



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**SOUND ENERGY TO ELECTRICAL ENERGY: STUDY ON ITS
SUITABLE APPLICATIONS**

This report submitted in accordance with requirement of the Universiti Teknikal
Malaysia Melaka (UTeM) for the Bachelor Degree in Electrical Engineering
Technology (Industrial Power)(Hons.)

by

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920118-01-5163

FACULTY OF ENGINEERING TECHNOLOGY

2015

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: Sound Energy To Electrical Energy: Study On Its Suitable Applications

SESI PENGAJIAN: **2014/15 Semester 2**

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfilment of the requirements for the degree in Bachelor of Electrical Engineering Technology (Industrial Power) (Hons.). The member of the supervisory committee is as follow:

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ABSTRAK

Bunyi adalah suatu bentuk tenaga yang boleh diperbaharui. Dalam kajian ini, terdapat empat kaedah penukaran daripada tenaga bunyi kepada tenaga elektrik telah diperkenalkan. Penukaran ini adalah berdasarkan kepada hukum pertama termodinamik. Kajian ini adalah berkaitan dengan penjanaan kuasa yang melibatkan kos rendah dan mesra alam sekitar. Kajian ini bertujuan untuk mengkaji aplikasi yang boleh diimplimentasikan terhadap projek ini. Kajian lepas menunjukkan bahawa banyak aplikasi boleh menggunakan tenaga elektrik yang terhasil. Ini boleh membantu untuk memperkenalkan penggunaan empat kaedah yang digunakan dalam kajian ini sebagai penjana elektrik dalam kalangan masyarakat. Terdapat tiga perkara penting dalam menjalankan kajian ini. Pertama, membina sistem penukaran. Sistem penukaran perlu dikaji dengan betul berdasarkan jurnal yang berkaitan. Kedua, data akan dikumpulkan berdasarkan beberapa pembolehubah seperti jarak, jenis sambungan dan sebagainya. Perkara seterusnya adalah aplikasi yang sesuai untuk menggunakan tenaga elektrik ini mesti ditentukan. Projek ini menawarkan penjanaan elektrik yang bebas daripada apa-apa bekalan kuasa luar. Kajian ini juga memberi tumpuan kepada aplikasi projek ini untuk menyedarkan masyarakat bahawa pencemaran bunyi juga boleh memberi manfaat kepada dunia dari segi penjanaan tenaga elektrik. Secara keseluruhannya, kajian ini dapat membantu dalam meningkatkan taraf hidup manusia. Diharapkan juga agar projek ini mesti dimiliki oleh setiap rumah di seluruh dunia kerana kosnya yang murah dan fungsinya yang sangat berguna kepada manusia.

ABSTRACT

Sound is a form of renewable energy. In this study, there are four methods of conversion from sound energy into electrical energy has been introduced. This conversion is based on the first law of thermodynamics. This study is related to power generation that involved low cost and environmental friendly. This research aimed to study the applications that could be implemented to this project. Past researches showed that many applications could use the electrical energy generated. These could help to introduce the use of four methods used in this study as an electric generator in the community. There are three important things to conduct this research. Firstly, develop the conversion system. This conversion system must be studied properly based on the related journal. Secondly, data will be collected based on a few variables such as distance, type of connection, and others. The next thing is appropriate applications to use this energy must be determined. This project offered the generation of electrical energy independently from any external power supply. This study also focused on the applications of this project to make the society realized that the noise pollution also give benefits to the world in term of electrical generations. Overall, this study can help in improving the standard of human life. Hopefully that this project must be owned by every household around the world because of its low cost and its functions those are very useful to humans.

DEDICATION

Specially dedicated to my family

ACKNOWLEDGEMENT

First of all, I would like to thank to Allah s.w.t.because let me breath until this day to complete this Bachelor's Degree Project for 2 semester.

I also would like to thank to my parents and my siblings for their full support in making this report.

Not forget also to my supervisor, Engr. Asri bin Din for giving guidance to me in solving problems encountered during the completion of this project.

Last but not least, thank to all FTK lecturer and friends who helped me in completing this study.

Thank you

Hafizuddin Bin Othman

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

mW	=	milliWatt
cm	=	centimeter
v	=	volt
dB	=	decibel
dc	=	direct current
ac	=	alternating current
PMPH	=	Piezoelectric Micro-Power Harvester
V _p	=	Peak voltage

CHAPTER 1

INTRODUCTION

1.1 Background

Sound is a wave that is used to send orders, instructions or warnings to a party. The sound produced by a vibration process of an object. Sound is a mechanical wave that carried over medium such as air, and addressed to the relevant parties. Usually the sound properties can be studied through its characteristics such as amplitude, frequency, speed, direction, pressure and others. Sound strength is usually measured using the unit decibels, hertz, sone, phon and others.

Humans are also involved in the production of sound. Conversation between two people is an example of the process of production, transmitting and receiving sound waves. Humans produce sound through the vibration of the vocal cords caused by gusts of wind in the larynx. At the receiver, the ear is the organ that is used to receive the sound signals. Sound waves will be captured by the conch and went into the ear hole. In the port there are eardrum that will vibrates when hit by pressure sound waves. Cell receptors would receive a sound signal; then transmitted to the brain for interpretation process.

Sound energy can also give positive effects on humans. According to a study conducted by Dr. Alfred Tomatis (1920 - 2001), the sound can change a person's mood and give peace to the mind. The process which called music therapy is commonly used and practiced by people who are very busy with their daily activities and often experience stress due to the problems encountered.

But now, the sound are often considered negative and harass someone. Many people are not willing to live in developed areas because of noise pollution are rampant and uncontrolled. This situation can be seen by comparing the atmosphere in the village to the city. Usually, the village is more calm and peaceful and away from the noise. By contrast, the atmosphere in the city is often contaminated with noise, no matter during day or night.

Based on the Factories and Machinery (Noise Exposure) Regulation 1989, level of exposure to noise must not exceed 90dB for employees who work 8-hour shifts, not exceeding 115dB for intermittent noise and not exceeding 140dB for the impulsive noise. This regulations are actually created to protect the safety and health of the employees while at workplace where are exposed to excessive noise. The work area that are not likely to comply with this regulation may result in lose hearing for life of their workers.

Sound energy has its own advantages and disadvantages. Sound reproduction should be controlled so as not to disturb others. There are certain places that should be avoided by people because of exposing to excessive noise. Various ways and alternatives that have been used to fully optimize the noise and thus give benefit to all mankind.

1.2 Problem Statement

These researches are based on several problems that arise in human's daily life. Firstly, noise pollution. This noise pollution is a result of human daily activities such as heavy industry, breakdown maintenance, construction work, traffic jams and so on. This noise pollution gives negative effect on humans, both physically and emotionally. This noise pollution is also often considered offensive to all parties and does not provide any benefit. To deals with this problem, this pollution can be converted into electrical energy, thereby benefiting all mankind. However, the conversion process is best done in places with high intensity of sound only.

Secondly, conventional energy sources will be depleted to a great extent. Conventional energy sources are generally referred as non-renewable source such as coal, crude oil, natural gas and others. These sources are used as fuel to generate electricity. These sources are used since a long time ago and very finite. Nowadays, scientist has conducted many researches to minimize the use of this non-renewable source and replaces it with renewable energy sources. This is very critical issue because most likely the next generation will not be able to enjoy the use of this non-renewable source if there are no precautions taken immediately. Therefore, the use of sound energy as a renewable energy source in power generation is very appropriate in helping to maintain conventional energy sources that still remain.

Thirdly, the four methods used for the conversion from sound energy to electrical energy are not among the well-known method or device to generate electricity. This is because the methods are only capable of producing low output voltage at a time. People also do not realize that the uses of four methods that are discussed in this report are actually able to facilitate human life and reduce electric costs. Therefore, the study of these four methods must be done to open the eyes of the society to see the sound energy as a gift and could improve people's lives.

1.3 Objectives of Project

- There are several objectives to be achieved through this study. Firstly, this study focuses on possible method to convert sound energy to electrical energy. Now there are various ways to generate electricity. As mention earlier, there are four methods of conversion from sound energy to electrical energy covered in this research; that's are Electromagnetic Induction – Speaker, Portable Piezo External – Drive, Enormous Piezo Self – Drive, and Portable Piezo Beam. Based on these methods, some variables are varied to analyze the performance of the four methods. Among the aspects that need to be taken care of during conducting this research are the total production of electrical energy, the ability to apply sound energy completely, and others.

- Secondly, this study sets out to develop conversion system. This conversion system is equipped with a number of components such as operational amplifiers, diode, capacitor and more. These components will serve to convert sound energy into electrical energy. This conversion system must efficiently in terms of equal amount of input and output; and no wasted energy.
- Thirdly, this study investigates to determine the suitable application that can be applied to this project. The appropriate application must be reviewed and considered based on their power consumption to be operated. The application must operate with low voltage such as led lights, 5V fans and others.

1.4 Scope of Project

- ❖ This project focuses on the four methods. From these methods, one of them is basically using an electromagnetic-induction process. The remaining method are basically consists of piezoelectric component. Piezoelectric is one of the appropriate devices to convert sound energy into electrical energy. The working principle of a piezoelectric is involving linear electromechanical interaction between the mechanical and the electrical state. Piezoelectric is chosen because its only requires a low mechanical energy such as sound energy to move it.
- ❖ This research will cover on conversion circuit. The function of this conversion system is to convert ac to dc and boost the output voltage; make it suitable for use in a particular application.
- ❖ These researches also cover the appropriate application. The electrical energy that full enough, stored in the batteries will be use to energize an appropriate application using this power. These applications should consist of electrical loads that used a low voltage such as a lighting circuit.

1.5 Significant Contribution

These projects are able to give benefit to the industry in which the sound energy that produced in the plant can be converted into electrical energy, thereby reducing the cost of electricity bills. Many applications in factories can use the electricity from this conversion system.

This project was also able to reduce the consumption of non-renewable source to generate electricity. Although its output voltage is very small, but if the project is carried out on a large scale, then its output voltage will also increase drastically. This will also give benefit to future generations to enjoy conventional energy source that is getting decreasingly.

This project is also environmentally friendly and does not pollute the environment. Unlike the other method of producing electrical energy that need to change the geography of the earth. For example, the construction of the dam to accommodate hydroelectric generation has resulted in the destruction of forests on a large scale.

This project is also very useful to society today where electricity consumption is very important. This project is portable, where they can be implemented anywhere regardless of time and place. The project was also able to work when the power failure because the project is not dependent on external source to work. In other words, this project will improve the living standards of society.

1.6 Summary

This chapter describes the introduction of this research. Firstly, the basic knowledge of sound has been presented. Sound is the most important element in this study. Secondly, the problem statement has been reviewed. This problem statement describes the main reason why this kind of project has been chosen or conducted. Thirdly, the objectives of this project have been stated. These objectives are the

things that will be achieved throughout this research. Fourthly, the scope or the limitations of this project has been discussed. This will help to narrow down the field of this study for better understanding. Lastly, all the benefits from this study have been discussed in the project significance section. This project has been found to be beneficial to all level of mankind.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This section will present the other researches that have been conducted by several people regarding to the conversion of sound energy to electrical energy using piezoelectric transducer. This section is divided into several components where each components will contains one or more journal. The main objective of this section is to compare the research between journals and combined the idea obtained. As the result, a great idea will be arise to completing this project

2.1.1 Objective

Objective of certain journals are very important because it describes what are going to be achieved throughout the research that has been conducted. Here some objectives are reviewed to get some idea and inspiration. Alrashdan, Majlis, Hamzah, and Marsi (2013) has conducted research on Piezoelectric Micro-Power Harvester (PMPH). PMPH is designed to harvest maximum output power available in environments. So they are interested in PMPH motion and its shape in one single mode where the maximum displacement and hence maximum mechanical energy harvesting and maximum output power occur (Alrashdan, Majlis, Hamzah, Marsi, 2013). This is the objective of PMPH. It aims to capture maximum sound energy and convert it to electrical energy. Paper researched by J. Dicken, Mitcheson, I. Stoianov, and E.M. Yeatman presents a systematic analysis and comparison of all the principal types of power extraction circuit that allow this damping force to be increased, under

both ideal and realistic constraint (J. Dicken, Mitcheson, I. Stoianov, E.M. Yeatman). This section stated that the objective of this paper is to compare of all the principal types of power extraction circuit which allow the increasing of damping force. In this paper they review and compare these circuits in terms of the power densities that can be achieved under both ideal and realistic constraints, and identify which provide the best performance under specific conditions. They also discuss a circuit that has the potential to perform best overall operating conditions called single-supply pre-biasing, the purpose of which is to avoid the need for the open-circuit voltage to overcome diode drops by using a minimal number of synchronous rectifiers. This allows effective operation of an energy harvester even for low-amplitude input vibration. The objective of this paper is to determine the best circuit under specific conditions. It also stated that when using single-supply pre-biasing, it allows effective operation of an energy harvester even for low-amplitude input vibrations. The objective of the research conducted by Geoffrey K. Ottman, Heath F. Hofmann, Archin C. Bhatt, and George A. Lesieutre (2002) described herein was to develop an approach that maximizes the power transferred from a vibrating piezoelectric transducer to an electrochemical batter. Here it describes the objective of this research; that is to get maximum power transfer from the piezoelectric to the rechargeable battery. This paper presents an adaptive approach to harvesting electrical energy from a mechanically excited piezoelectric element. The dc–dc converter with an adaptive control algorithm harvested energy at over four times the rate of direct charging without a converter. Furthermore, this rate is expected to continue to improve at higher excitation level (Geoffrey K. Ottman, Heath F. Hofmann, Archin C. Bhatt, George A. Lesieutre, 2002). This part explains the objective of this research. Its aim is to develop very efficient circuits that are able to transfer electrical energy from piezoelectric transducer to rechargeable battery.

2.2 Problem Statement

A research is conducted because several problem arise and this problem will become as guidance to proposed a method. Here are some problem statements taken from a few journals. Jamal, Hassan, Das, Ferdous, and Lisa (2013) stated that fuel is