

A Generic Approach towards the Conversion of Destructive sound and Vibrational Energy into Useable Energy for Airplane Internal Lightning Systems

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Abstract

This project deals with the conservation of the destructive waste energy like noise and vibration produced in an aircraft while in air by the use of piezoelectric materials. Piezoelectric materials or piezoelectric actuators along with some smart nanoparticles are used to generate electricity. These being crystalline, can also act as absorbers of sound and vibration. Piezoelectric materials can convert the energy produced by sound and vibration by the running of engine while in air. In this system piezoelectric material 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 amplifiers along with other components used to carry the sound waves directly on the piezoelectric 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 use smart foams to minimize the radiation of vibrating structures.

1. Introduction

Piezoelectricity- it essentially transforms kinetic energy into electrical energy, and it is implemented in wide areas ranging from energy-generating trains to electronic circuits that recycle wasted heated energy. Piezoelectric materials are used for different sensing as well as for generating electricity from vibrations in road surface works. In the aerospace industry, piezoelectric components serve in moving parts of satellites, optical positioning and for onboard corrections. Naturally occurring Piezoelectric materials are: Berlinite, Sucrose, Quartz, Rochelle Salt, Topaz etc.

Sound is a mechanical form of energy which travel 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. Transducer is also used to convert Mechanical energy to electric energy i.e.it can convert sound energy to electric energy ,the simple e.g. of use of transducer to convert sound to electric and vice versa is in speakers, headset...also it could be converted into electric energy by other methods.

2. Sections

2.1 Methodology

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 i.e. Aerodynamic noise, Engine and other mechanical noise, Noise from Aircraft systems. Aerodynamic noise arises from the airflow around the aircraft fuselage and control surfaces. Aircraft Gas turbine engines, Propeller, main and the tail rotors are responsible for the production of engine and other mechanical noise in an aircraft. Cockpit and cabin pressurization and conditioning systems are often a major contributor to the production of noise from the aircraft systems.

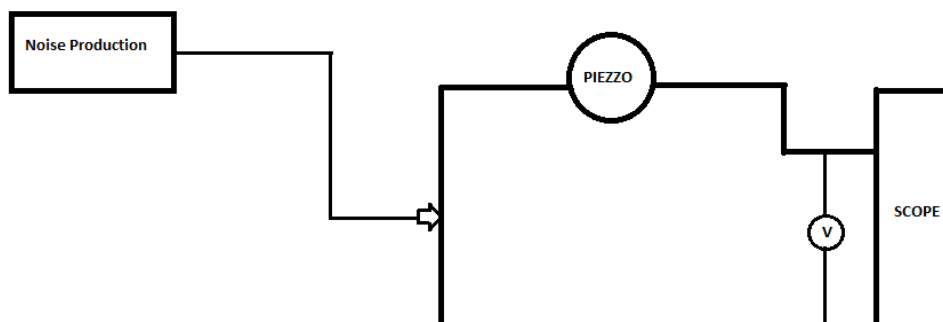
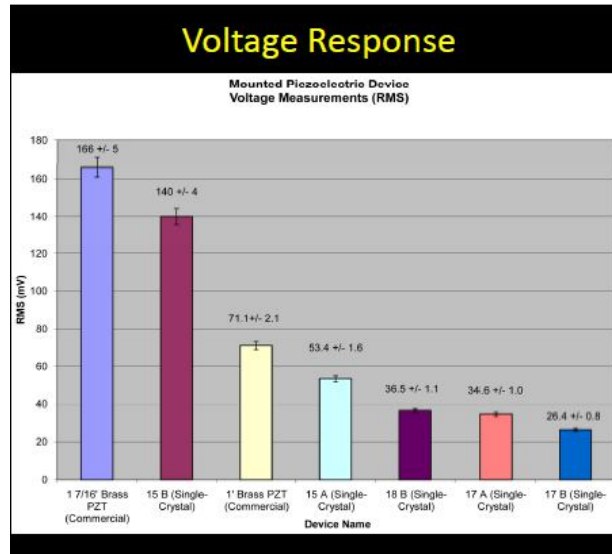


Figure 1: Block Diagram for the conversion of noise into Electric scope.



The piezoelectric 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 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.

3. Mathematical description

Piezoelectricity is the combined effect of the electrical behavior of the material:

$$D = \epsilon E$$

where D is the electric charge density displacement (electric displacement), ϵ is permittivity and E is electric field strength, and

Hooke's Law:

$$S = sT$$

where S is strain, s is compliance and T is stress.

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

$$\begin{aligned} \{S\} &= [s^E] \{T\} + [d] \{E\} \\ \{D\} &= [d^t] \{T\} + [\epsilon^T] \{E\} \end{aligned}$$

where d is the matrix for the direct piezoelectric 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.

4. Conclusions

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. In recent years, scholars in China have actively engaged in the research of smart materials and structure. This article presents the studies on applications of piezoelectric 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.

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