# Conversion of Destructive Acoustic Energy into Useful Energy for Aircraft Internal Lighting system

### A. Bharathi[1], M. Avadi Ammal[2]

**ABTRACT-**This paper deals with the conservation of the destructive waste energy like noise and vibration produced in an aircraft while in air by the use of piezo-electric materials are piezo-electric actuators along with some smart nano particles are used to generate electricity. These being crystalline, can also act as absorbers of sound and vibration .piezo-electric materials can convert the energy produced by sound and vibration by running of engine while in air. In this system piezo-electric materials will be installed in the wings, vertical and horizontal stabilizers, engine cowling where there is maximum noise and vibration and it will be connected to a circuit. The circuit consists of noise absorbing amplifier along with other components used to carry the sound waves directly on the piezo-electric material. The pressure is created by suppression of material because of noise and vibration produced by engine. Thus the sensors will be installed which will determine this energy and convert it into electrical energy which can be stored in cells or can provide continuous electricity to offset the energy need of passenger cabin lighting system. Our study is also dedicated to the maximization of acoustic absorption and efficient power generation, but we can also smart foams to minimize the radiation of vibrating structures

*Key words: Acoustic energy, piezo-electric material lighting system*

## I. INTRODUCTION

Acoustic energy is a mechanical energy which travels in the form of wave. It is an oscillation of pressure which needs medium to travel through liquid and gas state. Through liquid and gas state sound is transmitted as longitudinal wave whereas through solid it could be transmitted as both longitudinal wave and transversewave. Longitudinal waves are of alternating pressure deviation from the equilibrium pressure, causing local region of compression and rarefaction, while transverse and wave alternating shear stress at right angle to the direction of propagation. When sound wave travel through a medium matter in that medium is periodically displaced and thus oscillates with sound wave. The sound wave displace back and forth between the potential energy of compression or lateral displacement strain of the matter and the kinetic energy of the oscillation. As sound energy is a mechanical energy it could be converted into electricity as mechanical energy could be converted into electricity by the law of thermodynamics. Sound energy could be converted into electricity but it is not highly efficient as the loss in conversion will be more whereas the other method is converting sound energy to electricity by piezo electric

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material, piezo electric materials are the crystal which converts mechanical strain to electric energy by such method. So we could see that sound is a form of mechanical energy and according to third law of thermodynamics mechanical energy could be converted into electric energy .So it could be seen that theoretically sound energy could be converted into electricity now we will view practically possible.

## II. Methodology

Sound is a mechanical form of energy which travels in the form of wave, mechanical wave that is an oscillation of pressure. This pressure created by the sound could be used to convert it into electric energy or other form of energy .also according to law of thermodynamics. Mechanical energy could be converted into electricity. Piezo material converts mechanical strain into electric energy this property of piezo material could be used to make a device which would be able to sustainably convert the sound energy to electric energy.

Some of the energy conversions are

1. Faraday's Electromagnetic induction

   Principle.

2. Newton's Thermal energy conversion

3. Piezo electric energy conversion.

4. The inverse Piezo electric energy Conversion.

As sound wave is a mechanical wave when it travels through a medium it disturbs the particle of the mediumthese disturbance created by sound could be used toproduce electricity.
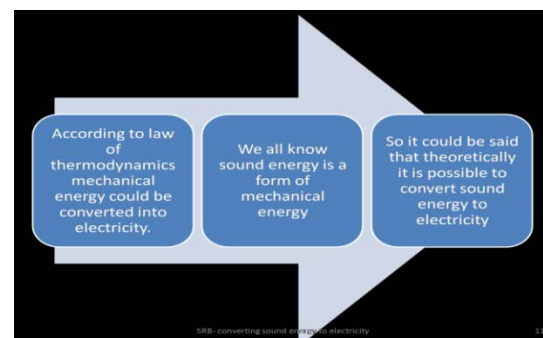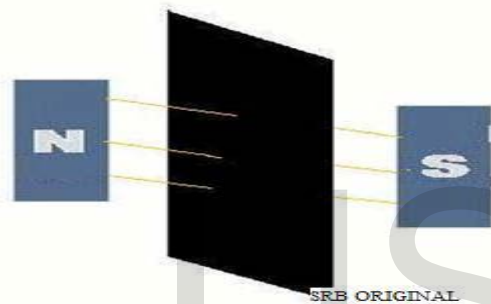


Fig.1.Converion of Acoustic Energy into Electrical Energy

METHOD 1 :Suppose we create a very thin curtain likediphagram which will get fluctuated by the oscillationdiphagram which will get fluctuated by the

oscillation and pressure created by the sound wave and a conductor will be attached to it which will be placed between magnetic bars these fluctuation in the curtain will create movement in conductor which will affect the magnetic field of the magnet this will generate motional EMF and will generate voltage across it. As per Faradays law generated EMF is given by

Generated voltage = EMF
 = (velocity of conductor) x (Magnetic field) x (length of conductor)

Thus the oscillation created by the sound wave could be converted into electrical energy and as the frequency is high the movement will be fast due to it we will get appreciable amount of electric energy. It would work similar as the working of turbine this type of device could be made. But its limitation will be that it will be efficient only in the place where high decibel of sound is available for example nuclear power plant, industries using huge and noisy machines.



Fig.2.Converion of Mechanical Energy to Electrical Energy

METHOD 2: In this method we could convert sound energy to heat energy as sound wave travel by oscillating the particles of the medium so when sound energy travel through the medium it will disturbs the particle of the medium these disturbance created by sound will be used to convert it into heat energy as when the particles of the medium will be pushed by the sound wave it will collides with adjacent particle of the medium this collision will result in production of heat energy the production of heat energy will be more in the denser medium so for more heat production we will need material with very high density. This heat energy will be converted into electrical energy.
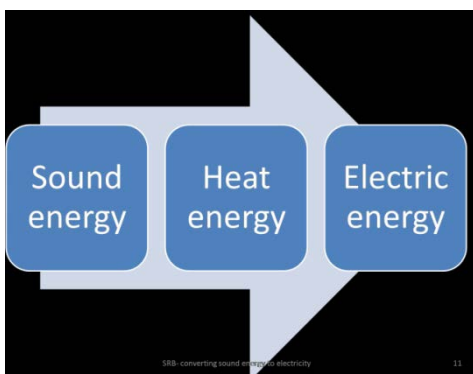


Fig.3.Converion of Mechanical Energy to heat energy into

Electrical Energy

This method is less efficient due to more energy losses taking place while conversion of sound energy to heat energy and then heat energy to electric energy then the other methods. As here the conversion is done two times.According to Newtown's law energy neither can be created nor could destroy .but it can be only converted from one form to another. So how there could be an energy loss. So while converting sound energy to heat energy there will be some loss of sound energy as some of the sound energy would be converted into another form also while converting from heat energy to electric energy all energy would not be converted into electric energy some of the heat energy would get converted into another form of energy. And here as our main focus is to convert sound energy to electric energy so conversion into other form of energy is loss of energy for us.

METHOD 3:Converting sound energy to electrical energy bypiezo electric material (piezo electric materials are the crystal which convert mechanical strain to electricenergy.Piezo electric materials are transducers its crystals could convert mechanical strain to electricity. They could convert mechanical strain to electricity, The crystals are formed naturally e.g. quartz, bone, DNAwhereas artificially ZnO , lithium niobatetLeadMetaniobate the sound energy could be converted into electrical energy using piezo electric material. Let us see the properties of piezo electric material.
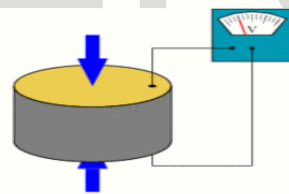


Fig.4.Piezo-Electric Effect

Certain single crystal materials exhibit the following phenomenon: when the crystal is Mechanically strained, (here sound energy) or when the crystal is deformed by the application of an external stress, electric charges appear on the crystal surfaces; and when the direction of the strain Reverses, the polarity of the electric charge is reversed. This is called the directpiezo electric effect, and the crystals that exhibit it are classed as piezoelectric crystal.
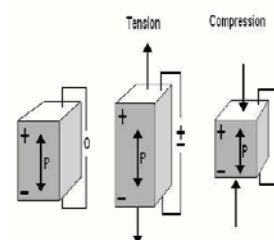
Fig 5.The direct piezoelectric effect

Inversely, when a piezoelectric crystal is placed in an electric field, or when charges are applied by external means to its faces, the crystal exhibits strain, i.e. The dimensions of the crystal Changes, When the direction of the applied electric field is reversed, the direction of the resulting strain is reversed. This is called the inverse piezo electric effect.
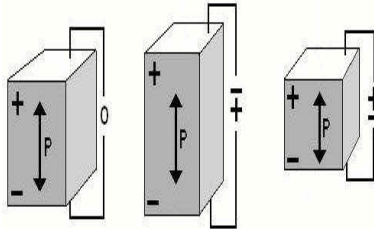
Fig.6 -The inverse piezo electric effect.

So it could be seen that when the sound energy is applied to the piezoelectric material it create strain in thecrystal then it reverse it and the strain is converted into electric energy. This direct piezo electric effect property of a piezo electric material could be used for making the device to convert sound energy to electric energy.

Piezo converter (srb )-a device could be made using piezo electric material which will collect the sound wave which are travelling near it and that sound wave will beused to cause a strain due to pressure created by its oscillation in the piezo crystal and that will create the disturbance in its atoms resulting in the flow of electric charge on the surface of the crystal thus sound energy could be converted into electricity as the piezoelectric material convert mechanical strain to electric energy. And thus this sound energy could be used to perform various tasks by converting it into useful electric energy.

If we will be able to convert sound energy to electric energy efficiently it could help us to reduce the scarcity of electrical energy globally and help in the development of mankind and reduction of $CO_2$as electric energy is one of the cleanest energy .The noise pollution in the road would be able to convert into electric energy and lights the street lightning ,signals and various other electricalappliancesThe noise pollution in runway could be used to produce electricity

**III Aircraft lighting system**

Attaching the piezoelectric materials to the surface of the aircraft where the maximum amount of noise is produced and converting it into electrical energy: Usually an aircraft faces 3 different kinds of noise during its flight
1. Aerodynamic noise, Engine and other mechanical noise, Noise from Aircraft systems.
2. Aerodynamic noise arises from the air flow around the aircraft fuselage and control surfaces. Aircraft Gas turbine engines, Propeller, main and the tail rotors are responsible for the production o f engine and other mechanical noise in an aircraft.
3. Cockpit and cabin pressurization and conditioning systems are often a major contributor to the production of noise from the aircraft systems.
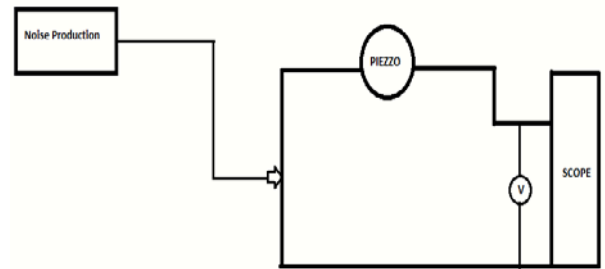
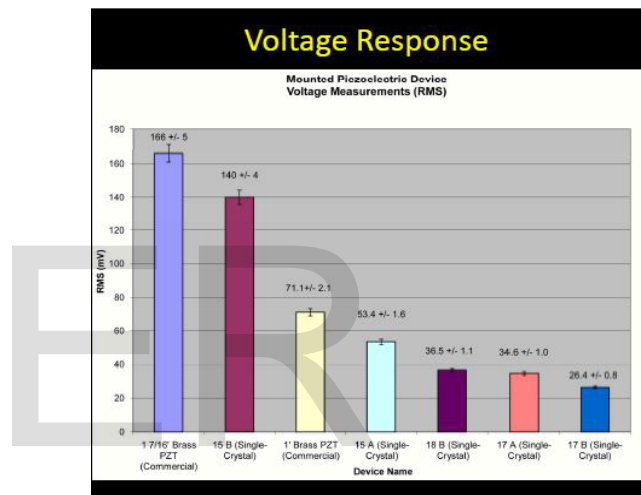**Figure.7.**Block Diagram for the conversion of noise into Electric scope

Fig.8. a Generic Approach towards the Conversion of Destructive Acoustic energy

The piezo electric materials are thus attached to these major parts for the absorption of the sound waves directly coming from these sources which can further be converted to electrical energy. One way is to attach a diaphragm on the piezoelectric crystals of the sound waves directly coming from these sources which can further be converted .The piezo electric materials are thus attached to these major parts for the absorption directly to the surfaces of the noise producing parts of the aircraft so that the vibration of the diaphragm due to sound waves pushes against the crystal, causing it to generate an electric current of variable voltage, the amount of voltage produced can be increased or decreased by the use of various transformers.

**IV Mathematical Description**

Piezoelectricity is the combined effect of the electrical behaviour of the material

**D= εE**
Where,

D-is the electric charge density displacement (electric displacement)

ε- is permittivity and

E-is electric field strength, and

Hooke's Law

$$\varepsilon = s\sigma$$

Where,

ε- is strain,

s- is compliance and

σ- is stress.

These may be combined into so-called coupled equations, of which the strain-charge form is

$$\{\varepsilon\} = [s^E]\{\sigma\} + [d]\{E\}$$

$$\{D\} = [d^t]\{\sigma\} + [\varepsilon^T]\{E\}$$

Where,

d-is the matrix for the direct piezo electric effect and

d (t)- is the matrix for the converse piezoelectric effect.

The superscript E indicates a zero, or constant, electric field;

The superscript T indicates a zero, or constant, stress field; and

The superscript t-stands for transposition of a matrix.

## V. SCOPE OF THIS PAPER

1. It can globally reduce energy scarcity as well as reduces $CO_2$ reduction.
2. All transport noises cold be utilized as useful energy.
3. All the power plant as well as all plant noise pollution can be converted useful energy.

## VI. CONCLUSIONS

The electricity produce in nuclear power stationcould increase as the sound produce during nuclear fission also could be used to get more electric energy .The noise pollution in industries could be used to produce electricity and work certain low voltage machine. Its scope does not end. As sound has enormous amount energy with it, it could be used by converting it into electric energy for various purposes. Sound energy is a mechanical energy so according to law of thermodynamics mechanical energy could be converted into electric energy. Sound energy could be converted by different methods.Due to their excellent electromechanical coupling characteristics and their ability to directly convert mechanical energy into electrical energy, piezoelectric materials have become the most attractive functional materials for sensors and actuators in smart structures.

This article presents the studies on applications ofpiezo electric materials in smart structures, including vibration control, noise control, energy harvesting, SHM, and hysteresis control on an aircraft. The material is attached to those parts where the maximum noise is produced like propellers, fuselage, aircraft gas turbine engine, rotors etc. So that the material faces a maximum amount of sound waves which results in the deformation of internal structure of the piezoelectric material giving rise to electrical energy.

## REFERENCES

[1] JinhaoQiu* and HongliJi** TheApplication of PiezoelectricMaterials inSmart Structures inChina, Int'l J. of Aeronautical &Space Sci. 11(4), 266–284 (2010) DOI: 10.5139/IJASS.2010.11. 4.266.

[2] Arjun A.M*, Ajay Sampath**,SandhyaThiyagarajan***, and Arvind V****A Novel Approach to Recycle Energy Using Piezoelectric Crystals,*International Journal of Environmental Science a nd Development, Vol. 2, No.6, December 2011.*

[3] Bhagavantam*Crystal Symmetry and Physical Properties*AcademicessPr (1966), London, New York.

[4] Opechowski, W. and Guccione, R., Magnetic symmetry, G. T. Radoand H.*Magnetism*, Vol. II/A, p. 105,Academic Press (1965) New York,SuhledsLondon.

[5] Piezo materials-(1.)Maelguennou-εεtitzeff