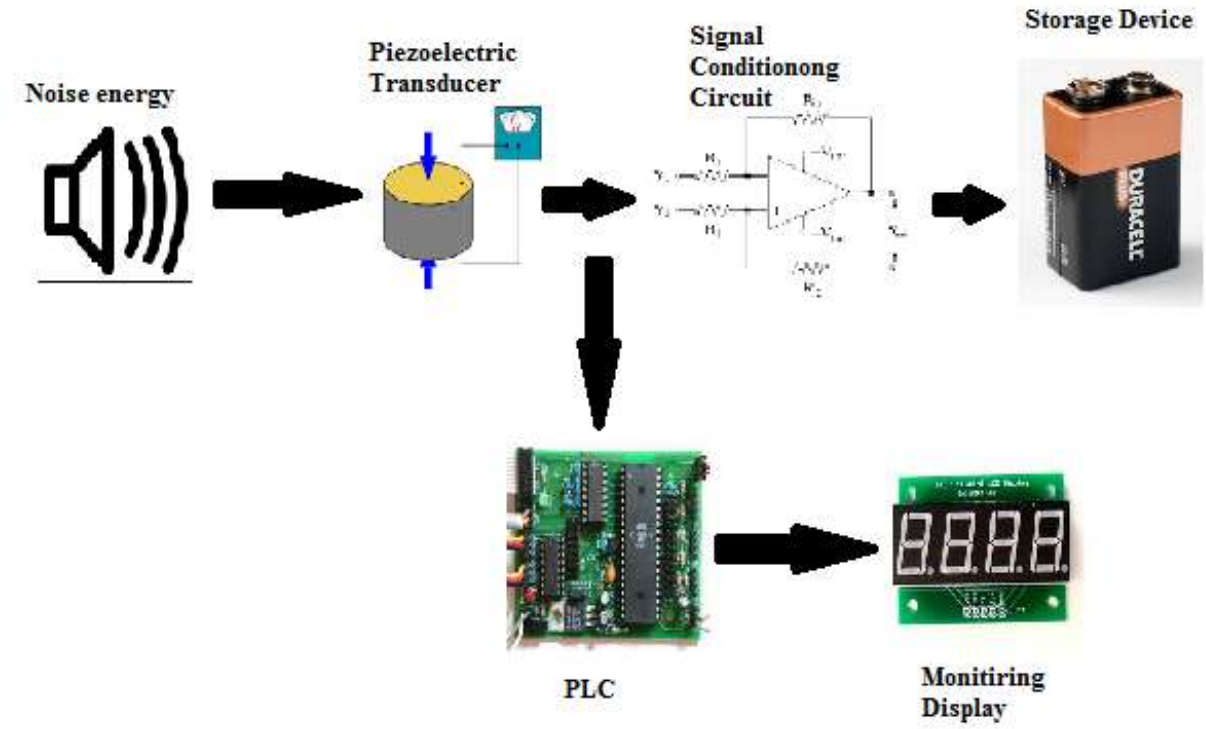

Fig.3 Schematic Diagram of Noise Power Conversion

The active element of most acoustic transducers are used today is a piezoelectric ceramics, which can be cut in various ways to produce distinct wave modes. A large piezoelectric ceramic element can be seen in the figure of a sectioned is low frequency transducer. Preceding the adventure of piezoelectric ceramics in the early 1950's, piezoeletric crystals obtained from quartz crystals and magnetostrictive materials were primarily used. The active element is still referred to as the crystal by old timers in the NDT domain. When piezoelectric ceramics are introduced, they became the dominant material for transducers due to their good piezoelectric characterestics and their ease of manufacture into a variety of modules and sizes. They also operate at low potential and are usable up to about 573K . The first piezoceramic in general use is barium titan ate, and that was followed during the 1960's by lead zirconate compositions, which are the most commonly employed ceramic for manufacturing transducers. New materials such as piezopolymers and composites are also being used in some applications.

The thickness of the active element is defined by the desired frequency of the transducer. A thin wafer element oscillates with a wavelength that is two times of its thickness. Therefore, piezoelectric crystal is cut to a thickness that is half the desired radiated wavelength. The higher frequency of the transducer, the thinner active

element. The primary reason that high frequency contact transducer is not produced is because the element is very thin and too fragile.

III. CONCLUSION

Multiple types of sounds are often produced around us from various sources. These random sounds play no role except producing noises for us. In this work, random sound energy around us is treated as a source of electric power after their efficient conversion through suitable transducer is producing usable electric power from available random sound energy is presented. Piezoelectric transducers are used for conversion of sounds into electric energy. The produced electric energy from piezoelectric transducers is stored in supercapacitors which are then summed up and amplified through adder and voltage multiplier circuits. In the resultant electric power was used to charge a rechargeable DC battery so as to store this energy. A small 6 volt DC battery was found to be fully power looms, factories, industries, laboratories, class rooms, etc… Sound produced from a running hydraulic pump and sound produced from construction piling. In all cases, it was found that battery can take charge from these sound sources through the proposed conversion circuit from a reasonable distance from the source. This distance varies depending on the nature and intensity of the tested sound sources. Using the proposed method, random sound energy from numerous sources around us can be stored as electric energy which can be used later to deliver electric power to drive compatible small apparatus. The proposed method opens the door of a relatively less explored source of green energy. It can give a new source of green energy and can contribute in global search for renewable energy.

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