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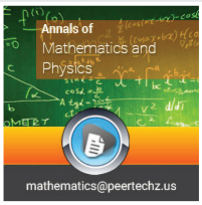

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Research Article

Sound Energy Harvesting and Converting Electricity (SEHCE)

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Abstract

The research study "Sound Energy Harvesting and Converting Electricity (SEHCE)" aims to create a better and easier way of producing another source of clean and renewable energy through sound. The study did not aim to be compared to other proven sources of electricity such as heat, wind, solar and hydroelectric, instead, it was created to find and explore new ways of producing an alternative source of energy. The project will undergo several processes such as designing, construction, testing, and evaluation. Through this, the researcher will be able to find out that sound energy can be converted to electricity.

Introduction

Background of the study

Harvesting clean energy from a renewable source of energy like the sound has been the belief of the researcher. Harnessing and producing electrical energy from the mechanical vibrations produced by sound is something that could be useful for everyone.

In the research study of "Evaluation of Electric Energy Generation from Sound Energy" by Mohana Faroug Attia [1], "law of conservation of energy," energy cannot be created nor destroyed. It can only transform from one form to another. Under the consideration of this law, people have discovered numerous ways how to reproduce and extract energy from sources and convert it into a source of power for conventional use.

There are various so-called eco-friendly sources of energy such as solar, wind, and heat energies which have been discovered and used until the present time. Some of them are being maximized under suitable circumstances to overcome and possibly prevent possible short runs of energy that have led energy needs to their highest.

Renewable sources of energy such as hydroelectric power, solar power, and wind power require too much financial investment but give poor power output with respect to their cost, over the years, there has been a growing interest in harnessing the power of mechanical vibrations and magnetism to generate electricity.

With the following thoughts, the researchers come up with a Sound Energy Harvesting and Converting Electricity (SEHCE) which can be used to gather sound energy (mechanical energy) and turn it into electricity. This project can be used for charging small electrical devices (cellular phones, power banks, flashlights, etc.); furthermore, it may be used to charge traffic signals, warning signals, and the like.

Statement of the problem

The purpose of the study is to transform sound into another form of useful energy.

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Specifically, it seeks to answer the following questions:

General Problem

Can sound be a source of electrical energy?

Sub-problem

1) How will the device harvest sound?

2) How is sound energy converted to electrical energy?

3) How much energy can the project produce?

Objectives

The study was conducted to find a possible way of producing electricity from other forms of energy, aside from solar, wind, heat, hydroelectric, etc. The study presents the effectiveness of sound energy as it is used to generate another form of energy (electricity). Moreover, the research exposed the utilization and sustainability of noise energy, being another source to produce clean electricity.

Significance of the study

The research "Sound Energy Harvesting and Converting Electricity (SEHCE)" will be beneficial for charging small electrical devices (cellular phones, power banks, flashlights, etc.) and it may be used to charge traffic signals, warning signals, and the like.

Through the project, the researchers will be able to expose and discover the effectiveness of sound energy as a source of clean and renewable source of energy. In addition to this, anyone can create electricity everywhere because the device is considered portable.

The project will be most effectively used in places that can produce so much sound (decibels) and mechanical vibrations. And, most of all, it does not cost too much.

Scope and limitations

The study was conducted at Tagaytay City Science National High School, Tagaytay City, Cavite, Philippines, from August 01 - October 22, 2017. The targets of the project are areas that lack a source of electricity. The project used to convert sound energy into a useful form of energy. It is also ideal in areas with a high rate of irregular vibrations – noise. Furthermore, the project device will only be able to power several electrical devices (cellular phones, power banks, flashlights, etc.).

Review of related literature

To give life to the study on the effectiveness of sound energy as an alternative source of electrical energy, the following presents the findings and other research studies related to the aforementioned project.

Based on the study of Siva Aditya Putrevu's and Sri Kumar Chaladi's [2] on the generation of electricity using sound, "the sound that is used as input is made to pass through the hollow cones in such a way that the sound propagated through the vibration of the molecules is 'pin-pointed' over to the wings of the turbine." The vessel is filled with a very stable gas like helium in order to have a very low pressure inside the vessel. They chose this as the speed of sound is higher in it.

Another study was conducted on the generation of electrical energy to sound energy [3]. Sound energy can be converted into a viable source of electric power using a suitable transducer. This can be done by using a transducer by converting vibrations caused by noise into electrical energy. The vibrations created by the noise can be converted into electrical energy through the principle of electromagnetic induction. The demonstrated ideas probe into a clean and readily available source of energy.

Furthermore, in the study of David Cohen-Tanugi [4], there is definitely energy contained in that sound. But the density of the energy is very low, and there is no way to capture it all. You have obscenely loud, continuous noise for harvesting to be worthwhile. It is more efficient to collect and store sunlight using solar panels than to harvest energy from sound because solar energy is converted to electrical energy directly by semi-conductors materials used in Photovoltaic (PV) panels.

The energy density in oil and gas is of higher magnitude, making generating power from those sources even more, cost-effective. Harvesting acoustic noise is more about mechanical vibrations than the sound itself. The idea is definitely there, and it's quite promising [5-16].

Materials and methods

The proposed project used a metal cone-shaped with a small diaphragm to vibrate and to move the sound inside the closed-vessel injected with helium gas. Helium gas was injected to make the kinetic energy of air molecules move faster. It also uses a large metal diaphragm to vibrate with solenoid and neo magnet where the electric current was induced.

Designing of sound energy harvesting and converting to electricity

The project is designed to harvest sound energy and convert it to generate electricity. It will use an iron metal cone-shaped diaphragm which sound energy will vibrate. Helium gas will be injected inside the closed vessel so that sound waves will radiate directly to the iron metal diaphragm, where vibration may cause the movement of the solenoid over the Neodymium magnet, where the electric current will be induced.

Testing

The Sound Energy Harvesting and Converting Electricity (SEHCE) will be tested to show the effectiveness of the device to convert sound energy into electrical energy.

The following conditions are to be tested:

- Amount of sound energy to vibrate the metal diaphragm, and move the coil side to side over the Neodymium magnet.

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- The Electromotive Force (EMF) produced in each pair of coil and magnet, and the total EMF produced from the project.
- Comparison of the relationship between the harvested sound and the amount of electricity produced.

Design of the proposed project

The noise from the environment enters the closed vessel through a small diaphragm which made the metal diaphragm vibrate and produce sound waves. The metal cone-shaped will help to amplify sound through the irregular vibration of the small diaphragm. The close vessel was injected with Helium gas to make the air molecules move faster, thereby increasing its Kinetic energy (KE) Figure 1.

When sound waves strike the large metal diaphragm it will move the solenoid over the series of Neodynium magnets. The movement of solenoid and magnet (Neo magnet), produces an electromotive force (emf) due to the process of Electromagnetic induction. The series of changing the movement of coils and magnet - speed, and changing electromotive force is generated.

Practical methods of conversion

The researchers came across various devices that serve similar purposes that are as converting sound to electrical signals. For example, a microphone is an example of a transducer, a device that changes information from one form to another. Sound information exists as patterns of air pressure; the recording engineer is interested in the accuracy of this transformation, a concept he thinks of as fidelity.

The basic idea is that sound is a mechanical wave. When it travels through any given medium, it disturbs the particles of the particular medium, and these disturbances caused by the sound can be used to produce electricity.

The efficiency of transducers and several such devices are quite low and cannot be used for practical applications. Thus, the major arena to focus on is how we can increase the efficiency of the electricity produced by the conversion of sound energy.

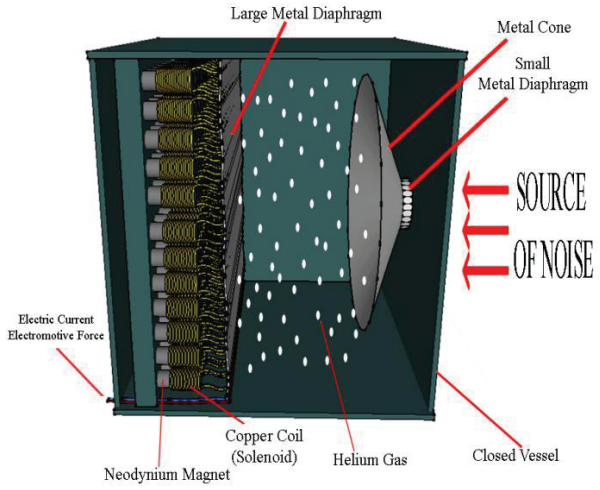

Figure 1: Proposed Sound Energy Harvesting and Converting Electricity (SEHCE).

The oscillation frequency is represented in Hertz (Hz) and the sound pressure level is represented by decibels (dB). Such electrical properties include voltage (V), Current (I), Resistance (R) and Power (P).

Mathematical analysis

The speed of sound travels at a constant speed of 332 m/s in a normal temperature of 27 °C of air and it increases by 0.6 m/s/ degree Celcius.

Since the study will be using Helium gas as one of the mediums in which the sound will travel, the equation for the speed of sound in an ideal gas is given by the relationship

$$V\,sound = \sqrt{\frac{\gamma RT}{M}}$$

where:

γ = adiabatic constant

R = gas constant

M = molecular mass constant

T = absolute temperature

- R = the universal gas constant = 8.314 J/mol K,
- T = the absolute temperature
- M = the molecular weight of the gas in kg/mol
- γ = the adiabatic constant, characteristic of the specific gas

For air, the adiabatic constant γ = 1.4 and the average molecular mass for dry air is 28.95 gm/mol. This leads to

$$V\,sound = \sqrt{\frac{1.4\,(\frac{8.314J}{mol}.K)}{0.02895kg\ /mol}}\sqrt{T}$$

This can be compared with the speed of molecules inside the device as a result of their thermal energy. For the specific example of dry air at 20°C, the speed of sound in air is 343 m/s, while the RMS speed of air molecules is 502 m/s using a mean mass of air molecules of 29 amu.

For helium gas, γ = 5/3 and the molecular mass is .004 kg/mol, so its speed of sound at the same temperature will be higher.

By doing so, this calculation for air at 0°C gives v_{sound} = 331.39 m/s and at 1°C gives v_{sound} = 332.00 m/s. This leads to a commonly used approximate formula for the sound speed in the air:

$$Vsound\ in\ air = 332\frac{m}{s} + \frac{0.6m}{s}T$$

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However, the assumption of an adiabatic constant of $\gamma = 1.4$ used in the calculation is based upon the diatomic molecules N_2 and O_2 and does not apply to water molecules.

In the study, the Electromotive force and current as output will be based on the speed of sound in the gas.

Furthermore, the induced Electromotive Force from the electromagnet will be based on three factors: a. magnetic field strength of Neodymium magnet, b. length of the copper wire (solenoid), c. and velocity of the movement of wire over the magnet.

Thus, we can calculate the amount of Electromotive Force (EMF) using the given equation:

$$Emf = BLv$$

where:

B is the magnitude of the magnetic field strength, express in Tesla, T

L= length of the wire, in m

V= the velocity of the wire, in m/s

The Electric current induced in the electromagnetic induction can be calculated based on three factors: Electromotive force, Magnetic field, and Length of the solenoid.

From the equation,

$$F = BIL$$

where:

F = Electromotive force

B = Magnetic field strength

L = Length of the solenoid

I = Current

Therefore, the current can be deduced into:

$$I = \frac{F}{BL}$$

And power output can be calculated as:

P = FI

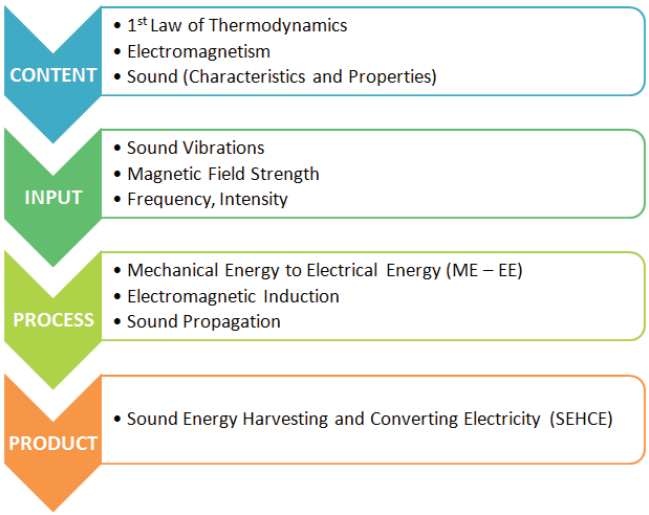
where:

P = Power

F= Electromotive Force

I = Current

Theoretical framework



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