



Study of conversion of Sound Energy into Electrical Energy

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ABSTRACT: In this paper we explore a less popular but useful source of clean energy i.e. Noise (Sound Energy). Waste form of sound energy can be used for some creative purpose. Random unwanted noise can be treated as a source of electrical energy which can be converted by a transducer. The output of a transducer is enhanced by the use of signal conditioning device. The resultant electrical energy is stored in a battery such that it can be used for further applications.

Keywords: component; formatting; style; styling; insert (key words)

I. INTRODUCTION

Renewable energy technique is the process of converting available ambient energy into usable electrical energy through the use of a particular material or transduction mechanism. So, one can imagine if we were able to convert the sound energy to electricity then we can charge our mobile phone just by talking to our friends on mobile itself.

According to the law of conservation of energy "Energy can neither be created nor destroyed, but it can be converted from one form of energy into another form of energy". In energy, harvesting technology, extracting unused or wasted energy from our environment and then converting such energy into usable energy has received considerable research interest. Electricity can be produced in a number of ways. Electricity can be formed from various sources such as Wind energy, Tidal energy, Solar energy etc. Since sound energy is a mechanical energy which travels in the form of a wave, and mechanical wave is an oscillation of pressure which requires a medium to travel i.e. it could not travel through vacuum as it needs medium. The sound waves displace back and forth between the potential energy of compression or lateral displacement strain of the matter and the kinetic energy of the oscillation. Sound which is tolerable by human ears has frequency ranging from about 20 Hz to 20,000 Hz. In air at ordinary temperature and pressure, the equivalent wavelengths of sound waves range from 17 m to 17 mm. The efficiency of the transducers and several such devices is quite low and cannot be utilized for practical applications. Thus, the major area to focus is how we can enhance the performance of the electricity formed by conversion of sound energy.

Waste form of sound energy can be changed and used for some productive purpose. Random sound energy or unwanted noise around us can be dealt with as a source of electrical power after their efficient conversion by the use of suitable transducer.

II. INTRODUCTION TO SOUND ENERGY

Sound is created by very fast back and forth movements known as vibrations. When we hit the drum the skin of drums vibrates and the movement of the drum skin forces air particles to be pulled back and forth. After a very small time the air particles are pushed together. The pulling and pushing of air particles continues till the drum skin comes to its idle position again. The energy produced by the vibrations of the drum skin is transferred to the air particles. So, the air particles come into motions the drum skin vibrates. The vibrating air particles collide with the other particles nearby, making them vibrate as well. If the energy is enough in the vibrating air, the vibrations are passed on to your ear. If the vibrations reach your ear, you hear sound.

We cannot actually see the sound but it does not mean we cannot measure it. We are fortunate enough that we can measure the sound. Actually, the sound can be converted into the electrical energy. It means that we can measure it how quickly it makes the air to vibrate and how much the air is compressed as sound passes. This tells us how high or low the sound is and how loud it might sound. The pitch of sound can be determined by the factor that how quickly the air is vibrating by the virtue of sound. The high-pitched sounds can make the air vibrate very fast and hence the air pressure changes quickly, as a result they produce bounced-up waveforms.

The Low-pitched sound makes the air vibrate less quickly, so the air pressure changes very slowly. The waveforms are more spread out. The number of times a sound makes air vibrate every second is known as its frequency. The frequency is measured in a unit called Hertz(Hz).

III. METHODOLOGY

A. Piezoelectric Effect

There are various methods by which sound energy can be converted to Electrical form. One way of conversion is by using Piezoelectric materials. Piezoelectric materials show basic (natural) polarization. Most of the piezoelectric materials are ceramic in nature. For example, barium titanate, but there are some polymeric materials that are used for special applications. Piezoelectric materials are usually polycrystalline materials that are categorized into sections of similar polarization (fields). Once they are aligned, these domains produce a net polarization. If an electric field is applied, the dipoles within the domains either contract or expand (producing a change in the volume). If a strain is applied, the dipoles are again forced to contract or expand, this time producing a potential difference. Piezoelectric materials have found applications as gas igniters, displacement transducer, actuators, delay lines, wave filters, and as producers of ultrasonic energy. Collections of piezoelectric elements have been used to yield ultrasonic imaging equipment. This link between electricity and mechanism forms the basis of the method for developing conversion technique. The Piezoelectric materials have established a platform for mechanical energy to be utilized in new ways such as productions of high voltages, electronic frequency generation and many other applications.

B. Piezoelectric Materials [1]

Piezoelectricity 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 heat energy. Piezoelectric materials are used for different sensing as well as for generating electricity from vibrations in road surfaces. 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, etc.

Piezoelectric materials play a vital role in generating power which range is microwatt to milliwatt. It is one of the most interesting methods of obtaining the energy surrounding a system is to use piezoelectric materials. This distortion created by various means are directly transformed to electrical charge by piezoelectric effect.

Use of Diaphragm

Another method of conversion is the use of a Diaphragm. In our daily life, we essentially come across many devices that help in the purpose that is they convert the sound to electrical energy. A microphone is an example of a transducer. It is a device that converts the energy from one form to another. Sound energy occurs as shapes of air pressure; the microphone changes this energy into the form of electric current. The basic property of sound is that sound is a mechanical wave. When sound travels over any medium then it disturbs the particles of that specific medium and these disturbances caused by the sound can be used to produce electricity. Suppose we create a very thin curtain like diaphragm which will get fluctuated by the oscillation and pressure created by sound wave. A conductor will be attached to it which will be placed between magnetic bars, these fluctuations will create a movement in conductor which will affect the magnetic field of the magnet. This will produce motional emf and will generate voltage across it.

IV. SIGNAL CONDITIONING DEVICES [2]

Many applications require environment changes from sensors such as temperature and vibration. These sensors, in turn, require signal conditioning before a data acquisition device can effectively and accurately measure the signal to be processed.

Signal conditioning devices provide more accurate sensor measurements and these system enhances the quality of a signal coming from a sensor. Common signal conditioning device is Operational Amplifier which is a high gain voltage amplifier. Transducers are another signal conditioning device used here which senses physical phenomenon like temperature and noise and convert it into electrical signal i.e. Voltage or current.

A. LTC 3108 [2]

The LTC 3108 is an Integrated Circuit which is a DC to DC convertor used for managing very small input voltages generated from the sources like Solar Cells. The LTC 3108 is an ultra-low voltage Step-up convertor. This IC operates at a minimum voltage of 20mv. It functions as a small step-up transformer which provides a power management solution for wireless sensing and data acquisition. The LTC 3108 uses compact step-up transformers which enhances the input voltages of order 20mV generated from the thermopiles, solar cells and TEGs.

This IC is designed for the charging and regulation of multiple outputs in which the average power drawn is

low, but there may be periodic pulses of higher load current required. An Oscillator convert the direct current (DC) into alternating current (AC). The LTC 3108 utilizes a MOSFET switch to form a resonant step-up oscillator using an external step-up transformer and a small coupling capacitor. The frequency of oscillation is determined by the inductance of secondary winding and ranges from 10 kHz to 100 kHz. For the input voltage of 20mV, the number of turn ratio from primary to secondary should be 1:100. As the input voltage increases from 20mV, the ratio of number of turns from primary to secondary decreases. The AC voltage produced on the secondary winding of the transformer is boosted using an external charge pump capacitor and rectified using an internal rectifier to the LTC 3108.

V. CONCLUSION

- Since sound is present in enormous quantity in nature therefore it can be utilized by converting into suitable Electrical energy.
- Sound energy can be converted by using various methods into Electrical form. This includes following methods:
- Method 1-by creating apparatus using curtain magnet and conductor
- Methods 2-by converting sound to heat and further to Electricity

- Method 3-by using transducers such as piezo electric material which converts mechanical strain to electrical and vice versa

VI. FUTURE SCOPE

-If sound energy is able to be converted into electric energy efficiently it could help us to reduce the scarcity of electrical energy across the globe. This helps in the reduction of CO₂ since Electrical energy is clean energy.

-The noise pollution in the road would be able to get converted into electric energy and lights the street lightning, signals and various other electrical appliances altogether.

-The noise pollution in runway could be used to produce electricity.

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